CLIMATE POLICY INITIATIVE

IRENA
International Renewable Energy Agency

GLOBAL LANDSCAPE OF **ENERGY TRANSITION FINANCE**

2025

IRENA
International Renewable Energy Agency

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The International Renewable Energy Agency (IRENA) serves as the principal platform for international co-operation, a centre of excellence, a repository of policy, technology, resource and financial knowledge, and a driver of action on the ground to advance the transformation of the global energy system. A global intergovernmental organisation established in 2011, IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security, and low-carbon economic growth and prosperity.

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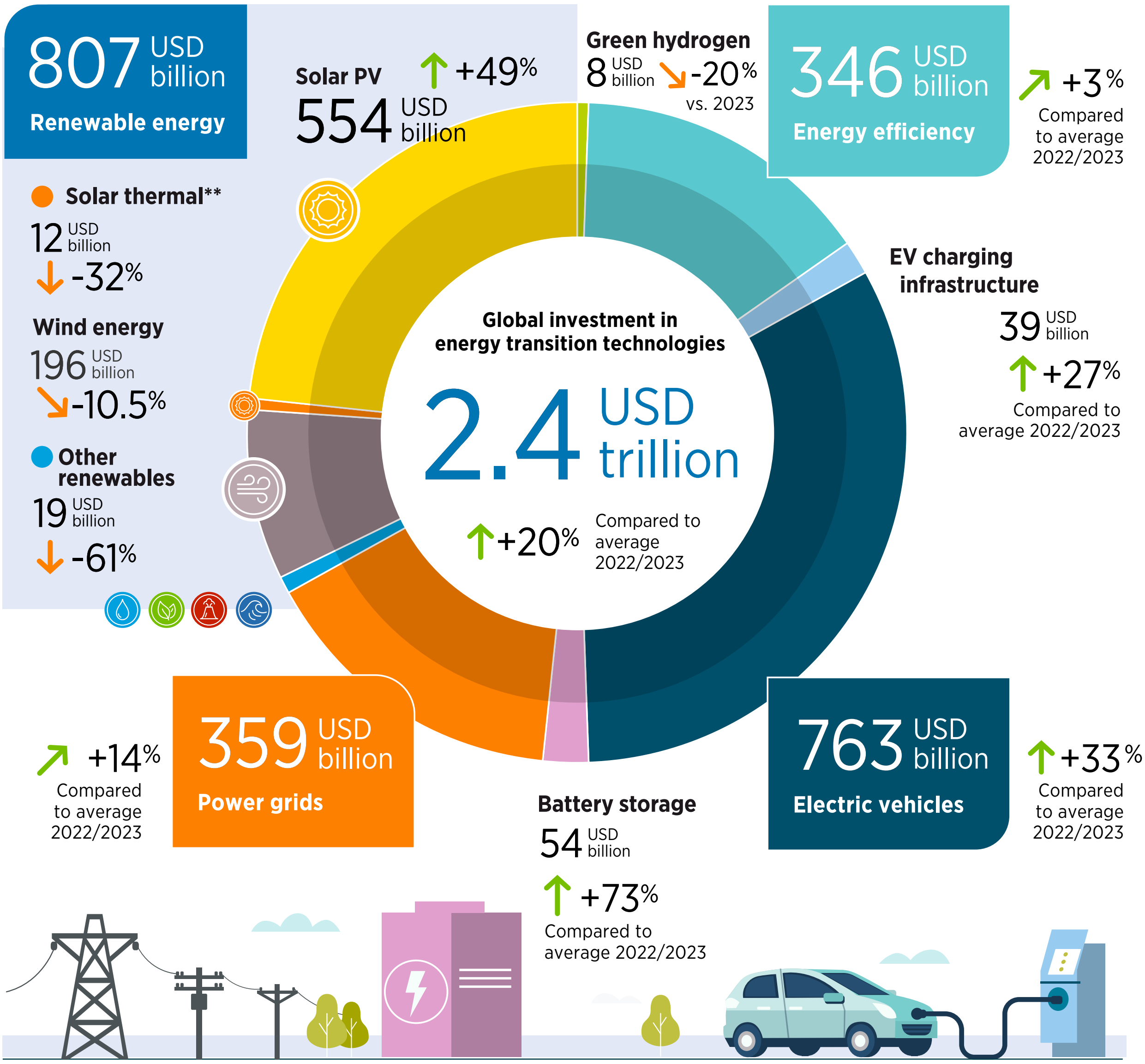
Energy transition investment in 2024*



2024: Investment in renewable power, grids, and storage exceeded fossil fuels

Fossil fuels	USD 1.13 trillion
Renewable power, grids and battery storage	USD 1.19 trillion

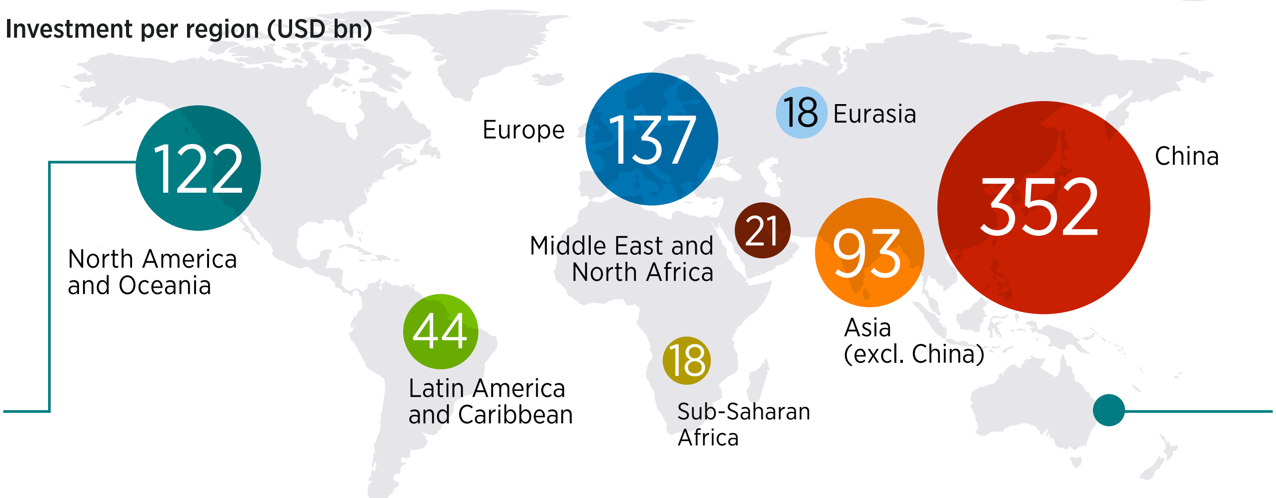
** Includes renewable energy (power and end-uses), grids, energy storage, electric vehicles (EV), EV charging infrastructure, carbon capture and storage (CCS), green hydrogen, energy efficiency and heat pumps.*
*** Concentrated solar power and solar heating systems (e.g. water heaters).*

KEY FINDINGS
continued

Renewable energy investment in 2024

807 USD billion ↑ +22% vs. 662 USD billion 2022/2023

Investment per region (USD bn)

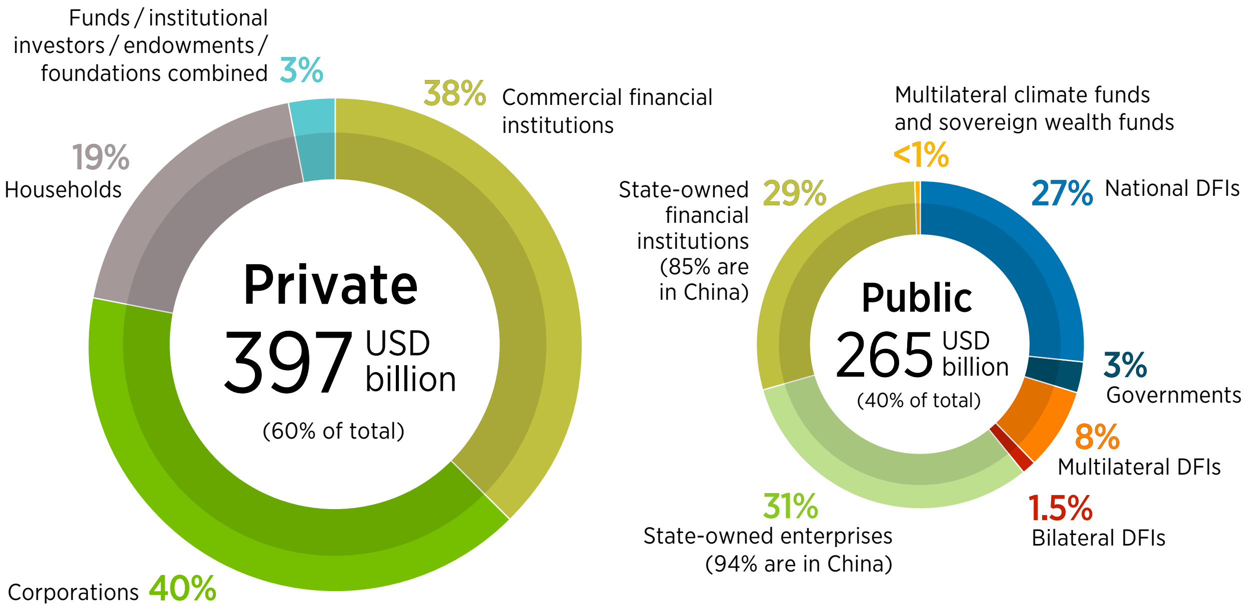


Region	Share of global investment 2024	Change to average 2022/2023	Share of domestic sources 2022/2023	Investment per capita 2024
North America and Oceania	15%	+31.4 USD billion, ↗ +34%	81%	USD 219
Europe	17%	+25.2 USD billion, ↗ +22%	70%	USD 229
China	44%	+20 USD billion, ↗ +6%	99%	USD 248
Latin America and Caribbean	5.4%	+6.6 USD billion, ↗ +18%	77%	USD 82
Eurasia	2.2%	+10.1 USD billion, ↗ +130%	84%	USD 70
Asia (excl. China)	11.5%	+41 USD billion, ↗ +77%	79%	USD 32
Sub-Saharan Africa	2.3%	+4.2 USD billion, ↗ +28%	53%	USD 15
Middle East and North Africa	2.6%	+8 USD billion, ↗ +62%	71%	USD 38

KEY FINDINGS

continued

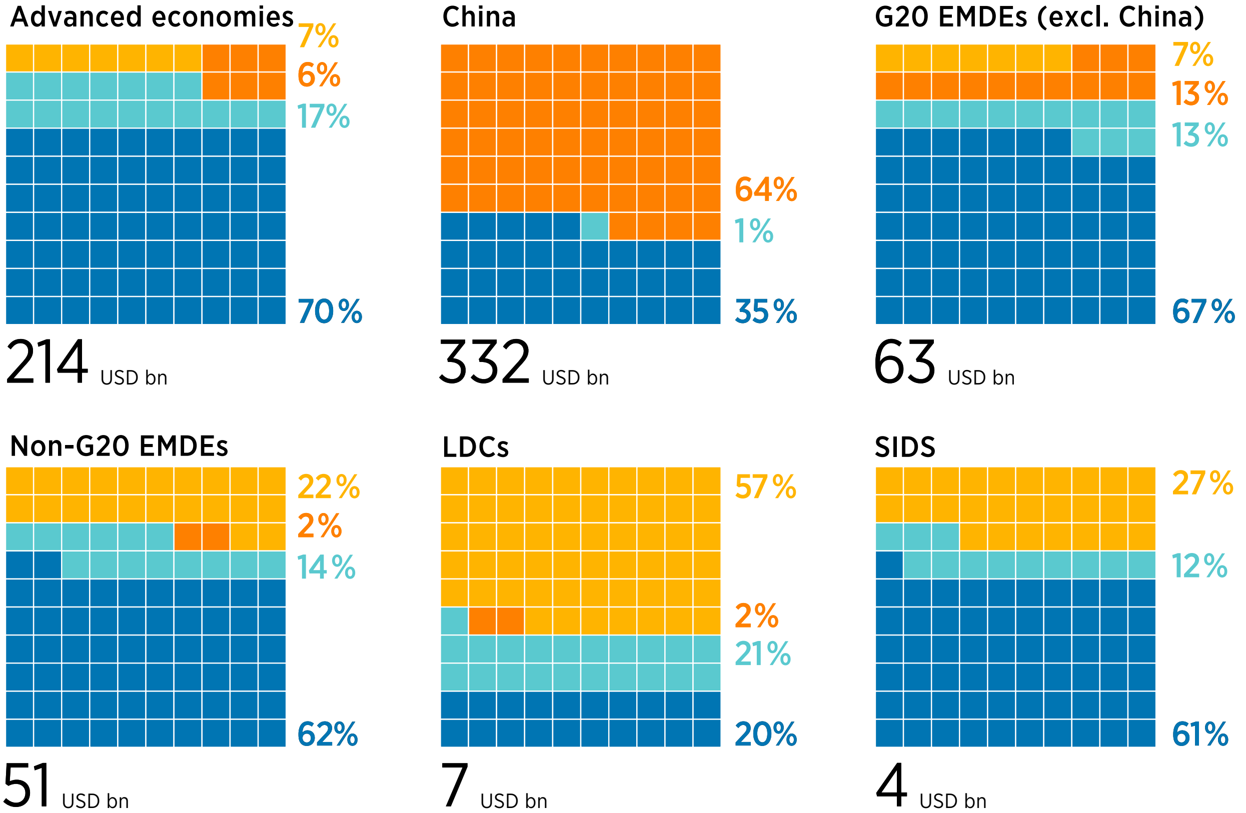
Source of investment in renewable energy; global (average 2022/2023)



Source of investment in renewable energy by country/group (average 2022/2023)

