Network for Greening the Financial System

Energy investments in the NGFS long-term scenarios phase V

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Summary

This report assesses global and regional energy investment needs under the NGFS Phase V long-term scenarios, benchmarked against historical investment data from the International Energy Agency (IEA) and BloombergNEF (BNEF). The NGFS scenarios results for 2025 are broadly in line, although they do not exactly match the numbers from BNEF and IEA due to differences in scope, methodology, and assumptions. The report provides forward-looking comparisons of investment trajectories to inform central banks, financial institutions, and policymakers of the structural and regional allocations of investment capital required to achieve climate objectives aligned with the Paris Agreement.

The analysis compares investment volumes globally and across three aggregate world regions, categorized by per-capita income levels, under three illustrative scenarios:

- Current Policies (CP): assumes no additional strengthening of climate policies beyond current legislated policies.
- Fragmented World (FW): reflects delayed and uneven climate actions across different regions globally.
- Net Zero 2050 (NZ): assumes immediate, coordinated global actions to limit global warming to 1.5 °C, aligning with the Paris Agreement.

Based on the results of Phase V of NGFS long-term scenarios, which were released in November 2024, the report finds:

- Current total energy investment levels are insufficient to deliver a Paris-aligned transition. However, the recent, very fast upscaling of clean energy investments means that trends in particular sectors and regions have already achieved the scale of investment required.
- Further upscaling is particularly needed in lower-income regions and electrified transport solutions.
- Achieving the NZ scenario will require a major reallocation of capital, particularly into electric vehicles (EVs), grids, and renewables, with a global investment upscaling to USD 5 trillion by 2050 compared to 2025.
  - EVs: USD 3 trillion (67%)
  - Power grids: USD 1 trillion (19%)
  - Renewables at USD 0.7 trillion (14%)

Future NGFS work will enhance scenario granularity, refine regional mappings, and integrate macro-financial risk assessments to strengthen the analytical foundation for climate-aligned investments.

1. Introduction

Emissions from the use of fossil fuels are a key contributor to anthropogenic climate change, and thus any efforts to stabilize the climate in the coming decades require a profound transformation of the energy system. While it is still dominated by fossil fuels today, numerous academic studies[1], assessments[2], and the NGFS scenarios[3] show that a shift to a system dominated by renewables and other low-emissions technologies is possible over the next three decades. While not incurring fuel costs, most low-emissions technologies are capital-intensive, which implies a large requirement for investments in the coming years.

The purpose of this report is to provide a detailed analysis of the energy investment results in the NGFS scenarios, which can be used for broader analysis of the macro-economic and political implications and requirements of these pathways. The NGFS long-term scenarios include a granular description of system transitions provided by three Integrated Assessment Models (IAMs); GCAM, REMIND-MAgPIE and MESSAGEx-GLOBIOM. The report analyzes the latest NGFS scenarios published at the end of 2024, and with a three-region global differentiation that provides a first-order insight on regional differences. The NGFS energy investment variables are similar to the set covered in the latest IPCC assessment report (section 3.6.1 of Riahi *et al.*[2] and section 15.4.2 of Kreibiehl *et al.*[4]). This report also provides a comparison with the latest data on energy investments from the IEA[5] and low-emissions energy investments from BNEF[6].

The next section discusses the definitional differences between investment data from the NGFS scenarios versus the IEA and BNEF categories, by analyzing the data for 2024 and 2025. The subsequent section discusses in detail (1) the differences in investments across the three scenarios, Current Policies (CP), Fragmented World (FW), and Net Zero 2050 (NZ), and (2) the gap between current investments and those needed for a Net Zero transition, including at a regional level.

1 Luderer *et al*. 2018. "Residual Fossil CO_2 Emissions in 1.5–2 °C Pathways." *Nature Climate Change* 8 (7): 626–33. https://doi.org/10.1038/s41558-018-0198-6.

2 Riahi *et al*. 2022. "Mitigation Pathways Compatible with Long-Term Goals.", 295–408. Cambridge, UK and New York, NY, USA: Cambridge University Press. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter03.pdf.

3 NGFS 2024: NGFS long-term scenarios for central banks and supervisors https://www.ngfs.net/en/publications-and-statistics/publications/ngfs-climate-scenarios-central-banks-and-supervisors-phase-v Richters *et al*. 2024. NGFS Climate Scenarios Data Set (5.0) [Data set]. Zenodo. https://doi.org/10.5281/zenodo.13989530.

4 Kreibiehl *et al*. 2022: Investment and finance. 295–408. Cambridge, UK and New York, NY, USA: Cambridge University Press. https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter15.pdf.

5 IEA 2024: World energy investment 2024: https://www.iea.org/reports/world-energy-investment-2024/ and IEA 2025: World energy investment 2025: https://www.iea.org/reports/world-energy-investment-2025/.