Private investment
- Private domestic
- Private international

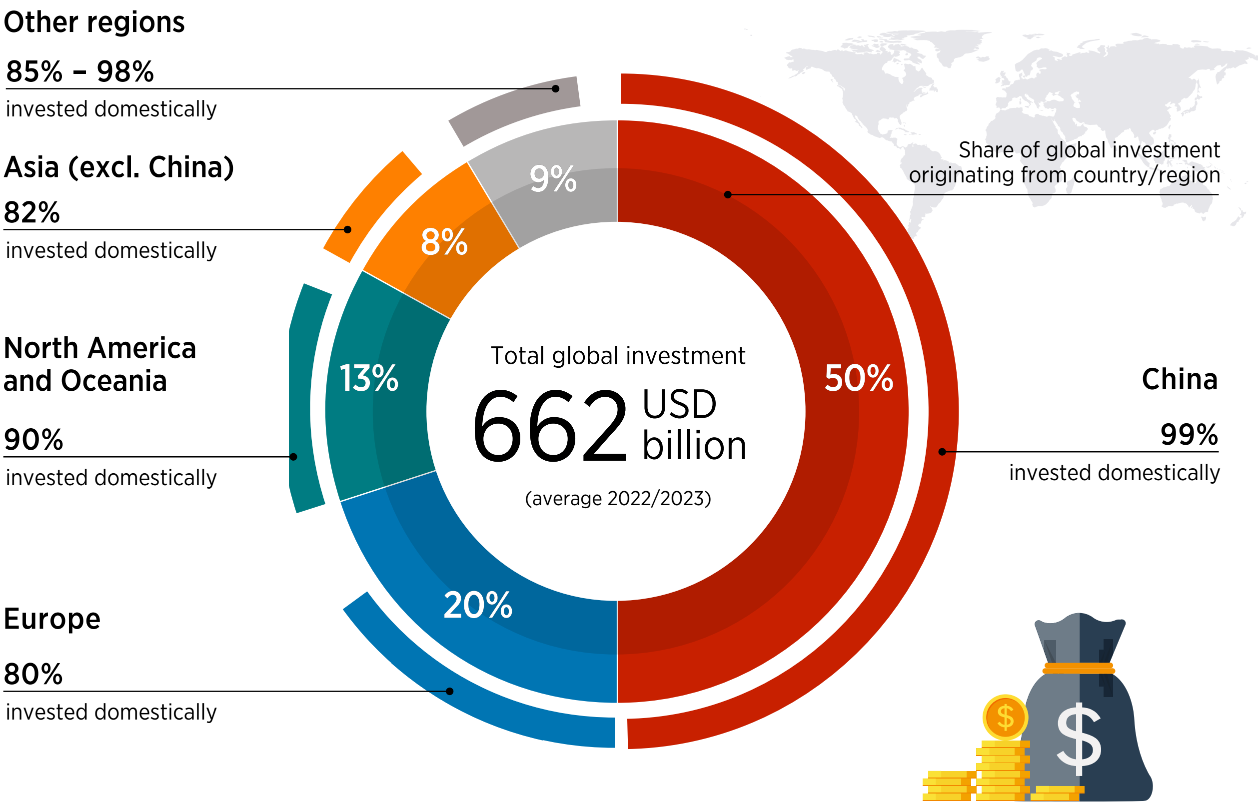
Public investment
- Public domestic
- Public international



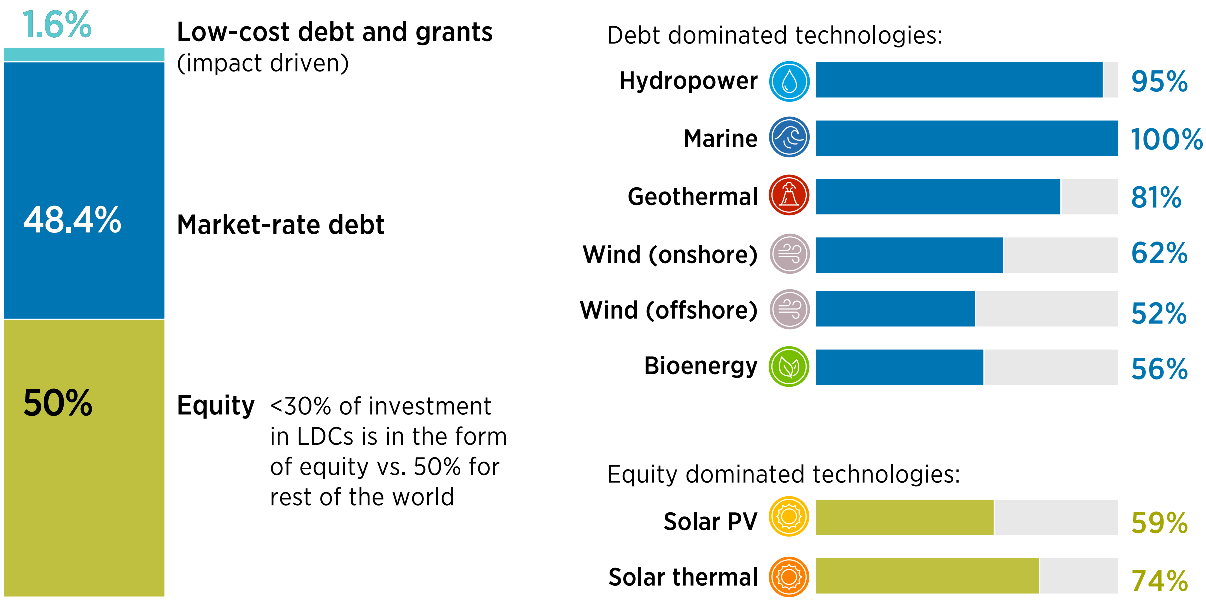
Notes: EMDEs = emerging markets and developing economies; DFIs = development finance institutions; LDCs = least developed countries; PV = photovoltaic; SIDS = small island developing states; USD = United States dollar.

KEY FINDINGS
continued

Origin of global investments by country/region and share invested domestically
(average 2022/2023)



Share of global renewable energy investments (average 2022/2023) **by financial instrument**



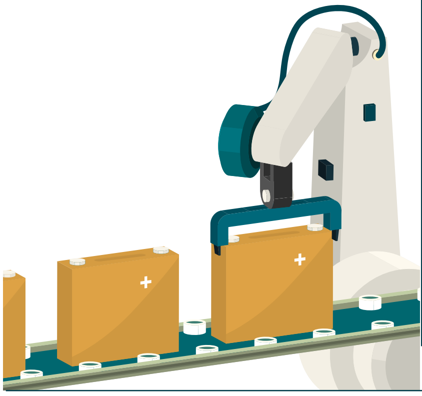
Notes: PV = photovoltaic; USD = United States dollar.

Energy transition supply chain investments in 2024

Total

-21% Compared to 2023

102 USD billion (2024)



Solar PV factories

-72% Compared to 2023

24.5 USD billion (2024)

Battery factories

+112% Compared to 2023

74.5 USD billion (2024)

Wind nacelle factories

-80% Compared to 2023

1 USD billion (2024)

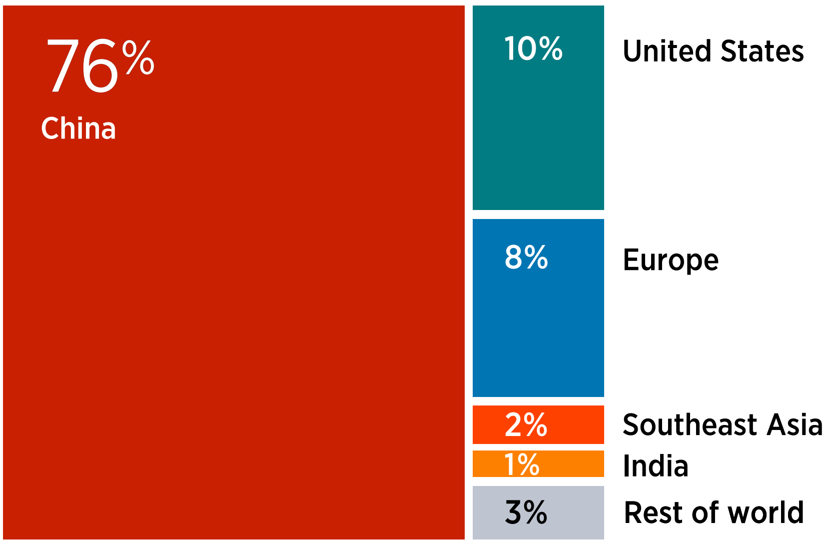
Electrolyser assembly factories

+26% Compared to 2023

1.9 USD billion

Regional breakdown of supply chain investment (2024)

102 USD billion



Notes: PV = photovoltaic; SIDS = small island developing states; USD = United States dollar.

INTRODUCTION

This is the fourth edition of the *Global landscape of energy transition finance* analysis (previously, *Global landscape of renewable energy finance)*, jointly produced by the International Renewable Energy Agency (IRENA) and the Climate Policy Initiative (CPI). Since 2018, these landscape analyses have aimed to provide the most comprehensive overview of renewable energy investments, analysing trends by technology, end use, region, type and source of investment (public or private), and financial instrument.

This year's report expands its coverage to additional energy transition sectors, including power grids, energy storage, energy efficiency, green hydrogen and electrification of transport. Data on heat pumps, carbon capture and storage (CCS), and other energy transition technologies are also presented. The series has therefore been renamed.

Compared with previous analyses, this 2025 edition:

- Includes more granular data on energy transition investments beyond renewables, analysing trends by region, type and source of finance, and financial instrument.
- Controls for the impact of inflation on total investment by converting investments at current prices to constant prices.
- Includes a chapter on investments in supply chains, crucial for localising value chains, maximising socio-economic benefits, ensuring security of supply and reducing dependencies on imports.
- Goes beyond analysing investments by source (public or private) and differentiates between impact-driven funds – including grants and concessional debt – and profit-driven capital, because the lines become increasingly blurred between the drivers of investment: public funds increasingly behave like private capital in terms of risk aversion and expectation of returns commensurate with risks, and private funds engage in impactful investments with no expectation of financial returns under corporate social responsibility and philanthropic activities.

By enhancing understanding of the current landscape of energy transition finance, including the largest players and how they vary across different contexts, this report series aims to inform public policy and investment decisions and to support the alignment of financial flows with global climate and sustainable development goals.

This report is structured as follows:

Chapter 1 presents an overview of energy transition investments – covering renewable energy, grids, battery storage, electrified transport (electric vehicles [EVs] and charging infrastructure), energy efficiency and green hydrogen – drawing a comparison with the investment required under IRENA's 1.5°C Scenario based on the *World energy transitions outlook 2024* and *Delivering on the UAE Consensus* reports. It further contextualises energy transition investments within broader investments in the energy sector in general, including fossil fuels.

Chapter 2 analyses renewable energy investments by technology and region (destination and origin).

Chapter 3 explores renewable energy investments by source of investment (public or private), financial instrument and driver of investment (impact driven or profit driven).

Both Chapters 2 and 3 also analyse investments for the following countries or country groups: China, advanced economies,[1] Group of Twenty (G20) emerging markets and developing economies (EMDEs) (excluding China and African Union),[2] non-G20 EMDEs, and least developed countries (LDCs).[3] See the Annex for the full list of countries.

Chapter 4 discusses investments in specific segments of energy transition supply chains: manufacturing (solar photovoltaic [PV] markets batteries and wind nacelles) and mining (lithium, cobalt and nickel), focusing on key markets.

The conclusion discusses the structural change needed for energy transitions to achieve their potential positive socio-economic impacts and highlights some recommendations to meet global sustainable development and climate goals.

Throughout the report, the analysis focuses on the most recent trends, using – wherever available – preliminary data for 2024. Comparisons with previous years are based on average annual investments over two years (2022 and 2023) to smoothen short-term fluctuations caused by large project commitments in individual years.

[1] *Countries classified as "developed" according to the World Bank classification.*

[2] *Argentina, Brazil, India, Indonesia, Mexico, Saudi Arabia, South Africa, Türkiye.*

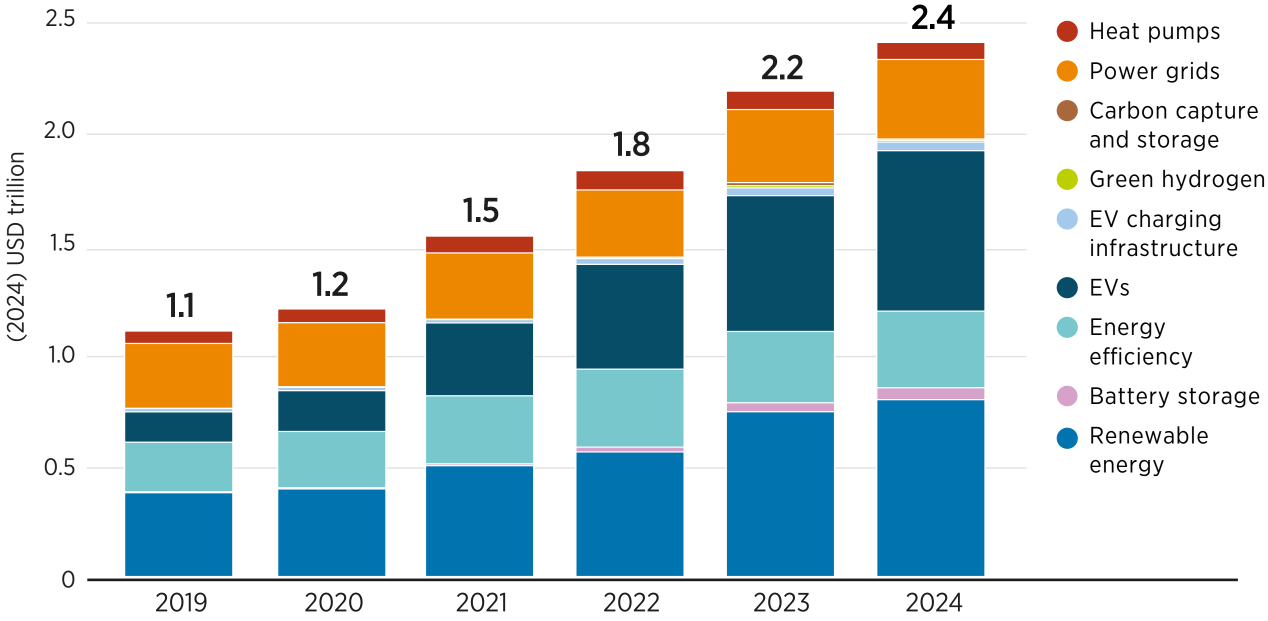
[3] *LDCs are defined as low-income countries confronting severe structural impediments to sustainable development (UNCTAD, 2024a).*

01 ENERGY TRANSITION INVESTMENT LANDSCAPE

In 2024, global investments in energy transition technologies[4] reached a record high of USD 2.4 trillion, up 20% compared with the average annual levels of 2022/2023. Growth in relatively mature technologies – renewable energy, energy efficiency, grids and electrified transport – continued in 2024, albeit at a slower pace than in previous years. Investment in nascent technologies – green hydrogen and CCS – declined in 2024. Battery storage remains a notable exception, sustaining robust growth through 2024.

Since 2019, the share of investments going to renewable energy has stayed largely consistent, at about one-third (35% in 2024), but this share has evolved considerably for other energy transition technologies. The share of investments going to EVs and charging infrastructure expanded from 13.6% to 31.6% between 2019 and 2024. However, the share of investments going to power grids and energy efficiency shrank from 26% and 20%, respectively, to a combined 29%, split almost equally between the two technologies. Figure 1.1 presents investments by technology from 2019 to 2024.

Figure 1.1 Annual energy transition investments by technology, 2019-2024



Based on: (CPI, 2025), (IRENA, 2024a), (BNEF, 2025a), (IRENA *et al.*, 2025).

Notes: Renewable energy investments in 2024 were calculated by applying BNEF 2023-2024 growth rate to Climate Policy Initiative 2023 data. Data for 2024 for EVs, battery storage, and carbon capture and storage come from (BNEF, 2025a). Data for 2024 for EV charging infrastructure and green hydrogen come from (CPI, 2025) and data for 2024 for grids and energy efficiency come from (IRENA *et al.*, 2025a). Renewable energy investments were deflated to base year 2023 as these data were finalised prior to 2024 deflators becoming available. All other technologies were deflated to base year 2024. As a result, limited comparisons should be drawn between renewable investments and other technologies.
EV = electric vehicle.

While each technology faces unique drivers and constraints, with investments in these technologies therefore progressing differently over the last few years (as discussed throughout Section 1.1), there are two common denominators:

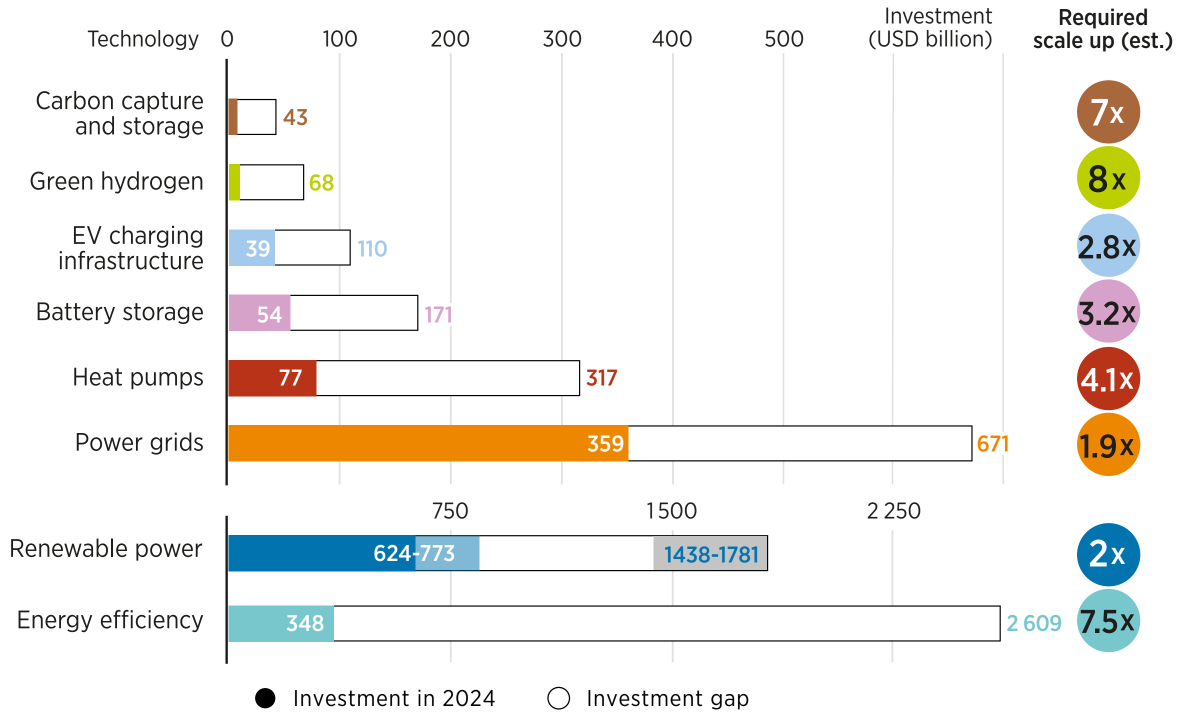
1. There is significant disparity in the distribution of investments: China and advanced economies are the primary innovation, deployment and value creation hubs, making up 90% of energy transition investment in 2024: 44% and 46%, respectively. In contrast, LDCs accounted for less than 0.22% of energy transition investments and around 2.2% of renewable energy investments in 2024. Most of these LDCs are in Sub-Saharan Africa – a region that remains underinvested, despite its enormous energy potential and needs (Section 2.2.1).

2. Despite significant progress in recent years, annual investments across key energy transition technologies still fall short of the level required to align with IRENA's 1.5°C pathway. According to IRENA's World Energy Transitions Outlook 2024 and Delivering the UAE Consensus publications, annual investments in renewable power generation must almost double from current levels to reach USD 1.4 trillion per year between 2025 and 2030 (IRENA *et al.*, 2025), with a significant increase needed in renewable energy for end uses beyond power (*e.g.* heating and transport) as well.[5] The largest step-up (in absolute terms) is required for energy efficiency, which needs to grow 7.5 times to reach nearly USD 2.6 trillion annually between 2025 and 2030 (IRENA *et al.*, 2025). Investment gaps for key energy transition technologies are presented in Figure 1.2.[6]

[5] *Detailed investment needs will be provided in IRENA's World energy transition outlook 2026 report.*

[6] *This does not cover investment needs for bioenergy with CCS, pumped hydropower or green hydrogen derivatives (ammonia and menthol), which are also needed under IRENA's 1.5°C Scenario and will be explored further in IRENA's upcoming World energy transitions outlook 2026.*

Figure 1.2 Global investments gaps in key energy transition technologies, 2024 versus 2025-2030 needs in IRENA's 1.5°C Scenario



Based on: (CPI, 2025), (IRENA, 2024a; IRENA *et al.*, 2024), (BNEF, 2025a), (IRENA *et al.*, 2025a).

Notes: For the renewable power investment figures, the lower-bound estimates for historical investments and needs are based on a capacity-based approach while the higher-bound estimates are calculated based on projects reaching final investment decision (FID). This is further explained in section 1.1 (also see footnote 7). In either case, the central message is that investments need to double. All other technologies are deflated to base year 2024. Annual investment needs are based on IRENA's 1.5°C Scenario. For renewable power, energy efficiency, power grids and battery storage, investment needs are for 2025-2030 (IRENA *et al.*, 2025a). For EV charging infrastructure, green hydrogen, carbon capture and storage, and heat pumps, needs are based on (IRENA, 2024a) for the years 2024-2030. The investment gap is calculated by comparing overall annual needs to 2024 levels. EV = electric vehicle.

The remainder of this chapter discusses recent investment trends for key energy transition technologies with respect to achieving IRENA's 1.5°C Scenario and highlights relevant policy and macroeconomic drivers that have shaped these trends, as well as regional trends. In addition, a discussion on how these investments compare with those in fossil fuels is presented in Section 1.2.

1.1 Investment trends and gaps across energy transition technologies

1.1.1 Renewable power

In 2024, global investments (based on final investment decisions[7] [FIDs] of projects) in renewable energy reached USD 807 billion, up 22% from the annual average of 2022/2023.

About 96% of FIDs (referred to in this report as "investments") in 2024 were in the power sector (USD 773 billion), and only 1% (equivalent to USD 10 billion) went to projects for direct use of renewables in heating and transport.[8] Based on data from (IRENA *et al.*, 2025a), current investment levels in renewable power are around half what is needed to be in line with the call to triple renewable power capacity to 11.2 terawatts (TW) by 2030.

Solar PV is the only renewable energy technology for which current investment levels are almost in line with IRENA's 1.5°C Scenario, with 2024 investment levels within close distance of the annual average needed through 2030 (Figure 1.3) (IRENA *et al.*, 2025a). These levels are driven by solar PV's rapid cost declines over the past decade as well as widespread policy support globally. In many EMDEs, PV adoption has been further driven by distributed systems (*e.g.* rooftop solar) as an alternative to grid-based power in contexts where grid-based power is unreliable, unavailable or unaffordable (see Section 2.1.1). Off-grid solar solutions are key in this regard, helping provide access to electricity to millions of people globally, particularly in Sub-Saharan Africa (see the deep dive on off-grid solar in Section 2.1.1).

Annual investments in **concentrated solar power (CSP)** need to be scaled up by 32 times during 2025-30 compared with current levels. In some cases, CSP investments are looking less attractive than solar PV and storage hybrids. In countries such as Morocco and the United Arab Emirates, the combination of solar PV and storage is being considered as a cheaper alternative to CSP (Section 2.1.1).

Onshore and offshore wind require significant investment growth; current levels (2024) need to be scaled up by three times and eight times, respectively (Figure 1.3). Wind projects have faced issues such as longer permitting processes, grid connection challenges, and public push-back in some countries (Winter *et al.*, 2024), which has slowed the pace of deployment. Some recent offshore wind tenders have had unsuccessful outcomes, highlighting the importance of well-designed policies and auction frameworks in ensuring sufficient investments going forward. A more detailed discussion is presented in Section 2.1.2.

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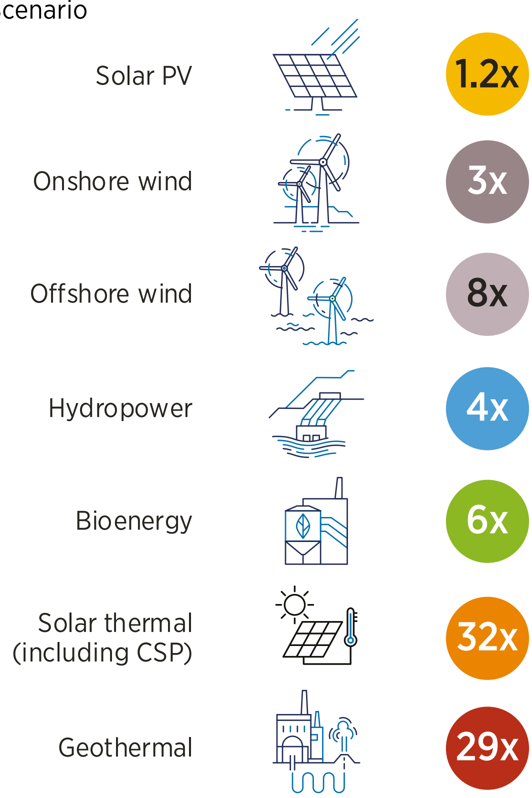
[7] *In this report, renewable energy investments are tracked at the time of financial close, meaning the funds have been obligated or committed legally speaking. As the FID method offers more granularity on investments by regions, sources and instruments, it is the preferred method for this report as it provides deeper insights into historical trends. In (IRENA et al., 2025a), the renewable energy investment figure is reported as USD 641 billion in 2024 as it is calculated based on capacity commissioned in a given year (in megawatts) multiplied by the unit cost of that technology (in US dollars per megawatt).*

[8] *The remaining 3% (USD 24 billion) went to unknown projects that could not be attributed to either the power sector or other end uses.*

Investment across other renewable technologies, including **marine energy,**[9] **geothermal power, bioenergy and hydropower**, remains far below what is needed. For hydropower, there is significant untapped potential in Africa, Asia and South America, but projects often face high construction risks, require extensive environmental and social impact assessments and long loan tenors (IRENA, 2023a). Policy volatility, increasing levelised electricity costs and rising feedstock costs continue to be the main challenges for bioenergy (IRENA, 2022a). For marine and geothermal power in particular, the less established supply chains and more limited policy support compared with solar and wind have led to slower deployment and more cautious investor appetite (Section 2.1.3). Dedicated policy support and tailored financing solutions are needed for each technology and context to address the global investment shortfall.

Figure 1.3 Global investment needs in renewable power technologies, 2024 versus 2025-2030 needs in IRENA's 1.5°C Scenario



Sources: (IRENA, 2024a), (IRENA *et al.*, 2025a), (CPI, 2025).

Notes: Baseline investment numbers for all technologies are based on 2024 figures from (IRENA *et al.*, 2025a) based on a capacity deployment approach and are not directly comparable to the Final Investment Decisions-based investment levels presented in Section 1.1.1 and Chapter 2. The investment gap is calculated by comparing overall annual needs to 2024 levels. As no capacity was deployed for marine energy in 2024, it is not included in the figure. According to (IRENA *et al.*, 2025a), an average annual investment of USD 29 billion is needed for marine technologies between 2025 and 2030. CSP = concentrated solar power; PV = photovoltaic.

Further discussion on renewable energy investments by technology, region, source and instrument is presented in Chapter 2.

[9] *Includes both wave and tidal energy.*

1.1.2 Power grids

Investment in power grids, including both transmission and distribution, grew by 14% in 2024, compared with the 2022/2023 average, reaching USD 359 billion. To support the integration of renewables and the adoption of technologies such as EVs and heat pumps in line with IRENA's 1.5°C Scenario, annual grid investment needs to reach USD 671 billion between 2025 and 2030 (IRENA *et al.*, 2025a), requiring an increase of 1.9 times current investment levels.

Based on recently announced plans, global spending on grids is expected to continue rising (BNEF, 2024a), but most of these plans have been made in China; in advanced economies such as Australia, the European Union, Japan, the Republic of Korea and the United States; and in EMDEs such as Brazil, India and Indonesia (IEA, 2023a). However, for many countries – particularly EMDEs and LDCs – the core challenge in financing grids lies in the limited resources of governments and utilities, as well as the inability to recover costs from consumers due to the presence of non-cost reflective tariffs, while simultaneously needing to both upgrade grid quality and meet rapidly growing electricity demand (IEA, 2023a).

While two-thirds of total transmission spending in EMDEs came from public sources in 2022 (OECD and IEA, 2024), this share may be shifting towards the private sector in some economies. Countries like Brazil and India are increasingly relying on private capital to expand their grids, mainly through independent transmission projects tendered to private developers (BNEF, 2024a).