6 BNEF 2025: Energy transition investment trends: https://about.bnef.com/energy-transition-investment/.

2. Energy-Investment accounting in NGFS scenarios compared to historic data from BNEF and IEA

Currently, the overall scale of energy-related investments is in the order of USD 3 trillion annually, or around 3% of global GDP in 2024, which is roughly double the absolute investment seen in 2015. The exact number varies by source and corresponding definitions, which is due to the fuzzy delineation of what 'energy-related' includes across sources. Therefore, it is helpful to compare the disaggregated components of energy investments across different studies (Figure 1). This report identifies three broad categories of investments: those into **Energy Demand Equipment**, into **Fossil-related Energy Supply**, and **Non-fossil Energy Supply**[7]. The NGFS scenarios results for energy investments for 2025 do not exactly match the numbers from BNEF/IEA. The reason is that the 2025 time step was a modeling period for the Phase V scenarios, and assumptions on technology cost, energy demand, and retirement of existing capacities differ across models.[8]

In the Energy Demand equipment category, it is often difficult to isolate the portion of investment in vehicles, buildings, and industrial equipment that is specifically attributable to energy efficiency improvements and electrification. Estimates of total investment in 2025 range from USD 300 billion (in the IEA and NGFS MESSAGEix-GLOBIOM) to USD 1,000 billion[9] (in NGFS REMIND-MAgPIE and GCAM that account for both efficiency investments and electrified transport). In the NGFS scenarios, post-processed investment reporting includes an aggregate estimate calibrated to the IEA's economy-wide investment figures, which are themselves based on detailed assessments of the additional cost associated with energy-efficient technologies. To complement this, this report includes sector-specific estimates of total investment in EVs, which enables comparisons with corresponding data from BNEF (but are only available for the REMIND-MAgPIE and GCAM models). These estimates reflect the full vehicle purchase price and therefore exceed the strictly energy-related component. However, from a macroeconomic perspective, particularly when assessing capital requirements, this broader investment figure is relevant. It also highlights the scale of opportunity for the automotive manufacturing sector.

Because the EV investment figures partially overlap with energy efficiency estimates, adding the two categories together results in some double-counting (estimated to be one-third of the "energy efficiency" components, or about USD 100 billion). Depending on the analytical context, it may be necessary to adjust for this overlap in total investment calculations.

Fossil fuel-related supply investments amount to USD 0.7 – 1.3 Trillion. These near-term estimates for the NGFS scenarios are largely post-processed based on the IEA data, ensuring a good match between the two sources. Most of those investments relate to oil and gas production.

Non-fossil energy supply investments are of a similar magnitude and now also amount to USD 0.8 – 1.2 trillion in 2025. This is due to the recent growth of investments into dedicated low-emissions electricity generation technologies like solar and wind, but also the growth of investments into electricity grids and storage, which are a key enabler for decarbonization.

A key point for climate negotiations is the availability of finance for the investments required for the successful transition, and various reports have highlighted the current regional imbalance of low-emissions investments. In order to provide robust and relevant information about regional investment patterns in the NGFS scenarios, this report analyzes investments for three different world regions (Figure 2), broadly following the World Bank classification[10] of countries, but aggregating the lower two tiers of their four-tier system ('Low income' and 'Lower-middle income' are aggregated to what this report calls

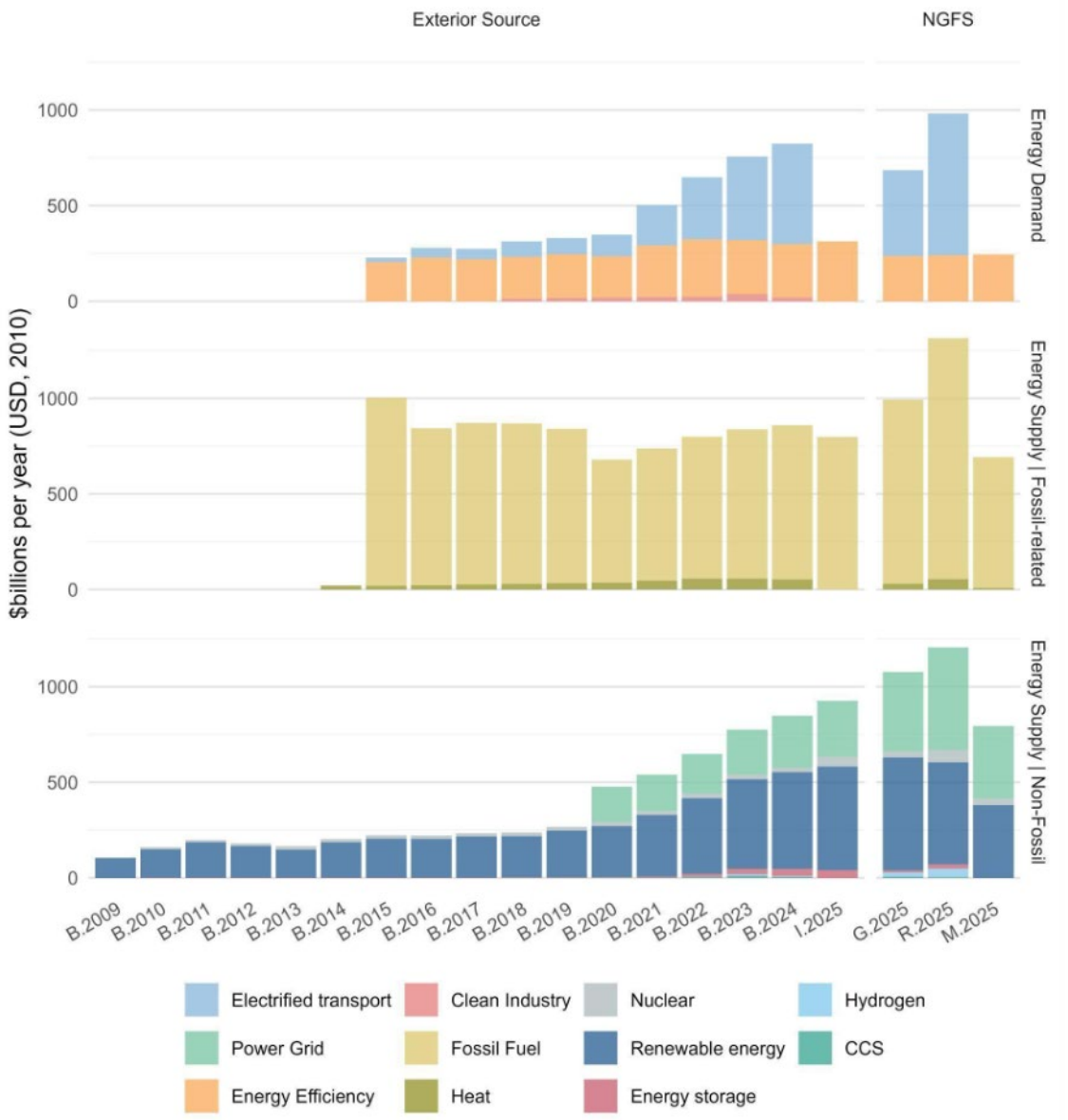
7 **Energy Demand** consists of investments into Electrified Transport, aggregate Energy Efficiency and Clean Industry. **Fossil-related Energy Supply** consists of investments into Fossil Fuel and Heat provision. **Non-fossil Energy Supply** consists of investments into Power Grid, Nuclear, Renewable energy, Energy storage, Hydrogen and Carbon capture and storage (CCS).