In economies where grid investments have occurred, only 16% of overall investment in 2024 was directed towards new connections (*i.e.* new transmission corridors and distribution infrastructure), 44% went into the replacement of ageing assets, and the remaining 40% went into grid reinforcements (*e.g.* structural upgrades to improve flexibility and digitalisation) (ETC, 2024a).[10] Globally, more than 1650 gigawatts (GW) of wind, solar PV and hydropower projects were waiting in grid connection queues – up from around 1500 GW in 2023, and five times the amount of new capacity commissioned in 2022 (IEA, 2024a).[11] Large queues are due to a mix of factors, including constraints related to grid capacity, planning and permitting processes, which could deter future investment in renewables. While some grid operators have taken measures to alleviate queue blockages, their benefits may not come into effect for a few years (BNEF, 2024a).

In 2023,[12] 65% of global grid investments were financed through market rate debt, mainly from commercial financial institutions and corporations; project-level equity made up 33% (CPI, 2025), and the remaining 2% was funded through grants. The reliance on market rate debt will likely persist so as to unlock the sheer volumes of funds required for grids. This debt can make electricity tariff rates more sensitive to periods of high inflation and interest rates (due to the increase in debt servicing costs) (BNEF, 2025b).

Balancing cost volatility with affordability will continue to be a key challenge for regulators (Peña *et al.*, 2025). Regulators will need to set tariffs in a way that allows sufficient cost recovery and a reasonable return for investors, while ensuring that consumers do not get charged unaffordable bills (Watt-Logic, 2018). Major utilities in Germany and California (United States), for example, have faced significant public backlash after hiking their retail rates by 10-20% over the last few years, as inflation and and living costs have risen (BNEF, 2024a, 2025b).

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[10] *See exhibit 6, page 11 of ETC, 2024a.*

[11] *Some estimates have grid connection queues at 2.6 TW in 2023 in the United States alone (Berkeley Lab, 2024).*

[12] *The latest data available.*

Based on CPI estimates, only one-quarter of global grid investment in 2023 (USD 86 billion) serves renewable energy generation (CPI, 2025),[13] as fossil fuels still produce majority of the world's electricity despite their declining role in the power mix (IRENA, 2025). Although not immediately serving renewable energy integration, the remaining three-quarters of investments still contribute to energy efficiency through reduced losses, enhanced flexibility (including facilitating the management of power supply and demand), and resilience. In addition, these investments will facilitate future investment in renewables and their integration.

1.1.3 Battery storage

Global investments in energy storage (batteries) reached USD 54 billion in 2024, a 73% increase over the average investment in 2022/2023, and more than 11 times the 2019/2020 levels. To align with a 1.5°C pathway, annual investments would need to triple (Figure 1.2), enabling further integration of renewables while ensuring a reliable, flexible and resilient power system.

Recent growth in battery storage investments is underpinned by a 94% cost decline between 2010 and 2024, driven by a scale-up in manufacturing, improved materials efficiency and advancements in manufacturing processes (IRENA, 2024b). Targeted policy support has further enabled deployment in certain markets.

China – the world's largest battery manufacturer – accounted for 40% of global investments in energy storage projects in 2024 and installed the most capacity, at 84 gigawatt-hours (GWh; 36 GW), representing an increase of 80% compared with the additions in 2023 and accounting for half of total global addition (IRENA, 2024b). This growth is driven by co-location mandates, provincial subsidies (Ye, 2025) and the domestic availability of battery technology. In the **United States**, incentives under the Inflation Reduction Act positioned it as the second largest destination of battery storage investments, making up 29% in 2024 and adding 41 GWh (13 GW), almost a quarter of global newly added capacity. Germany is the third largest destination for energy storage investments, making up 11% of such investments globally.

Investments in battery storage in developing economies such as Chile, India, the Philippines and South Africa are also growing (more than doubling between 2022/2023 and 2024), making up 3% of the total global investments. In the Philippines, construction is set to begin on a USD 3.3 billion project to develop one of the world's largest integrated solar-plus-battery facilities, combining 3.5 GW of solar generation with a 4.5 GWh battery energy storage system, spanning 3 500 hectares (Jowett, 2024a). Some countries, such as India and Indonesia, are also making efforts to support deployment by localising battery production (see Chapter 3 on supply chains).

[13] *This estimate was derived from CPI methodology and BNEF data on distribution and transmission investment, including system reinforcement, asset replacement and new connections. The climate relevance was assessed using renewable energy installed capacity and generation data over the rolling period of the last five years to estimate how much of the investment in grids can be classified as serving renewable energy generation for each market (country's or region's) (CPI, 2025). Further breakdowns by instrument and actor were informed by other sources, including IJ Global. While these data are based on general grid investment, the relative shares are used as a proxy in the clean grid analysis. This estimation exercise is newly developed in its first year and remains subject to ongoing refinement of assumptions and methodology. The results should therefore be interpreted as indicative only.*

1.1.4 Electrified transport (electric vehicles and charging infrastructure)

Global investment in EVs – including battery EVs (BEVs), plug-in hybrid EVs and fuel-cell EVs – surged to USD 763 billion in 2024, up 33% from 2022/2023 (Figure 1.1). This increase was driven by strong policy incentives for EVs, widespread rollout of public charging infrastructure and expanding availability of EV models from major automakers. The EV share of total car sales worldwide has increased from 4.4% in 2020 to 22% in 2024, catering to a wide range of consumer preferences, with 784 EV models available in the market as of 2024 (IEA, 2025a).

Investments in EV charging infrastructure grew 27% over the same period, reaching USD 39 billion in 2024 (CPI, 2025), three-quarters of which was for public charging. The number of public chargers in the global network reached 5.6 million in the first quarter of 2025, an increase of 1.7 million connectors compared with end-2023 (BNEF, 2025c).

Policy support for EVs

China and advanced economies combined accounted for more than 95% of global BEV investment in 2024; this has remained largely unchanged over the past five years.

China's growing dominance in the EV sector (49% of global BEV investment in 2024) can be attributed to a suite of measures. Between 2009 and 2022, the government introduced purchase subsidies as well as consumption and vehicle tax exemptions for EVs estimated to be worth more than USD 28 billion. Additionally, 760 000 public fast-charging points and 1 million public slow-charging points were installed in the country, more than in the rest of the world combined, and standardising the GB/T connector facilitated EV diffusion (Ecofactor, 2025). As a result, China accounted for 60% of global EV sales in 2022, with more than 6 million units sold (IEA, 2023a). In June 2023, China extended its EV tax incentives.

Europe accounted for nearly a quarter (23%) of global BEV investment in 2024 (down slightly from 27% in 2022/2023), reaching USD 97 billion. Growth in BEVs has slowed compared with previous years, rising only by 6% since 2022/2023 – a much smaller rise than in other regions. The phase-out and/or reduction of subsidies in some of the largest national markets, including France and Germany, have contributed to this slowdown.

The **United States** accounted for 19% of BEV investments in 2024, a steady share compared with 17% in 2022/23. Investment grew 35%, from USD 59 billion in 2022/2023 to USD 80 billion in 2024. Federal incentives, such as tax credits, and a range of state-level programmes had supported widespread adoption (Qadir *et al.*, 2024; IEA, 2025a), but many incentives have since been rolled back.

India and Australia saw BEV investments rise by approximately 87% and 33%, respectively, between 2022/2023 and 2024, reaching USD 8 billion and USD 4 billion, respectively. India's share of total BEV investment reached 2% in 2024 (up from 1.2% in 2022/2023), while Australia's share in 2024 was 1%, unchanged from 0.9% in 2022/23. In 2023, Australia introduced its National Electric Vehicle Strategy to accelerate the adoption of EVs through state-level subsidies and zero-interest loans (up to AUD 15 000 in the Australian Capital Territory), federal tax exemptions, and import tariff removals under the electric car discount (DCCEEW, 2023). The country is also prioritising the development of a national network of EV charging infrastructure and hydrogen refuelling stations. India's Faster Adoption and Manufacturing of Hybrid and Electric Vehicles scheme, launched in 2015, provides subsidies for EVs – including two-wheelers, three-wheelers and cars – and supports charging infrastructure expansion through government tenders. As part of this scheme, the target rollout of public charging points is at least 2 700 chargers in cities with more than 1 million inhabitants (Qadir *et al.*, 2024).

Electric vehicle charging infrastructure

Governments provided 75% of global investment in charging infrastructure in 2024. The remainder was provided by private entities, of which three-quarters came from households and individuals, and the remainder from corporations. Demographic factors and housing patterns can influence the source of capital (IEA, 2025a). In China, where high-density urban living and limited access to home chargers prevail, public investment accounted for 89% of total EV charging infrastructure funding in 2024. In China's major cities, where most residents live in high-rise apartments without private parking, home charging is often unfeasible, making EV adoption heavily dependent on public charging infrastructure, particularly DC fast-charging. This high-density urban context contrasts with many Western markets, where single-family housing enables more home charging (He *et al.*, 2022; McLane, 2021).

In Europe and the United States, the public sector makes up 60% and 62% of investments, respectively. US public investment in charging infrastructure has increased more than 200% between 2022/2023 and 2024, from USD 1 billion to USD 3.3 billion, driven by programmes like the USD 5 billion National EV Infrastructure Program. However, the rollout of further funding has been disrupted following Executive Order 14154 issued in early 2025, which paused further disbursements (IEA, 2025a).

1.1.5 Energy efficiency

Investments in energy efficiency – across industry, transport and buildings – grew by just 3%, from USD 337 billion in 2022/2023 to USD 346 billion in 2024.[14] It is estimated that energy efficiency improvements in buildings, industry and transport can deliver more than 25% of the emission reductions needed by 2050 under specific net-zero emissions scenarios (IRENA, 2024a; IEA, 2023b). However, the largest investment gap exists for energy efficiency measures – more than USD 1.8 trillion per year – requiring a more than seven-fold increase in current investment levels.

The demand for new housing and infrastructure drives increased demand for industrially processed materials such as cement and steel, themselves major hard-to-abate segments of the industrial sector. Rising incomes are also driving greater appliance ownership and use, alongside growing demand for cooling. Meanwhile, the already growing data centres, now expected to boom due to the influx of artificial intelligence-related technologies, will further drive demand. With energy demand set to rise considerably, the need for energy efficiency improvements is critical.

While notable energy efficiency gains have been made across buildings, industry and transport sectors globally since 2010, achieving additional energy efficiency gains in industry remains a significant challenge as industrial processes require high-temperature heat as well as feedstocks currently produced by fossil fuels. Industrial infrastructure also comprises long-life assets that have few opportunities for upgrades and are extremely costly to replace (IEA, 2024b). Despite the challenges, there remains a strong business case for investing in the industrial sector's energy efficiency given that the solutions often reduce production costs, improve competitiveness and reduce emissions simultaneously.

[14] *Energy efficiency in industry covers improved process efficiency, demand-side management solutions, highly efficient energy and motor systems, and improved waste processes. Energy efficiency in transport covers all passenger and freight transport modes, notably road, rail, aviation and shipping. Vehicle stock investments are excluded. Energy efficiency in buildings covers retrofits and upgrades of glazing; insulation; and heating, ventilation and air conditioning.*

1.1.6 Green hydrogen

Green hydrogen investments declined for the first time in 2024. Export and market risks are weighing considerably on projects, based on IRENA's survey of more than 65 financial institutions, project developers and other stakeholders (see Deep dive 1).

Investment trends

After significant growth in the previous four years, annual investments in green hydrogen declined by 20% in 2024 compared with 2023.[15] The sector faces significant economic, policy and technology related barriers, including high production costs, uncertain demand and limited infrastructure for transport and storage. This exposes projects to a range of risks, which have materialised in the form of many high-profile projects facing cancellations, for example Ørsted A/S in Germany and the United Kingdom in 2023; Woodside's 1.7 GW Project in Tasmania, Australia, in 2024 (Fuel Cell Works, 2024); Fortescue's Coyote project in Canada in 2024 (Parkes, 2024); and two ArcelorMittal projects in Germany in 2025 (Reuters, 2025). Even projects that reached financial close are facing significant challenges; for example, Fortescue cancelled two green hydrogen projects in Australia and the United States after reaching financial close in 2023 and having already started construction (Fuel Cells Works, 2025; Martin, 2025). The Saudi Neom project (2.2 GW) is struggling to find offtakers two years after reaching financial close (Gulf News, 2025: 20; NEOM, 2023).

As green hydrogen investments need to be scaled up by a factor of almost eight, to USD 68 billion per year, between 2024 and 2030 to reach the IRENA 1.5°C Scenario, these risk factors must be identified and mitigated.

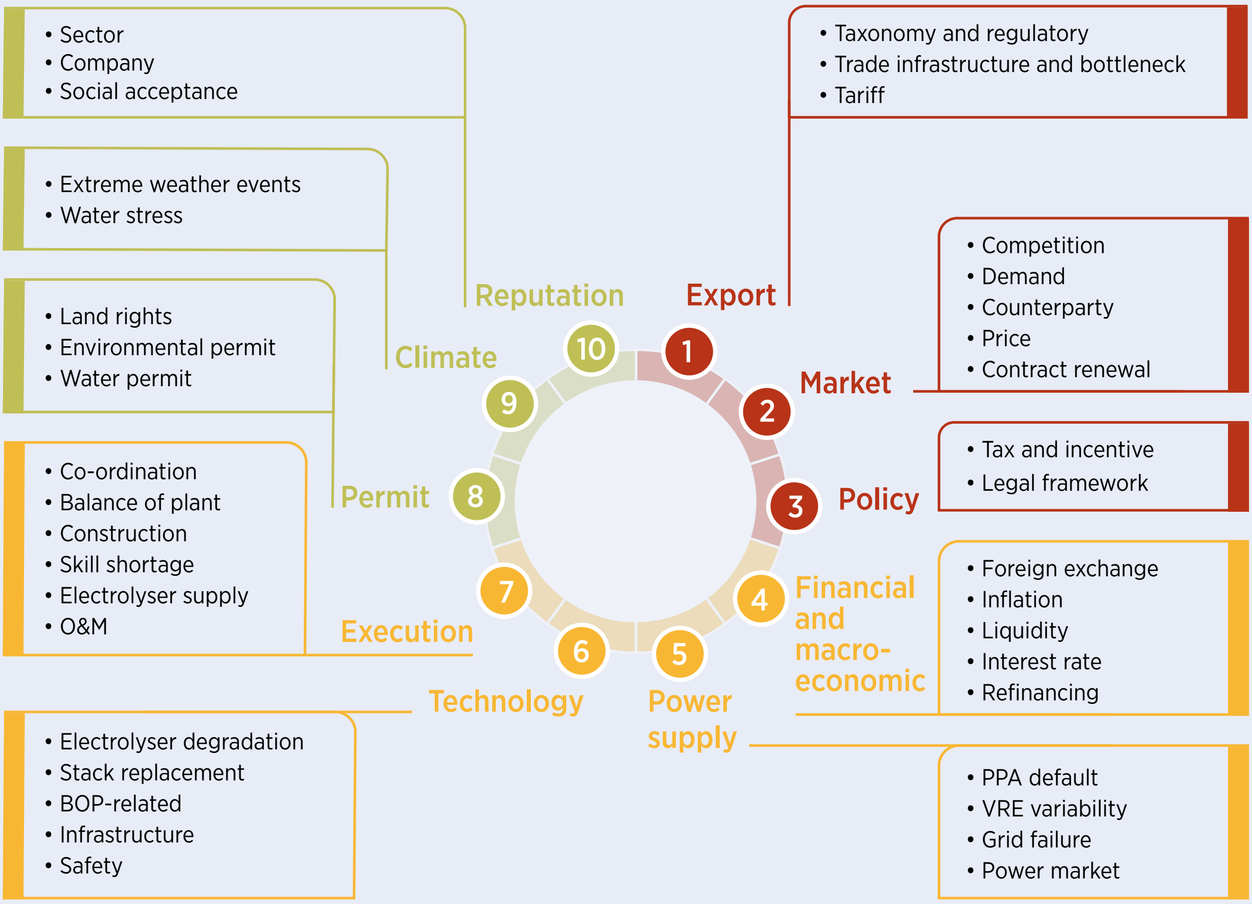
[15] *Although they are up 51% compared with the average investment in 2022/23 because 2022 numbers are very low, bringing the average down.*

Deep dive 1: De-risking green hydrogen projects

IRENA surveyed more than 65 financial institutions, project developers and other stakeholders to identify key risks facing current and prospective green hydrogen projects, and what governments can do to mitigate these risks.

Based on a literature review and expert interviews, 38 identified risks were classified into ten categories, as shown in Figure 1.4.

Figure 1.4 Results of the survey on risks facing green hydrogen projects



Notes: O&M = operations and maintenance; PPA = power purchase agreement; VRE = variable renewable energy; BOP = balance of plant.

A survey was launched that used mix-method sampling to assess the magnitude of each risk (high, moderate and low, depicted in orange, yellow and green, respectively, in Figure 1.4), with findings further cross-examined through expert interviews. The results of the survey showed that participants ranked **export, market and policy** risks as the most important risks, followed by economic and financial, power supply, and technology related risks, with risk perceptions varying considerably across different stakeholders. Table 1.1 shows the risk perception of green hydrogen by stakeholder group. Although the results of the survey offer useful insights, a larger survey with a more representative sample would be needed to confirm many of the findings in this deep dive.

Table 1.1 Green hydrogen risk perception rating by stakeholder group

<table>
<tr><th>Stakeholder group</th><th>Highest rated</th><th>Second highest</th><th>Second lowest</th><th>Lowest</th></tr>
<tr><td>Project developers (n=10)</td><td>Market</td><td rowspan="2">Export</td><td rowspan="2">Climate</td><td rowspan="2">Reputation</td></tr>
<tr><td>Consultant/advisory (n=13)</td><td>Policy</td></tr>
<tr><td>Research, think tanks, IGOs (n=7)</td><td rowspan="2">Export</td><td>Policy</td><td>Reputation</td><td>Climate</td></tr>
<tr><td>Financial institutions (n=16)</td><td>Market</td><td>Climate</td><td>Reputation</td></tr>
<tr><td>End users (steel) (n=2)</td><td colspan="2">Policy, power supply</td><td>Permit, reputational</td><td>Climate</td></tr>
<tr><td>Oil and gas/energy companies (n=8)</td><td>Market</td><td>Export</td><td rowspan="3">Climate</td><td rowspan="2">Reputation</td></tr>
<tr><td>Electrolyser manufactuers (n=3)</td><td>Export</td><td>Policy</td></tr>
<tr><td>EPC contractors (n=2)</td><td>Power supply</td><td>Market</td><td>Technological</td></tr>
<tr><td>Others (n=6)</td><td>Macroeconomic and financial</td><td>Export</td><td>Policy</td><td>Reputation</td></tr>
</table>

Notes: EPC = engineering, procurement and construction; IGO = intergovernmental organisation.

Different stakeholders in the green hydrogen sector perceive risks differently (see Table 1.1). The perception of risk in green hydrogen projects is shaped by the specific role and exposure of different stakeholders along the value chain. Export, policy and market risks are the primary concerns across all stakeholder groups, although the underlying drivers may differ. Power supply and broader macroeconomic and financial risks are high risks to some groups, but of limited concern for others.

Across all stakeholder groups – except for engineering, procurement and construction (EPC) contractors and end users – export risk is perceived as the highest or second highest concern. This underscores the diverse challenges of export-oriented green hydrogen projects, given the lack of harmonisation of standards, tariffs and regulations, which together may cause market fragmentation. Concerns about delays or failures in rolling out export infrastructure such as terminals and pipelines (*e.g.* the delayed Danish-German hydrogen pipeline project) (Energienet, 2024) were also recognised as a significant issue. Indeed, export-oriented projects, compared with domestic use cases, face an additional layer of complexity and risk.

Project developers display a higher overall risk perception, reflecting the direct impact of various risks on their business models, compared with other stakeholders who might be only indirectly affected. For developers, market risk is the highest concern (while being the second highest risk overall), displaying its central role for project viability. Uncertainties around the demand for green hydrogen and its derivatives make securing long-term offtake agreements and the reliability of offtakers meeting their contractual obligations very important.

Market risk has already been identified as one of the biggest concerns for developers, as the lack of secure offtake agreements may prevent projects from moving to implementation. The creation of a market and a reliable and predictable demand for green hydrogen is possible through policy action (*e.g.* through quotas, public procurement or carbon pricing schemes) (IRENA, 2020).

Financial institutions perceive risks to be lower than project developers do, with export, market and policy risks being viewed as the highest concerns, followed by economic and financial risk, which is not their main concern. Instead, financial institutions place greater emphasis on market conditions and enabling policy frameworks as a premise for investment. Financial institutions also assess technological risk to be higher than stakeholders such as electrolyser manufacturers, EPC contractors and project developers, reflecting the financial institutions' concerns of projects' long-term viability and potential for technology failure. Financial institutions may therefore be particularly risk averse to first-of-a-kind projects.

Electrolyser manufacturers exhibit a narrower, more manageable risk perception profile. While they recognise certain export and policy-related risks, their direct exposure is generally lower once electrolysers have already been sold. Policy risk and primary uncertainty and changes around taxation, incentives and legal frameworks affect the business case for green hydrogen projects, thereby affecting the demand for electrolysers (IRENA, 2024d).

EPC contractors, downstream stakeholders (*i.e.* steel industry) and energy companies rank power supply risk significantly higher than other stakeholder groups, which assess risk related to power supply as moderate. This higher rating stresses the importance of reliability of supply for offtakes, as any interruption or variability could affect production processes and the ability to meet commitments.

EPC contractors rank technological barriers as particularly low, a view shared across stakeholder groups, which generally rank technological risks moderately. These rankings indicate stakeholders' relative confidence in the availability and advancement of electrolysers and components. The growing number of electrolyser manufacturers, led by China, followed by Europe and the United States, results in significant overcapacity, with more than 100 manufactures worldwide (BNEF, 2025d).

End users in the steel sector rank execution risk as a greater concern, driven by potential construction delays and cost overruns. While execution risk is only ranked moderately overall, end users are more directly impacted. Several businesses are attempting to address this concern through modularisation and scalable electrolyser system design.

Across stakeholder groups, the overall lowest concerns were those related to climate and reputation. Although concerns about water supply and social acceptance rank low for most stakeholders, community engagement and environmental assessments remain central to ensuring the sustainable development and deployment of green hydrogen. The discourse around hydrogen and water usage is especially prevalent in regions where water scarcity is already a concern (IRENA, 2025).

To effectively mitigate these risks and accelerate investments in green hydrogen projects, it is important to take the differing risk perceptions of these stakeholder groups into account. Tailored strategies and adapted mitigation measures are necessary to advance the deployment of green hydrogen and the successful implementation of projects.

IRENA has developed analytical work to support policy makers in creating policy and finance frameworks for green hydrogen deployment, including instruments to promote the production of green hydrogen (IRENA, 2021a), decarbonise industrial sectors using green hydrogen and its derivatives (IRENA, 2022b, 2025b) and catalyse sustainable industrial development (UNIDO *et al.*, 2023).

The report *Green hydrogen auctions: A guide to design* provides detailed guidance on auction designs for green hydrogen, which can help mobilise investments (IRENA, 2024e).

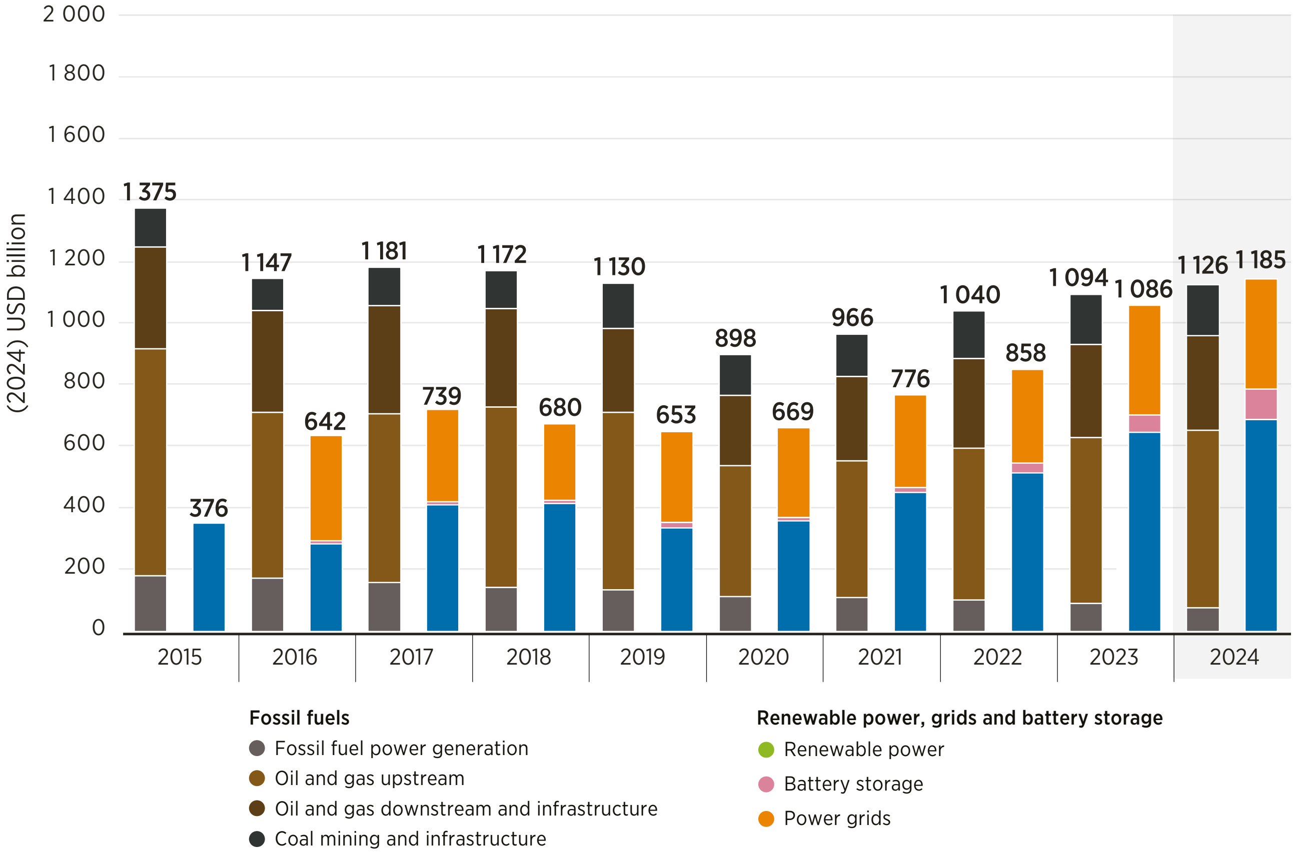
In addition, IRENA provides capacity building to Member States on green hydrogen strategy and policymaking, equipping governments with the knowledge to develop a national policy framework for the green hydrogen sector.

1.2 Investments in fossil fuels, renewables, grids and batteries

Investments in renewable power, grids and battery storage – which are essential to meet the pledge to triple renewable power capacity by 2030 in line with IRENA's 1.5°C Scenario – exceeded fossil fuel investments in 2024 (Figure 1.5).

However, vast resources are still allocated to carbon-intensive activities. Fossil fuel investments, including upstream, downstream and infrastructure investments, have been increasing since hitting a low in 2020. By 2023, they had almost returned to pre-pandemic levels, approaching levels seen in 2018/2019. Growth continued in 2024, although the increase was relatively modest at just 3%. This expansion in fossil fuel investment can be partly attributed to Europe's efforts to secure alternative oil and gas supplies following the Ukraine conflict.

Figure 1.5 Annual investments in renewables, grids and storage versus fossil fuels, 2015-2024



Based on: (CPI, 2025), (IEA, 2024c), (BNEF, 2025a), (IRENA *et al.*, 2025a).

Notes: Renewable energy investments are deflated to base year 2023 as these data were finalised prior to 2024 deflators becoming available. If renewable power investments are deflated to base year 2024, investments in renewable power, battery storage and grids combined may have first exceeded fossil fuels in 2023.

Fossil fuel investment is also driven by public financial support, which is still strongly skewed towards coal, oil and gas. In 2023, government support for fossil fuels reached at least USD 1.5 trillion, the second highest annual total on record after 2022[16] (IISD, 2024a). Public support consists of subsidies, capital investments made by state-owned enterprises (SOEs), and public finance. Globally, fossil fuel subsidies totalled USD 1.1 trillion in 2023 (Fossil Fuel Subsidy Tracker, 2024), the majority of which supported consumption, driven by higher international energy prices. Consumption subsidies distort markets: they encourage consumers to use more fossil fuels than they otherwise would and reduce input costs for electricity and industry, which disincentivises energy efficiency and a shift to low-carbon alternatives. Untargeted subsidies mainly benefit wealthy individuals, who use more energy. Instead, governments can phase out these subsides and redirect revenues towards targeted social protection to reduce poverty and inequality and towards the provision of clean energy alternatives. However, subsidies for clean energy alternatives should be similarly targeted to deliver equitable benefits.