8 The 2026 update of NGFS scenarios will have improved calibration of near-term trends.

9 All monetary values refer to US$2010, as reported on NGFS database https://data.ene.iiasa.ac.at/ngfs/.

10 https://blogs.worldbank.org/en/opendata/world-bank-country-classifications-by-income-level-for-2024-2025.

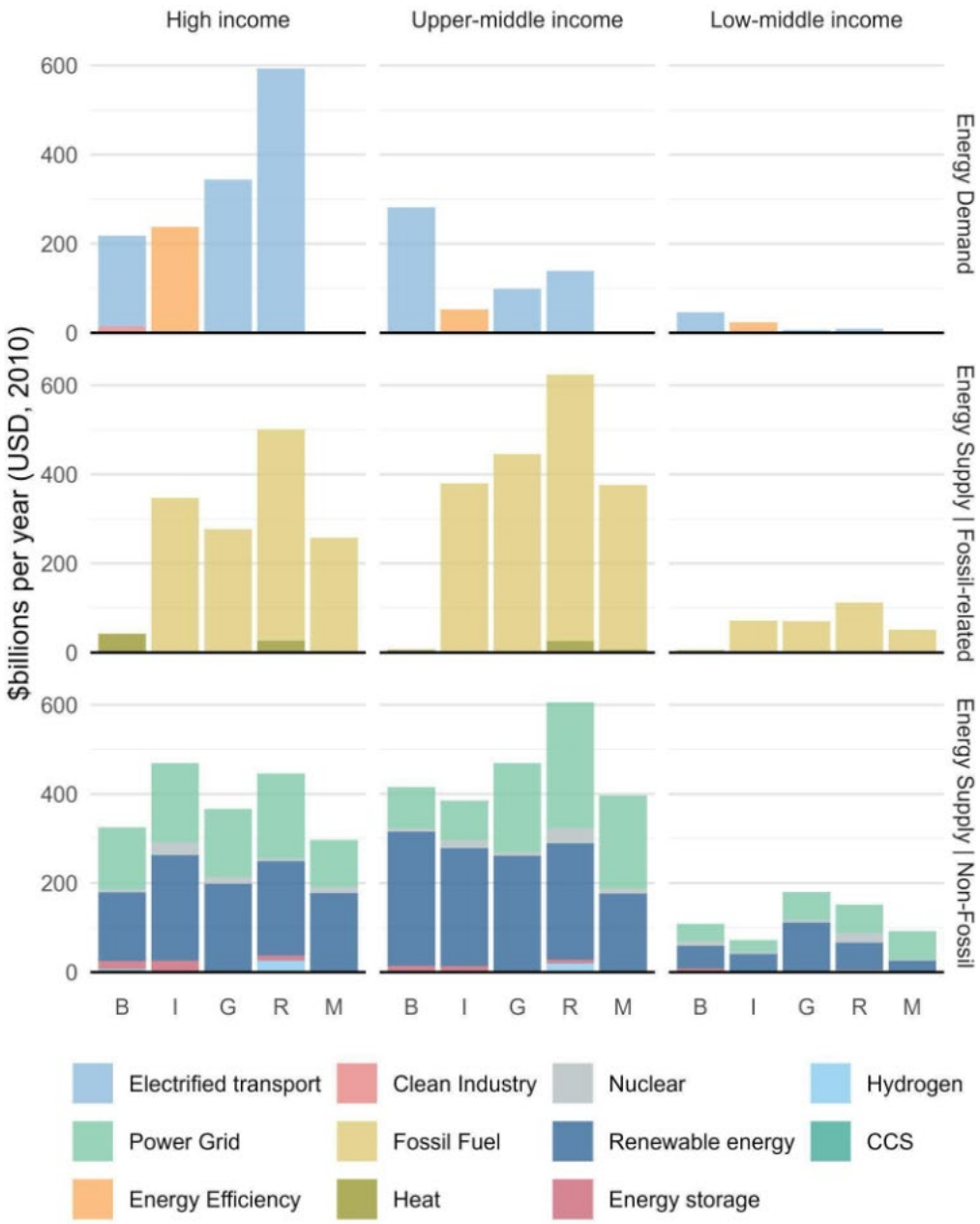
Figure 1 **2009-2025 Energy investment: World**



Notes: Global energy investment comparison in 2025 in the three NGFS models ("G": GCAM, "R": REMIND-MAgPIE, "M": MESSAGEix-GLOBIOM) compared to data from the IEA for 2025 ("I"), and combined BNEF and IEA data ("B") from 2009 to 2024. (Note: Investment data of fossil fuels and energy efficiency in BNEF is supplemented with IEA data for the World region to ensure complete sectoral coverage, with minimal double-counting of transport investments, see text above.).

'Low-middle income'). This level of aggregation is detailed enough to show the main difference between regions with existing substantial investments and those with smaller levels of investment. While these three world regions are also aggregated enough to allow for comparison between the various models and historical data sources, which often have limited and non-harmonized regional resolutions. In terms of the newly included EV investment category in this report, the NGFS investment estimates for 2025 range between USD 500 and 700 billion globally, which is broadly consistent with BNEF's statistics for 2024. However, NGFS estimates are higher than BNEF for High income, and lower for Upper-middle income and Low-middle income groups. This suggests a need for improved representation in the 2026 NGFS scenarios of the latest EV sales and investment dynamics, particularly in emerging markets.

Figure 2 **2025 Energy investment by regions**



Note: Regional investment comparison for 2025 in the three models of the NGFS Long-term scenarios ("G": GCAM, "R": REMIND-MAgPIE, "M": MESSAGEix-GLOBIOM) compared to 2024 data from BNEF ("B") and 2025 data from IEA ("I"), with regional disaggregation into 3 regions, informed by World Bank income classification.

3. Energy-investments in NGFS scenarios

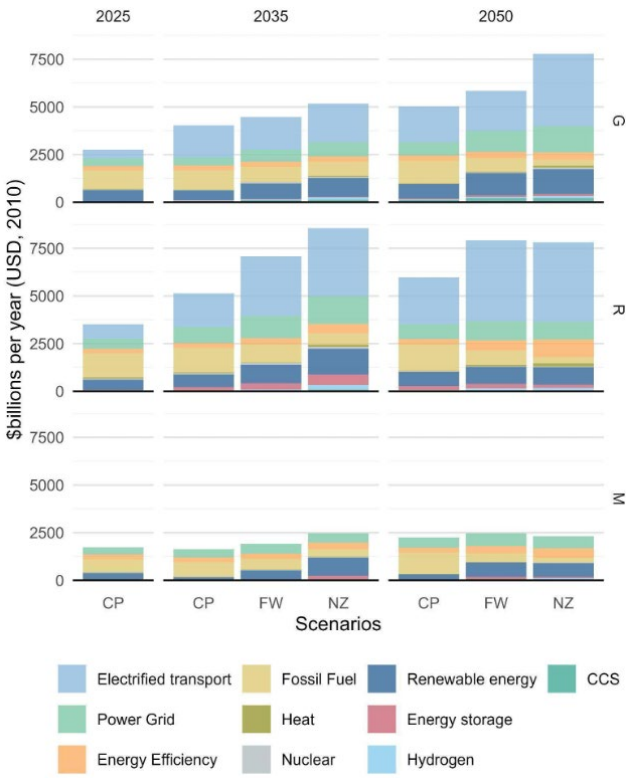
a. Scenario differences and uncertainties as reflected in cross-model differences

Energy investments in 2035 and 2050 differ markedly across models and scenarios (see Figure 3), with a clear signal of investments increasing with climate policy stringency, and thus being highest in the NZ scenario. Underlying the overall magnitude of change is a very clear structural shift, with decreasing investments into fossil energy (-USD 870 billion or -73% from CP to NZ in 2050, in GCAM scenarios). This is more than offset by increasing investments into renewable electricity generation technologies (+USD 530 billion or +69% from CP to NZ in 2050, in GCAM scenarios) and electricity grids (+USD 700 billion or +101% from CP to NZ in 2050, in GCAM scenarios) that also increase with stringency. As a robust result across all models, investments into nuclear power are much lower than those into renewable energy.

While the three models broadly agree on directional trends, such as rising investment needs under more stringent climate policies, they also show substantial variation in results. This results from the multiple plausible pathways available to reach climate targets, and that energy systems can evolve quite differently even under similar policy baselines. One of the main uncertainties across models is how quickly the electricity sector can transform, and how much investment will be needed in grids and storage to support large-scale renewables integration. This demand is projected to be highest in REMIND-MAgPIE, while grid investments are lowest in MESSAGEix-GLOBIOM, and storage investments lowest in GCAM. Furthermore, not only the deployment of specific technologies, but also their costs are uncertain, increasing overall uncertainty in investment requirements.

The additional reporting of investments in EVs in GCAM and REMIND-MAgPIE illustrates that in terms of absolute financial flows, these can easily constitute the single largest component of overall energy investments. In both GCAM and REMIND-MAgPIE, EV investments grow continuously from 2025-2050 and become the largest single category by 2050 across all scenarios. The NZ scenario consistently shows the highest EV investment levels. For the non-EV components, GCAM projects only a modest increase in investment requirements from 2035 until 2050. REMIND-MAgPIE and MESSAGEix-GLOBIOM project that, by 2050, investment differences across scenarios will be more structural than quantitative – that is, comparable overall investment levels, but higher low-emissions and lower fossil-related investments in scenarios with higher policy ambition. For instance, most of the system transformation in the most ambitious NZ scenario occurs by 2035 and overall investment volumes correlate with policy ambition until then. However, after 2035 overall investment levels remain flat until 2050 in these two models while sectoral composition continues to shift.