Around one-third of public financial support for fossil fuels (USD 447 billion in 2023) locks in new fossil fuel production through subsidies (USD 36 billion), capital investments by SOEs (USD 368 billion) and international public finance (USD 29 billion). These subsidies perpetuate dependence on price-volatile fossil fuels, undermining energy security objectives (IISD, 2025a).

The G20 governments provided around USD 168 billion in public financial support for renewable power in 2023, less than one-third of G20 fossil fuel subsidies that year (IISD, 2024b). Since 2009, G20 countries have pledged to gradually eliminate fossil fuel subsidies that promote inefficient and wasteful consumption – a commitment echoed by all parties to the 2015 Sustainable Development Goals (target 12c) and reinforced in the 2023 Global Stocktake under the Paris Agreement, which urged governments to accelerate subsidy phase-out. While some nations have referenced fossil fuel subsidies in their climate pledges (Nationally Determined Contributions [NDCs]), few have committed to clear timelines, and only the G7 has set a formal deadline of 2025 – though it is unlikely to be met (IISD, 2025b).

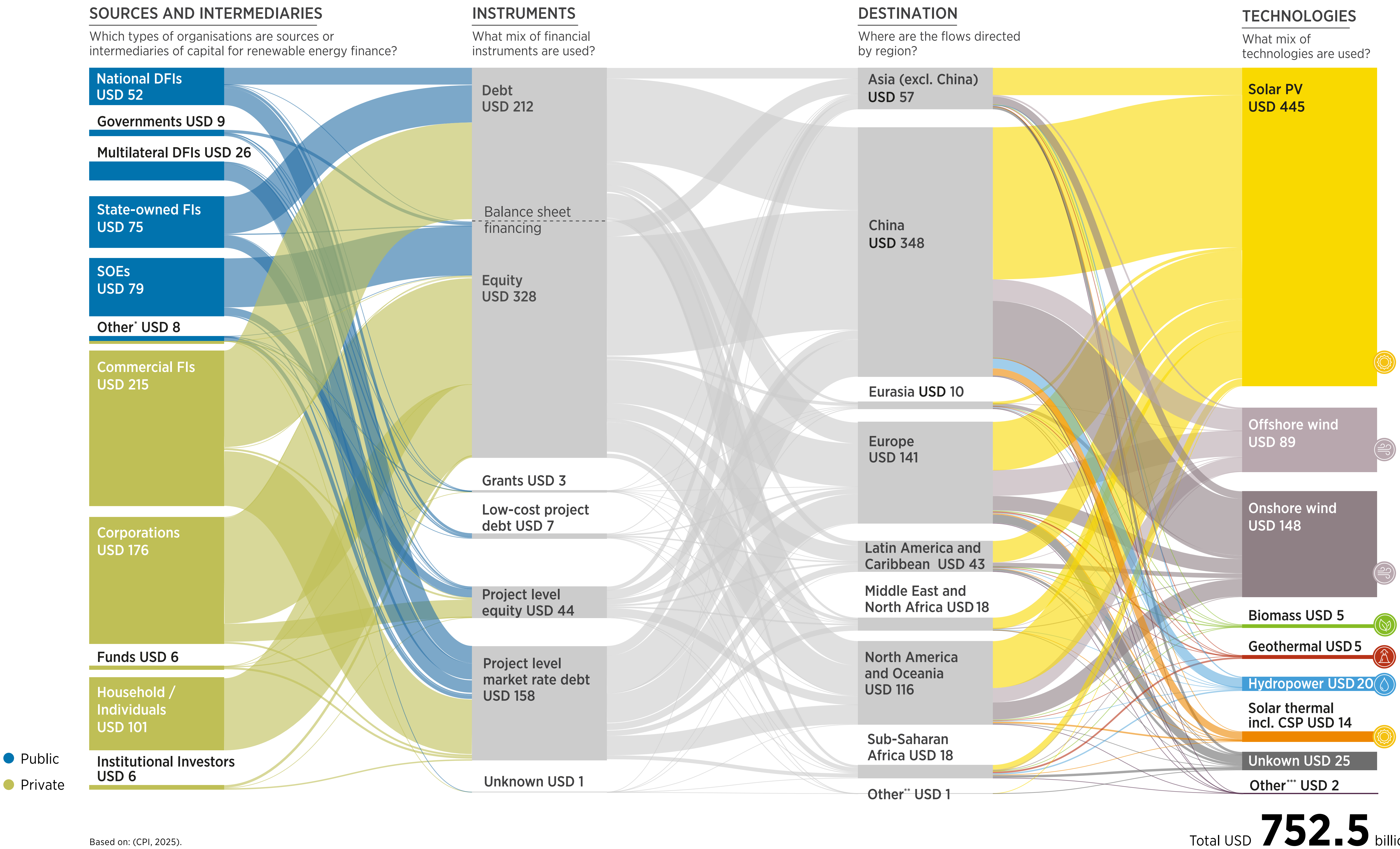
Public financial flows play a pivotal role in the energy transition. These financial flows should lead the shift away from fossil fuels as governments have direct control over them and can use them to steer much larger private investments. However, if public institutions delay action and continue backing fossil fuel interests, they risk becoming the fallback financiers, increasing exposure to stranded assets and limiting their ability to fulfil broader social and economic responsibilities (IISD, 2023).

[16] *Based on latest data available.*

02 RENEWABLE ENERGY INVESTMENTS BY TECHNOLOGY AND REGION

The global landscape of renewable energy finance consists of a complex flow of private and public investments that fund renewable energy projects through a range of financing models and instruments. The Sankey diagram in Figure 2.1 provides an overview of this landscape in 2023, based on the latest data available.

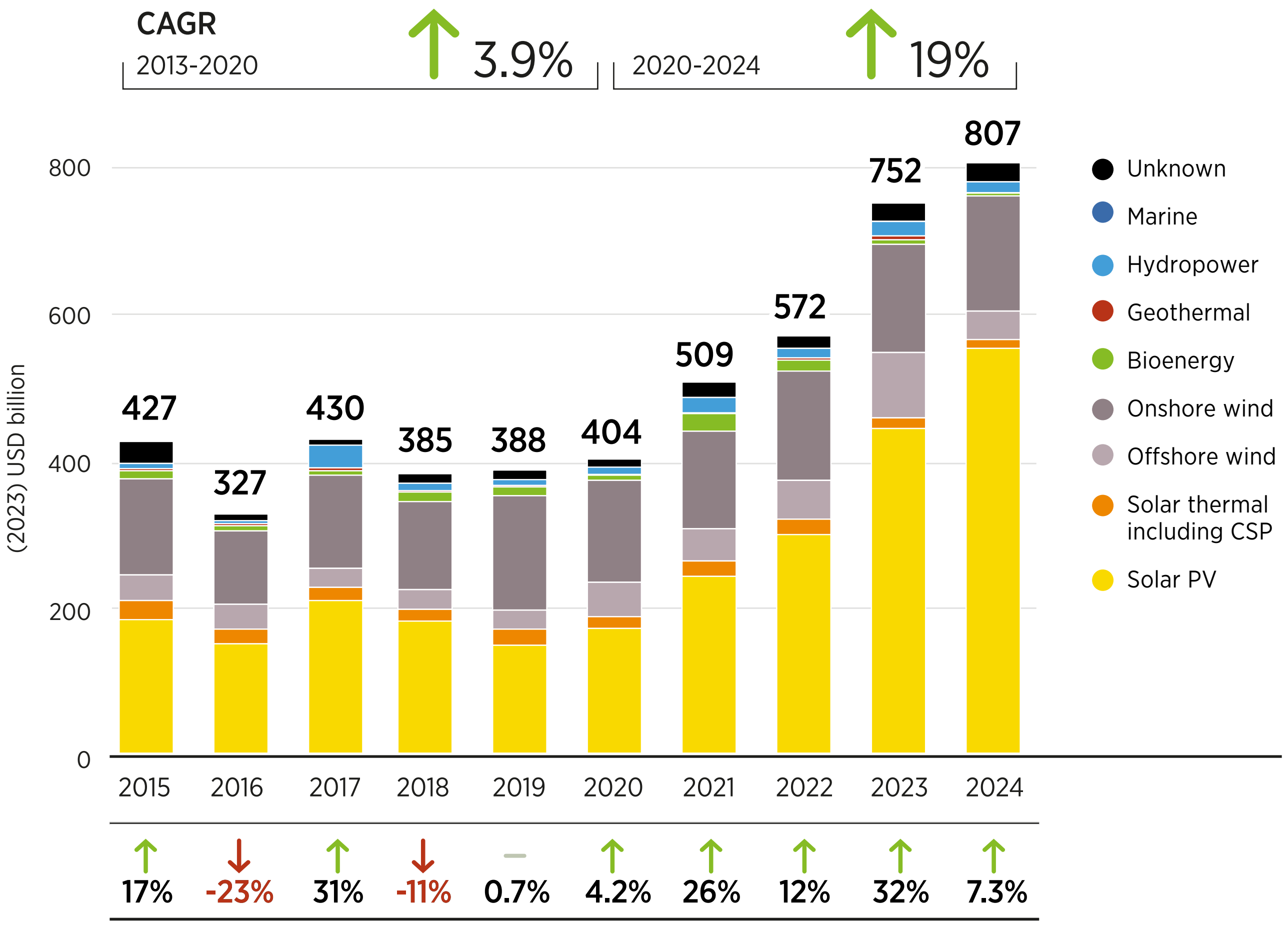
Figure 2.1 Global landscape of renewable energy finance, 2023 (USD billion)



Based on: (CPI, 2025).
Notes: CSP = concentrated solar power; DFI = development finance institution; FI = financial institution; PV = photovoltaic; SOE = state-owned enterprise.
* Other public sources include bilateral DFIs, export credit agencies (ECAs), multilateral climate funds, funds, public funds and unknown sources. "Other" private sources include non-profit driven organisations such as social enterprises, co-operatives, philanthropies, and charities, and unknown sources.
** Other regions inlude transregional and unknown values.
*** Other technologies include marine (USD 0.08), biofuels (USD 0.57) and biogas (USD 0.86).

In 2024, global investments in renewables reached another record high of USD 807 billion, but year-on-year growth has slowed down (Figure 2.2).[17] Annual investments grew just 7.3% in 2024, compared with 32% in 2023, when the US Inflation Reduction Act, the EU's REPowerEU and China's 14th Five-Year Plan for Renewable Energy kicked in. This slowdown can partially be explained by the initial surge of investments resulting from the incentives offered under these policies may have normalised. In addition, permitting issues and grid connection queues – particularly within the wind sector – have contributed to a slowdown.

Figure 2.2 Share of global renewable energy investments by technology, 2018-2024



Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025a).

Notes: CAGR = compound annual growth rate; CSP = concentrated solar power; PV = photovoltaic.

[17] *Investments for 2024 are estimated by applying the growth trajectory between 2023 and 2024 from (BNEF, 2025a) to 2023 CPI data.*

Policy cutbacks in the United States are undermining the country's earlier efforts to deploy renewable energy. The One Big Beautiful Bill Act (OBBBA) has reduced the US renewable energy and energy storage outlook up to 2035 by 23% (BNEF, 2025e). Tax credits for wind and solar power projects have been scaled back considerably (further discussed in Section 2.1). Reprioritisation of fossil fuel generation, temporary halts on renewable project permitting on federal lands, a federal funding freeze and the imposition of new tariffs on key imports have affected renewable energy programmes. The Solar Energy Industries Association (SEIA, 2025) expects state-level initiatives and sustained corporate demand to provide a counterbalance, helping uphold some renewable energy development momentum despite federal policy volatility.

In China, the shift to market-based pricing for new renewable energy projects may slow down investment activity in the near-term, as investors, project developers, and other stakeholders adjust. From June 2025, new renewable projects have been subject to market pricing (Yang *et al.*, 2025). The policy is expected to hit some large-scale wind, solar and battery developments in the short term, but the introduction of competitive electricity markets – putting fossil fuels and renewables in direct price competition – is viewed as a "necessary step in the gradual reduction of electricity fuelled by coal and gas over the coming decades" (Stylianou *et al.*, 2025).

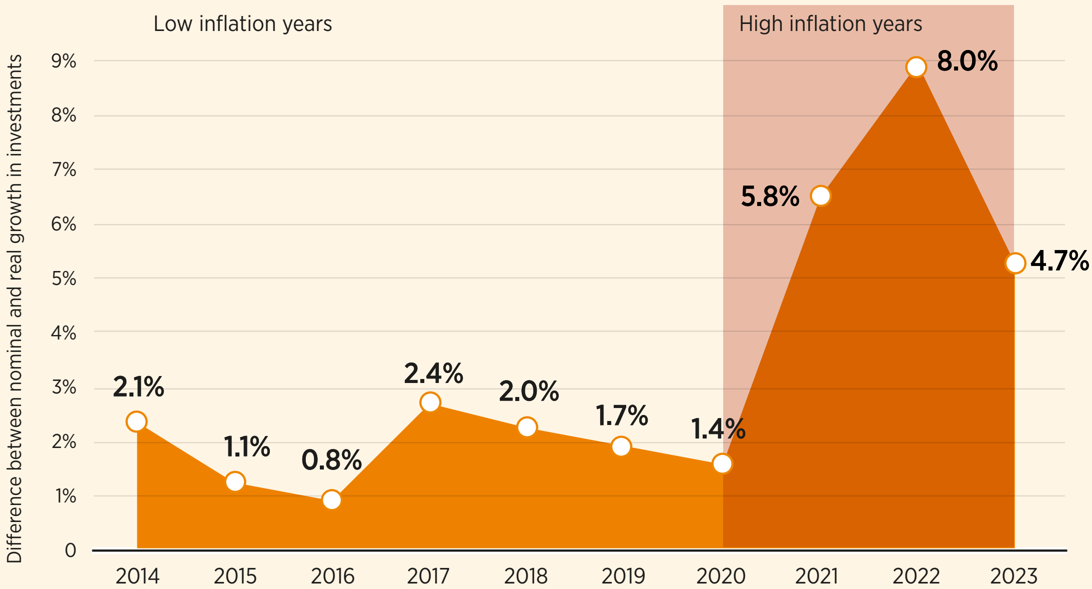
Despite policy cut-backs in the United States, and the shift to market-pricing in China, the global outlook for renewables remains positive. The adoption of China's first Energy Law in January 2025 places renewable energy at the core of national energy policy (Pozzi *et al.*, 2025). China's commitment to installing 3 600 GW of solar and wind capacity by 2035, compared with the 1 400 GW installed as of 2024, further reinforces this momentum. In Europe, the implementation of the Renewable Energy Directive III and related measures under REPowerEU aim to alleviate long-standing permitting bottlenecks and boost investment in renewables. Meanwhile, supportive policies and household demand remains a key driver of investment in EMDEs such as Brazil, South Africa, Pakistan and countries across Africa (Section 2.1).