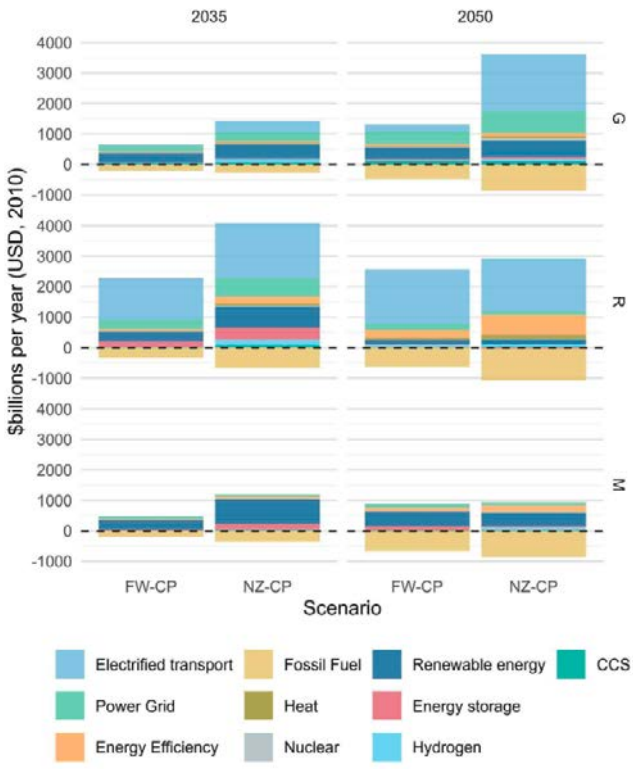
Figure 3 **Global energy investment 2025-2050**



Notes: Global Energy investments across scenarios in 2025, 2035 and 2050. Note that totals are not directly comparable as the scope of covered categories differs across models, with MESSAGEix-GLOBIOM not reporting electrified transport ("G": GCAM, "R": REMIND-MAgPIE, "M": MESSAGEix-GLOBIOM).

Achieving Net Zero by 2050 requires much larger low-carbon energy investments compared to Current Policies, and lower investments into fossil fuels (see Figure 4). At the global level, NZ consistently requires larger additional investments than FW. The composition of these differences is dominated by electrified transport, power grids, and renewable energy, which together account for the vast majority of the NZ–CP differences (e.g. electrified transport alone contributes roughly 69% of the GCAM gap in 2050 and over 90% in REMIND-MAgPIE). GCAM and REMIND also project considerable additional investments into hydrogen supply systems in NZ beyond those planned under CP. MESSAGEix-GLOBIOM, by contrast, projects only modest NZ-CP differences, ~0.8 trillion in 2035 and ~0.07 trillion in 2050, reflecting more optimistic assumptions outside the energy system, notably in AFOLU and negative emissions technologies (see Annex). The timing of investment differences also diverges: REMIND-MAgPIE concentrates the bulk of additional investment before 2035, while GCAM shows a stronger increase after 2035, differences that can be traced to contrasting assumptions about technology cost trajectories and carbon prices (see Annex and NGFS scenarios narratives and key findings: Net Zero 2050, Current Policies and Fragmented World[11], Figure 10).

Figure 4 **Energy investment differences across scenarios**



Notes: Additional Global Energy investments per year in the Fragmented World (FW) and Net Zero 2050 (NZ) scenarios in 2035 and 2050, ***compared to Current Policies level****. Note that the scope of covered categories differs across models with MESSAGEix-GLOBIOM not reporting electrified transport ("G": GCAM, "R": REMIND-MAgPIE, "M": MESSAGEix-GLOBIOM).*

b. *Investment upscaling* to achieve Net Zero 2050

The energy transition investment upscaling required for Net Zero (NZ) scenario refers to the increase from today's levels of investments to those needed in 2035 and 2050. Despite recent growth, the total investment requirement remains substantial, particularly in EVs, power grids, and renewable energy. According to estimates from both REMIND-MAgPIE and GCAM, annual global investment in the energy transition needs to grow from the current ~USD 2.5 trillion per year in 2025 to USD 5-7 trillion per year in 2035 (Figure 5 and Figure A.2). This corresponds to a compound annual growth rate (CAGR) of 7-11%, a pace that is above the projected GDP growth rate but consistent with recent trends (Figure 1 and Figure A.1). EVs represent the largest share of this, accounting for USD 2-3 trillion per year overall by 2035, followed by power grids and renewable energy, while investments in fossil fuels decline strongly over time in the NZ scenario.

Pronounced regional disparities are evident in the investment landscape. In high income countries, EV investments dominate the additional investment, comprising up to 85% of the total annual energy transition investment between 2025 and 2050 under the NZ scenario. In Upper-middle income countries, EVs, power grids, and renewables account for 62%, 28%, and 18% of the total, respectively (in GCAM).

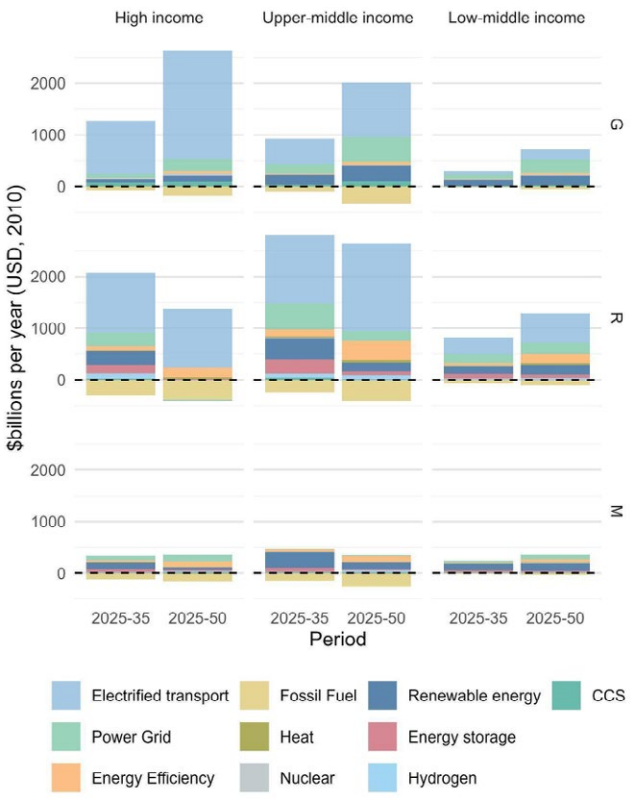
In contrast, the overall investment volumes are smaller in absolute terms in Low-middle income regions but show the highest relative scaling (up to factor of 4 until 2035 and 5 until 2050 in REMIND-MAgPIE) of all regions.

11 Hayez, L., Lécuyer, F., George, M., Ju, Y., Arora, M., Stevanović, M., Anz, J., Bertram, C., Edmonds, J., Fawcett, A., Fuhrman, J., Luderer, G., Piontek, F., Schleussner, C., van Ruijven, B., Zimmer, A., Kriegler, E. (2025). NGFS long-term scenarios, narratives and key findings: Net Zero 2050, Current Policies and Fragmented World. Network of Greening the Financial System. https://www.ngfs.net/en/publications-and-statistics/publications/explanatory-notes-ngfs-long-term-climate-scenarios.

Unlike in the other two regions, the majority of the gap consists of the various low-carbon supply categories, and EVs constitute a considerably lower share than in the other two regions. Many countries in this group face higher costs of capital[12], and due to limited fiscal space may require external support to mobilize these investments.

It is also important to note that the investment upscaling described here does not represent the full additional cost to society. Much of the investment in EVs substitutes for what would otherwise have been spent on new internal combustion engine (ICEs) vehicles, given regular fleet turnover. Additionally, low-carbon energy investments often deliver significant operational cost savings, such as reduced fuel and maintenance expenses for EVs and renewables, which further offset the upfront capital requirements.

Figure 5 **Regional energy investment upscaling for Net Zero 2050**



Notes: Regional energy investment upscaling for Net Zero 2050 scenario in 2035 and 2050, compared to 2025 level. (Note that totals are not directly comparable as the scope of covered categories differs across models with MESSAGEix not reporting electrified transport ("G": GCAM, "R": REMIND-MAgPIE, "M": MESSAGEix-GLOBIOM).)

Conclusion and outlook

This report provides a first integrated view of energy investment needs across the NGFS Phase V scenarios, benchmarked against historical data from IEA and BNEF. It identifies persistent gaps between current investment trajectories and what is needed for a Paris-aligned pathway, with significant regional disparities and large shortfalls in all regions. By 2050, global energy investment to be scaled up by about USD 5 trillion compared to 2025, with EVs alone accounting for over 67% of this growth. This highlights the magnitude of investment reallocation required.

Looking ahead, the NGFS long-term scenarios will continue to improve in terms of scenario granularity, especially on demand-side investments, and strengthening the alignment between investment pathways and macro-financial risk analysis. Future iterations will also aim to enhance regional comparability and address inconsistencies in model outputs and historical data, supporting more informed financial and policy decisions.

12 Calcaterra *et al.* 2024 https://www.nature.com/articles/s41560-024-01606-7.

Annex

Table A.1 Mapping of model regions and reporting regions from BNEF and IEA to the 3 tier region grouping used in this report

	Low- and lower-middle income	Upper-middle income	Higher income
REMIND-MAgPIE	• India • Sub-Saharan Africa	• China • Latin America and the Caribbean • Middle East, North Africa, Central Asia • Other Asia	• United States of America • Canada, NZ, Australia • EU 28 • Japan • Non-EU28 Europe • Countries from the Reforming Economies of the Former Soviet Union
MESSAGEix-GLOBIOM	• South Asia • Sub-Saharan Africa	• China • Middle East and North Africa • Other Pacific Asia • Latin America and the Caribbean • Rest Centrally Planned Asia	• North America • Pacific OECD • Western Europe • Eastern Europe • Former Soviet Union
GCAM	• India • Africa-Western • Africa-Southern • Africa-Eastern • South Africa	• China • Mexico • Middle East • Argentina • South America-Southern • Europe-Eastern • Colombia • Brazil • Indonesia • Central Asia • Southeast Asia • Africa-Northern • Central America and Caribbean • South Asia • South America-Northern • Pakistan	• European Free Trade Association • USA • Taiwan • Australia-NZ • Canada • EU-15 • South Korea • Japan • EU-12 • Europe-Non-EU • Russia
BNEF	• **Rest of World** • India • Rest of EMEA (Europe, Middle East, and Africa)	• China • Brazil • Middle East and North Africa* • Rest of Asia Pacific* • Rest of Americas*	• US • UK • Canada • Japan • EU 27
IEA	• Africa • India	• China • Central and South America • Middle East • Eurasia • Latin America • Southeast Asia	• US • Europe • Rest of World

Note: The * denote more detailed regional information only available for the variables renewable energy and power grids.