Progress is expected to continue despite strong inflationary pressures, a high interest rate environment, and debt sustainability issues, particularly in developing countries. Even though renewable energy technology costs continued to decline up to 2024, the impact of inflation – with sharp cost increases particularly in shipping, copper, iron, labour and capital – became more pronounced between 2021 and 2023, especially in certain technologies, project sizes and regions (see Box 2.1).

BOX 2.1 Inflation's impact on renewable energy investments

Globally, inflation reduced the real growth in renewable energy investments by an average of six percentage points in 2021-2023 (*i.e.* the difference between the nominal and real growth rate each year between 2021 and 2023 was 6%), compared with two percentage points between 2014 and 2020 (Figure 2.3). However, these averages mask a likely greater impact in EMDEs. Although inflation is easing (IMF, 2025a; World Bank, 2025a), higher interest rates and debt sustainability issues pose significant challenges in EMDES (particularly LDCs), which faces an elevated cost of financing and diminished fiscal and monetary capacity (IMF, 2025b; UNCTAD, 2024b). The energy transition needs to be financed in a way that does not further exacerbate debt burdens.

Figure 2.3 Impact of inflation on investments: gap between annual nominal growth rate and real growth rate in renewable energy investment, 2014-2023

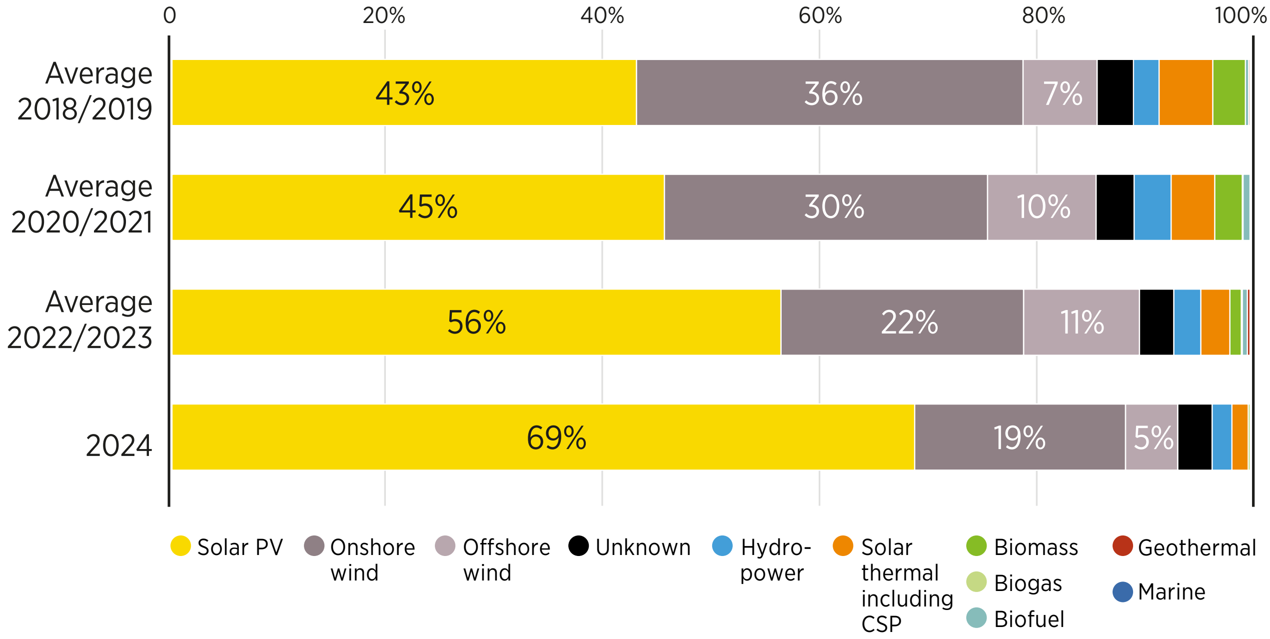


Based on: (CPI, 2025).

2.1 Renewable energy investments by technology

Solar PV and onshore and offshore wind technologies continue to dominate renewable energy investments,[18] making up a combined share of 93% of renewable energy investments in 2024, up from 89% in 2022/2023. Meanwhile, investments going to other renewable technologies (bioenergy, geothermal power, hydropower and marine energy) have declined in both absolute terms and relative terms, with their share dropping to 7% (from 11% in 2022/2023) (Figure 2.4).

Figure 2.4 Share of global renewable energy investments by technology, 2018-2024



Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025a).

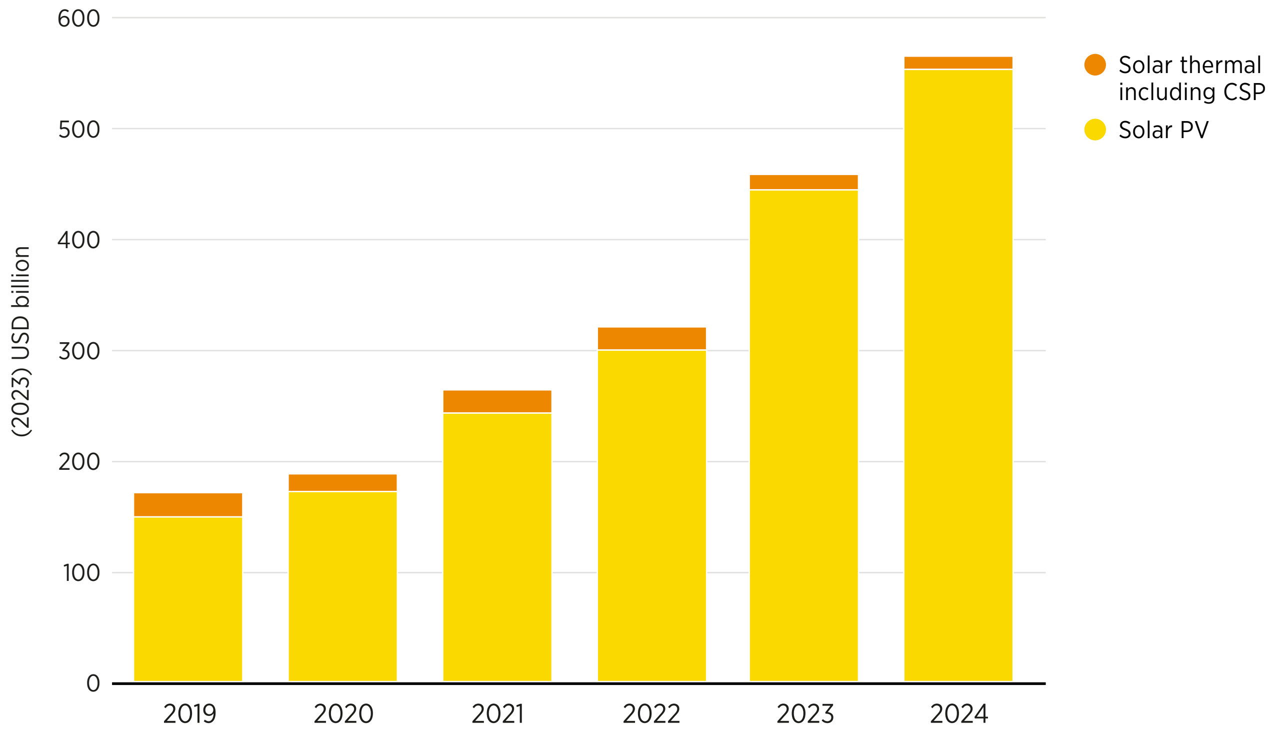
Notes: The "unknown" category captures projects that either (a) include multiple renewable technologies, which we cannot accurately split across technologies after further research, or (b) have no information on specific technologies (iv) Investments cover both power and end use, while those presented in Figure 1.2 and 1.3 are only for power; CSP = concentrated solar power; PV = photovoltaic.

[18] *In this section, investments are tracked at the time of FID – meaning the funds have been obligated or committed, legally speaking – rather than at the construction or project completion stage (i.e. when the resulting installed capacity is commissioned). This differs from (IRENA et al., 2025a), in which renewable energy investments were reported based on a capacity deployment approach (i.e. capacity deployment in a given year in megawatts, multiplied by the estimated unit cost of that technology in US dollars per megawatt). As the FID method offers more granularity on investments by regions, sources and instruments, it is the preferred method for this report to provide deeper insights into historical trends.*

2.1.1 Solar technologies

Investments in solar PV reached an all-time high of USD 554 billion in 2024, a 49% increase over 2022/2023, and over three times the amount invested before the COVID-19 pandemic in 2018/2019 (Figure 2.5). As a result, solar PV accounted for 69% of overall renewable energy investments in 2024 (Figure 2.4), up from 56% in 2022/2023. Policy support, combined with significant cost reductions for both utility-scale and small-scale projects, have contributed to this growth. According to (IRENA *et al.*, 2025a), solar PV investments are close to the average annual investments required under IRENA's 1.5°C Scenario (Section 1.1.1).

Figure 2.5 Annual investments in solar energy technologies (power and end use), 2019-2024



Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025a).

Notes: Investments are tracked at the time a project reaches financial close, rather than when project is commissioned. A decrease in investments in a given year may not translate into a decrease in the capacity installed in that same year. In 2019, for example, investments went down yet capacity added went up. This is in part due to cost decreases and in part due to the time lag between the financing and completion of a project. The average lag is estimated to be about 0.5 years for solar PV. CSP = concentrated solar power; PV = photovoltaic.

China, Europe and the United States remain the dominant solar markets, together accounting for 78% of additional solar PV deployment and 70% of investments in 2024. China reached its 2030 solar capacity target in 2024, six years ahead of schedule (IEA, 2025b), and has committed to installing more than 3 600 GW of wind and solar capacity by 2035.

In the **United States**, incentives under the Inflation Reduction Act have been rolled back, with the OBBBA either phasing out or modifying the eligibility for credits by the end of 2027. Some projects are required to meet specific "safe harbour" or "start of construction" definitions by July 2026 in order to meet the criteria for tax incentive eligibility (White & Case LLP, 2025). In October 2025, the US Bureau of Land Management listed the planned 6.2 GW Esmeralda 7 solar complex in Nevada as cancelled due to significant delays to its environmental review (U.S. Bureau of Land Manamement, 2025). Meanwhile, state-level initiatives are likely to continue driving some investment activity; many states have already established "green banks" to help leverage private capital for energy projects, as well as several renewable energy credit programmes for solar PV (Corvidae, 2025; DSIRE, 2025).

Europe – which made up 16% of solar investment in 2024 – has seen sluggish growth in solar PV, largely due to the gradual winding down of major EU structural support mechanisms such as NextGenerationEU and the Recovery and Resilience Facility, set to end in 2026 (Hemetsberger *et al.*, 2024).

EMDEs such as Brazil, Pakistan and South Africa and smaller markets such as Lebanon have also observed notable increases in solar PV investments, led in many cases by household funding for decentralised systems. Households make up a significant portion of investments in these countries – 43% in Brazil, 36% in Pakistan, 28% in South Africa, and 65% in Lebanon – based on the latest data from 2023 (some of these countries are discussed in Box 2.2 and Section 2.2). With grid electricity either being too expensive, unreliable or unavailable, households in these countries have taken matters in their own hands, often supported by feed-in or net-metering policies and the availability of cheap solar imports from China (see Box 2.2). Oversupply of manufacturing capacity – particularly in China – has resulted in very low prices for modules globally (see Chapter 3 on supply chains). Neighbouring Pakistan, for instance, took advantage of cost-competitive Chinese exports and became one of the highest importers of Chinese solar modules in 2024, above India and Saudi Arabia, and right after Brazil and the Netherlands (Jones and Cospey, 2025).

BOX 2.2 Solar PV growth in selected EMDEs

In **South Africa,** solar PV investments grew from USD 690 million in 2020/2021 to USD 3.6 billion in 2022/2023 (reaching a record high of USD 5.2 billion in 2023). This is due to a surge in rooftop installations, inspired by load shedding issues, which have been ongoing since 2007. Government policies and financial incentives have been pivotal in supporting this shift, including Johannesburg's city-operated feed-in tariff programme, a national tax rebate introduced in March 2023, and funding from the European Investment Bank and the Development Bank of Southern Africa (Rimblas, 2025). Furthermore, under South Africa's Renewable Energy Independent Power Producers Procurement Programme Bid Window 7 in 2024, the country procured 1760 megawatts (MW) of solar PV projects (ESI Africa, 2025), reinforcing its commitment to large-scale solar deployment. However, this growth has not been without challenges: regulatory delays, grid connection backlogs, limited financing options for small and medium enterprises, and constrained grid capacity are emerging as major obstacles (Kavitha, 2024).

India attracted USD 12.5 billion in solar PV investments in 2022/2023, up 88% from USD 6.7 billion in 2020/21. Preliminary figures suggest that in 2024, solar PV investments in the country further grew from the record high levels of 2023 (USD 4.8 billion). This momentum has been supported by government initiatives such as the National Solar Mission and the Production Linked Incentive scheme by the Ministry of New and Renewable Energy, which is designed to bolster domestic manufacturing of high-efficiency solar modules (Government of India, 2025). Under the Production Linked Incentive scheme, the Ministry of New and Renewable Energy has signed performance agreements with 11 companies to expand to 39.6 GW of local solar manufacturing capacity (Kumari, 2025). Furthermore, major power producers are significantly scaling up their investments in renewable energy, in line with the government's goal of achieving 500 GW of clean energy capacity by 2030 as part of its decarbonisation strategy (Sethuraman, 2024).