Table A.2 Mapping of variables from BNEF, IEA and NGFS to the reporting categories

	BNEF	IEA	NGFS
Electrified Transport	• Electrified Transport	*NA*	• Investment|Transportation|EV
Clean industry	• Clean industry	*NA*	*NA*
Nuclear	• Nuclear	• Power (Nuclear)	• Post-processed|Investment|Energy Supply|Nuclear
Hydrogen	• Hydrogen	*NA*	• Post-processed|Investment|Energy Supply|Hydrogen
Power Grid	• Power grids	• Electricity networks	• Post-processed|Investment|Energy Supply|Electricity|Transmission and Distribution
Fossil Fuel	The value in BNEF is supplemented with IEA data only for the World region	• Fuels (Fossil fuels) • Power (Coal, Oil, and natural gas)	• Post-processed|Investment|Energy Supply|Liquids|Oil • Post-processed|Investment|Energy Supply|Liquids|Fossil T&D • Post-processed|Investment|Energy Supply|Liquids|Coal and Gas • Post-processed|Investment|Energy Supply|Extraction|Uranium • Post-processed|Investment|Energy Supply|Extraction|Oil • Post-processed|Investment|Energy Supply|Extraction|Gas • Post-processed|Investment|Energy Supply|Extraction|Coal • Post-processed|Investment|Energy Supply|Electricity|Oil|w/o CCS • Post-processed|Investment|Energy Supply|Electricity|Gas|w/o CCS • Post-processed|Investment|Energy Supply|Electricity|Coal|w/o CCS
Renewable energy	• Renewable energy	• Power (Renewable)	• Post-processed|Investment|Energy Supply|Liquids|Biomass • Post-processed|Investment|Energy Supply|Liquids|Biomass T&D • Post-processed|Investment|Energy Supply|Extraction|Bioenergy • Post-processed|Investment|Energy Supply|Extraction|Wind • Post-processed|Investment|Energy Supply|Extraction|Solar • Post-processed|Investment|Energy Supply|Extraction|Hydro • Post-processed|Investment|Energy Supply|Electricity|Geothermal • Post-processed|Investment|Energy Supply|Electricity|Biomass|w/o CCS
CCS	• CCS	• Power (Fossil fuels: with CCUS)	• Post-processed|Investment|Energy Supply|Electricity|Oil|w/ CCS • Post-processed|Investment|Energy Supply|Electricity|Gas|w/ CCS • Post-processed|Investment|Energy Supply|Electricity|Coal|w/ CCS • Post-processed|Investment|Energy Supply|Electricity|Biomass|w/ CCS • Post-processed|Investment|Energy Supply|CO_2 Transport and Storage
Energy Efficiency	The value in BNEF is supplemented with IEA data only for the World region	• End-use (Energy efficiency)	• Post-processed|Investment|Energy Efficiency
Heat	• Heat	*NA*	• Post-processed|Investment|Energy Supply|Heat
Energy storage	• Energy storage	• Storage	• Post-processed|Investment|Energy Supply|Electricity|Electricity Storage

Notes: 'Investment|Transportation|EV' is a post-processed variable that is not included in NGFS Phase V public source. This report uses the following formula for 'Investment|Transportation|EV' specifically.

$$EVinvest_{m,t,s,v} = EVsales_{m,t,s,v} * \sum_{y} Unit\_Cost_{m,t,s,v,y}$$

Here, $EVinvest_{m,t,s,v}$ denotes the investment in electric vehicles under model m, year t, scenario s, and vehicle type v (including BEV, PHEV, FCEV, HEV, etc.).The unit cost term $Unit\_Cost_{m,t,s,v,y}$ consists of three components: **capital cost (purchase)**, **capital cost (infrastructure)**, and **capital cost (other)**. The unit cost data are taken from the **UC Davis transportation dataset**[13]. While GCAM and REMIND-MAgPIE produce different EV sales trajectories, both models rely on the same unit cost dataset for consistency.

13 UC Davis transportation dataset: https://escholarship.org/uc/item/8nk2c96d#main.

Model differences and their impact on energy investment

The three NGFS IAMs (GCAM, REMIND-MAgPIE, and MESSAGEix-GLOBIOM) broadly agree on the direction of change under stronger climate policies: declining fossil fuel investment and rising investment in renewables, power grids, and electrified transport. However, the absolute levels and the composition of investment vary considerably across models. To summarize, these differences arise from distinct assumptions in two main areas: (i) Energy demand levels and substitutability, and technology choice, and (ii) Accounting boundaries.

Demand levels and substitutability, and technology choice

Models differ in how far end-use sectors can be electrified and to what extent alternative fuels (non-electric, such as hydrogen, synthetic fuels, and bioenergy) are deployed. GCAM assumes higher electrification, which translates into larger investments in power generation and transmission infrastructure, alongside high EVs investment. REMIND-MAgPIE and particularly MESSAGEix-GLOBIOM assume lower electrification shares but higher reliance on alternative fuels, shifting investment towards hydrogen and synthetic fuel production while reducing relative grid requirements. Assumptions about material demand, building floor space, and transport activity also affect the size and timing of efficiency, grid, and storage investments. Please see more details in NGFS scenarios narratives and key findings: Net Zero 2050, Current Policies and Fragmented World, Section 2.5.2, Figure 2.18, 2.19, 2.20[14].

Figure A.1 **IEA Global energy investment 2015-2025**

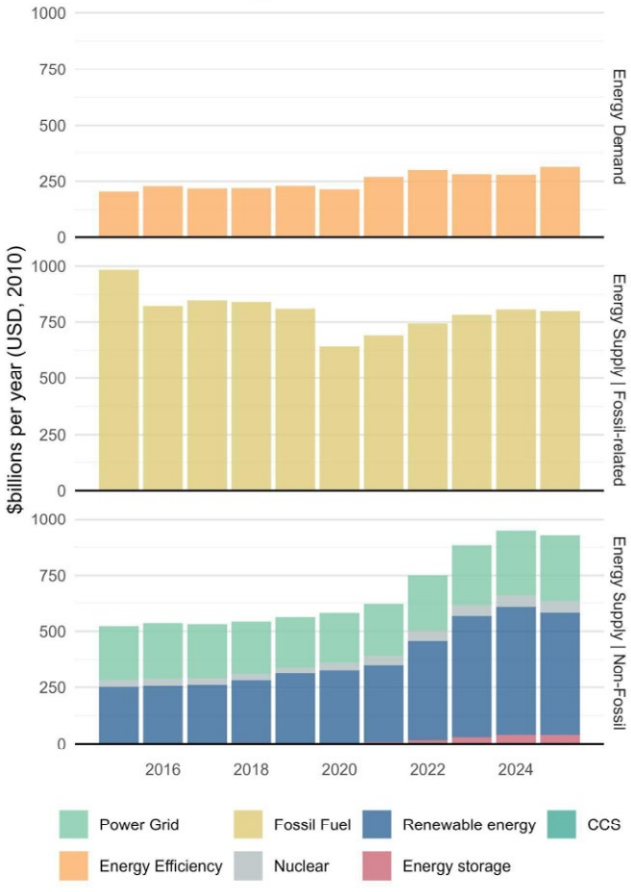
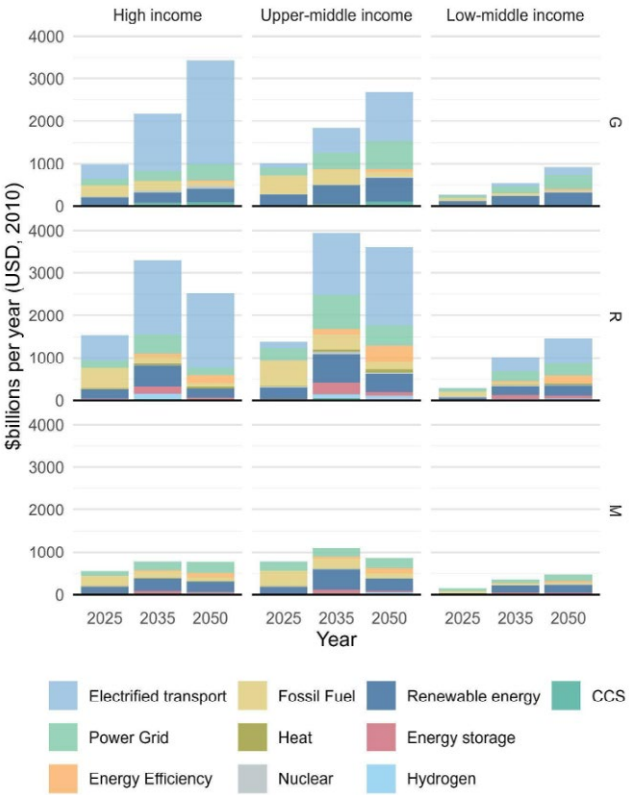


Figure A.2 **Regional energy investment 2025-2050**



Notes: Regional Energy investments under Net Zero scenario in 2025, 2035 and 2050. (Note that totals are not directly comparable as the scope of covered categories differs across models ("G": GCAM, "R": REMIND-MAgPIE, "M": MESSAGEix-GLOBIOM).)

14 Hayez, L., Lécuyer, F., George, M., Ju, Y., Arora, M., Stevanovic, M., Anz, J., Bertram, C., Edmonds, J., Fawcett, A., Fuhrman, J., Luderer, G., Piontek, F., Schleussner, C., van Ruijven, B., Zimmer, A., Kriegler, E. (2025). NGFS long-term scenarios, narratives and key findings: Net Zero 2050, Current Policies and Fragmented World. Network of Greening the Financial System. https://www.ngfs.net/en/publications-and-statistics/publications/explanatory-notes-ngfs-long-term-climate-scenarios.

The role of CCS and CDR also diverges NGFS scenarios narratives and key findings: Net Zero 2050, Current Policies and Fragmented World[15], Section 2.5.3: GCAM assumes more widespread CCS deployment, raising investment in capture and CO_2 transport infrastructure; MESSAGEix-GLOBIOM relies more on land-based sinks, the costs of which are out of scope of this report (Ref. 15, Figure 2.9); REMIND-MAgPIE lies in between, with higher shares of bioenergy with CCS. Carbon price trajectories also differ (Ref. 15, Figure 2.7), influencing the timing and sectoral distribution of capital flows.

Accounting boundaries

The treatment of investment categories varies across models. GCAM and REMIND-MAgPIE include the full purchase sales of EVs, making transport an essential category of investment by 2050, while MESSAGEix-GLOBIOM does not report EVs separately in Phase V. This directly affects the magnitude of reported transport investments. These choices mean that while trends are consistent, cross-model totals are not strictly comparable.

15 Hayez, L., Lécuyer, F., George, M., Ju, Y., Arora, M., Stevanović, M., Anz, J., Bertram, C., Edmonds, J., Fawcett, A., Fuhrman, J., Luderer, G., Piontek, F., Schleussner, C., van Ruijven, B., Zimmer, A., Kriegler, E. (2025). NGFS scenarios, narratives and key findings: Net Zero 2050, Current Policies and Fragmented World. Network of Greening the Financial System. https://www.ngfs.net/en/publications-and-statistics/publications/explanatory-notes-ngfs-long-term-climate-scenarios.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