Brazil attracted USD 16.7 billion in solar PV investments in 2022/2023, more than doubling from USD 6.4 billion in 2020/21, driven by strong policy incentives and a rapidly growing distributed market. Preliminary numbers suggest that this upward trend continued in 2024. Anticipation of new regulations set to introduce gradual grid access for small-scale residential and commercial systems prompted a surge in rooftop solar installations and investment ahead of the changes (REN21, 2025a). This momentum carried into 2024, with the country adding 15 GW of new solar capacity. Growth has been led largely by the small-scale segment (less than 5 MW), which benefits from net-metering policies that allow households to generate power and earn credits for surplus energy (BNEF, 2025f).

Pakistan saw solar PV investments grow 36%, from USD 5.7 billion in 2020/2021 to USD 7.7 billion in 2022/2023, an increase that seems to have accelerated in 2024 (based on preliminary data). The country experienced one of the fastest solar PV booms globally, having imported 17 GW of capacity in 2024 (Ember, 2025) – enough to generate one-third of the country's total power if fully deployed (Mangi, 2024). A dramatic 155% increase in electricity tariffs over three years drove households and businesses towards rooftop and off-grid solar, supported by net-metering policies, falling global solar prices and attractive payback periods (Renewables First and Herald Analytics, 2024). However, as consumers self-generate and either partially or fully "disconnect" from the grid, they contribute less revenue to the grid itself, worsening utility finances and making grid-connected power more expensive. Lower-income consumer segments that are not able to afford rooftop solar systems and remain reliant on the grid may have to bear higher costs as a result, worsening existing inequalities (Ariba *et al.*, 2025).

Looking ahead, the pace of renewable energy investments in solar PV technologies is expected to grow (IEA, 2025b), though momentum will face increasing pressures amid evolving trade dynamics, tariff uncertainties, macroeconomic headwinds and shifting geopolitical dynamics (Hemetsberger *et al.*, 2025). As countries strive to meet climate targets and energy security goals, and as households turn to more affordable sources of power, solar PV technologies are likely to remain a key driver of global clean energy investment. To sustain this growth amid higher levels of market penetration, it will be critical to develop new business models, expand storage solutions and implement supportive policies to sustain momentum (Cheung, 2025).

The off-grid solar industry has been a major driver of energy access expansion, with more than USD 3.8 billion invested between 2012 and 2024 and more than 500 million people provided with new or improved access globally (Figure 2.6). Distributed renewable energy technologies – such as solar home systems and solar water pumps – are extending the reach of the energy transition to households, communities and enterprises beyond the grid (see Deep dive 2 on off-grid solar).

Deep dive 2 Off-grid solar investment landscape: expanding energy access

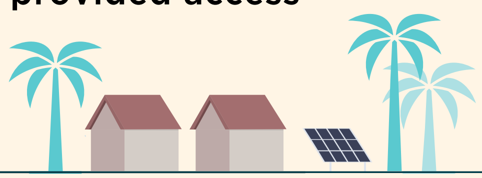
Off-grid solar technologies present a significant opportunity to achieve universal access to electricity for households, enterprises, smallholder farmers and public institutions (GOGLA, 2024). These technologies deliver clean, affordable, renewable electricity to hundreds of millions of people while contributing to broader socio-economic development goals. Off-grid solar will play a key role in achieving the Mission 300 goal of connecting 300 million people in Sub-Saharan Africa by 2030. It is the least costly and fastest option to reach approximately 45% of the targeted connections.[19] Nevertheless, the off-grid solar sector continues to face persistent financing challenges that constrain its ability to serve the poorest and most remote populations.

Data compiled by GOGLA show that the off-grid solar industry has raised over USD 3.8 billion between 2012 and 2024 (GOGLA, 2025). Over this period, off-grid solar delivered first-time or improved energy access to over 500 million people (GOGLA, 2024) (Figure 2 6).

Approximately 39% of off-grid solar funding has been in the form of equity, 57% in the form of debt (including 18% through securitisation of receivables), and 4% in the form of grants. While 50-100 companies have received funding annually in recent years, access to capital has been uneven. A select few multinational players have achieved scale and attracted larger, blended investments from institutional and commercial financiers, while many smaller and domestic enterprises continue to depend on catalytic and concessional capital to grow.

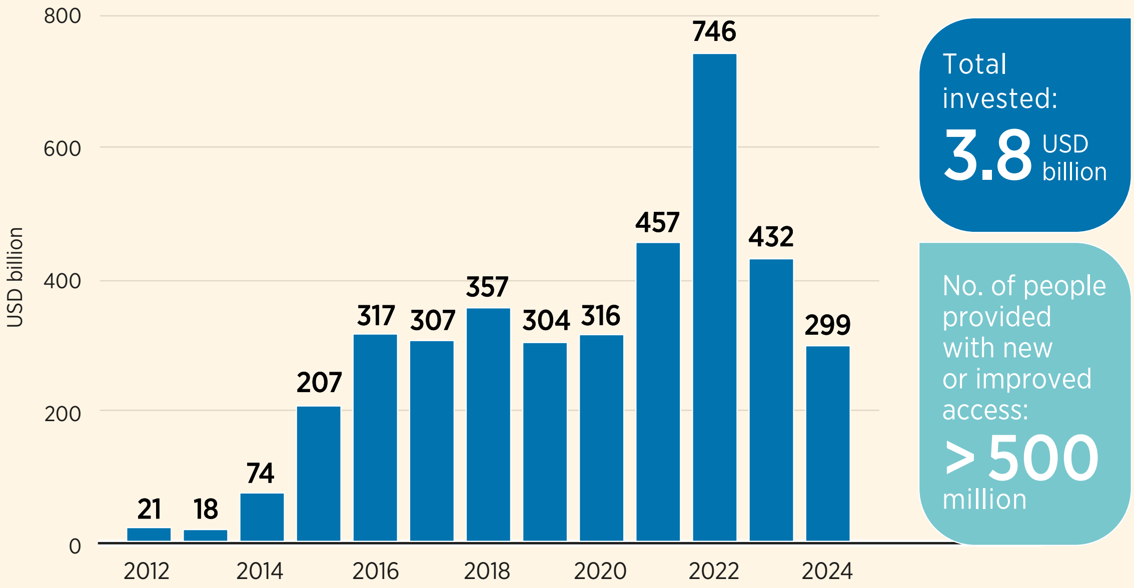
>3.8 USD billion (2012-2024)

worldwide invested in the off-grid solar industry, with >500 million people provided access



[19] *Bottom-up demand scenario, Global Electrification Platform (ESMAP, n.d.) (analysis based on Sub-Saharan Africa, using data available in 2025).*

Figure 2.6 Total investments (equity, debt and grants) in off-grid solar companies, 2012-2024



Source: GOGLA, Investments Database (2012-24).

Note: This does not include equity exits.

Following a peak in 2022 – when Sun King, one of the sector's largest companies, raised USD 330 million – overall equity, debt and grant flows declined in 2023 and 2024. This contraction reflects wider trends across the African venture capital landscape. Although consumer demand for off-grid solar solutions remains strong, macroeconomic headwinds – including high inflation, rising interest rates and currency depreciation – have dampened investment appetite and constrained market growth. To restore momentum, greater volumes of concessional capital and grants from public and development finance institutions (DFIs) are needed.

Local currency and off-balance-sheet receivables financing are becoming more prevalent, while innovative instruments are emerging to address financing gaps. New patient equity funds are being launched, the Green Climate Fund has expanded its engagement, and blended finance mechanisms are drawing new classes of investor into the space.

Momentum is growing through initiatives such as results-based financing and consumer subsidy programmes, which are increasingly being deployed to accelerate access. To date, more than USD 900 million has been committed to such mechanisms – over half within the last two years.[20]

Consumer subsidies will be essential to bridge the affordability gap. Current estimates indicate that only around one-quarter of people still without electricity access can afford basic off-grid solar products.

[20] *GOGLA, RBF and EUSL database (2013-24).*

Investments in solar thermal technologies (including CSP) fell to USD 12.1 billion in 2024 – their lowest since 2013. Outside China – the global leader in solar thermal deployment – the sector has struggled to grow due to long-standing issues such as large capital expenditure requirements, long lead times (four times more than solar PV), the availability of cheaper solar PV-storage hybrids, and insufficient policy support. Most of the project development pipeline for solar thermal (including CSP) remains concentrated in China, which hosted 87% (2 GW) of the global solar thermal capacity that reached financial close between 2023 and 2024 (BNEF, 2025g). However, CSP faced considerable challenges elsewhere: in Morocco, the Noor Ouarzazate plant (150 MW) experienced recurring technical faults and storage breakdowns in 2024, resulting in an estimated nine-month shutdown and losses of up to USD 47 million (El Jechtimi, 2024; El Jechtimi and Magid, 2024). The USD 2 billion (800 MW) Noor Midelt I plant is facing significant delays in construction (despite having secured a power purchase agreement), as the grid operator and the energy ministry negotiate for the original CSP design to be reshaped around cheaper PV modules and/or battery storage hybrids (instead of thermal salt energy storage) (El Jechtimi, 2024). Noor Midelt 2 and 3 were awarded as solar PV plus battery projects in 2024, instead of the initially planned PV-CSP hybrid (Aguinaldo, 2024; REN21, 2025b).

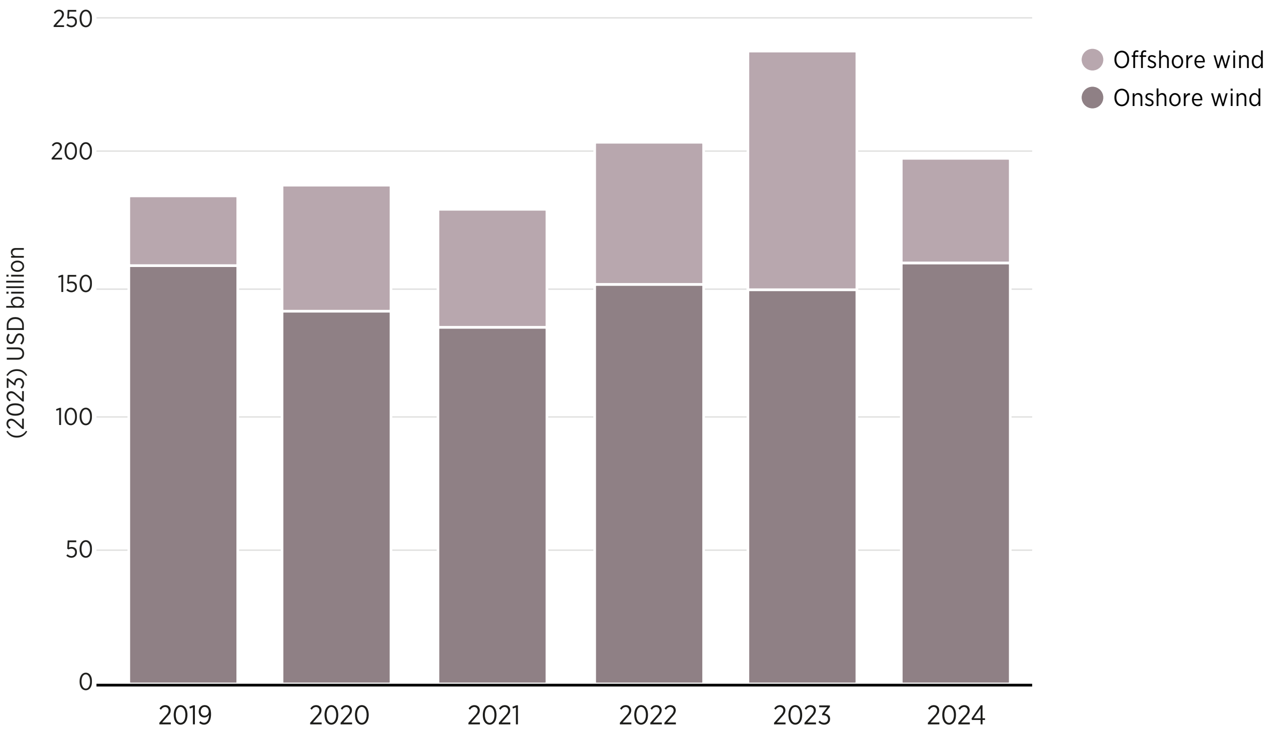
Elsewhere, Spain's 220 MW CSP auction held in 2022 did not award any projects, and the auction was not repeated, with the country delaying its target of 4.8 GW CSP installed capacity by 2025 for another five years (REN21, 2025b).

Overall, the required investments in CSP significantly falls short of what is needed under IRENA's 1.5°C Scenario (Section 1.1.1). Some of this shortfall may be partially offset by investment in solar PV–battery storage hybrids, although this claim warrants further analysis.

2.1.2 Wind technologies

In 2024, global investments in wind energy (onshore and offshore) reached USD 196 billion, down 10.5% from the levels in 2022/2023 (Figure 2.7). China remained the largest market for wind technologies combined, accounting for 50% in 2024 (BNEF, 2025a). Europe and the United States accounted for 20% and 14%, respectively, in 2022/2023.

Figure 2.7 Annual investments in wind power technologies, 2019-2024



Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025a).

Notes: Investments are tracked at the time a project reaches financial close, rather than when project is commissioned. A decrease in investments in a given year may not translate into a decrease in the capacity installed in that same year. The average lag is estimated to be about 0.9 years for onshore wind, and 2 years for offshore wind.

Investments in the two wind technologies followed opposing trends. While onshore wind investments set another record high at USD 157 billion in 2024, growing by 6% compared with 2022/2023, investments in offshore wind fell by 45% to USD 39 billion in 2024 (Figure 2.7). Although both sectors faced significant deployment challenges due to inflation, permitting delays, grid bottlenecks, and supply chain pressures (GWEC, 2024; IRENA *et al.*, 2024), these challenges are more pronounced for offshore wind, which has relatively longer permitting timelines (more than double on average), lower geographic feasibility and higher costs. Offshore wind also saw decreasing deployment due to rising financing and installation costs, particularly for projects whose contracts were finalised when costs were lower (ETC, 2024b; McKinsey & Company, 2024). These challenges have hampered project bankability in Europe and led to several cancellations in the United States (IEA, 2024d), and the challenges are expected to continue. In June 2025, Germany's auction for offshore wind resulted in a first-ever absence of bids, demonstrating a significant increase in risks for developers due to increased installation and financing costs as a result of geopolitical tensions and supply chain bottlenecks, as well as increasingly difficult-to-predict price and volume risks in the electricity market (Clean Energy Wire, 2025).

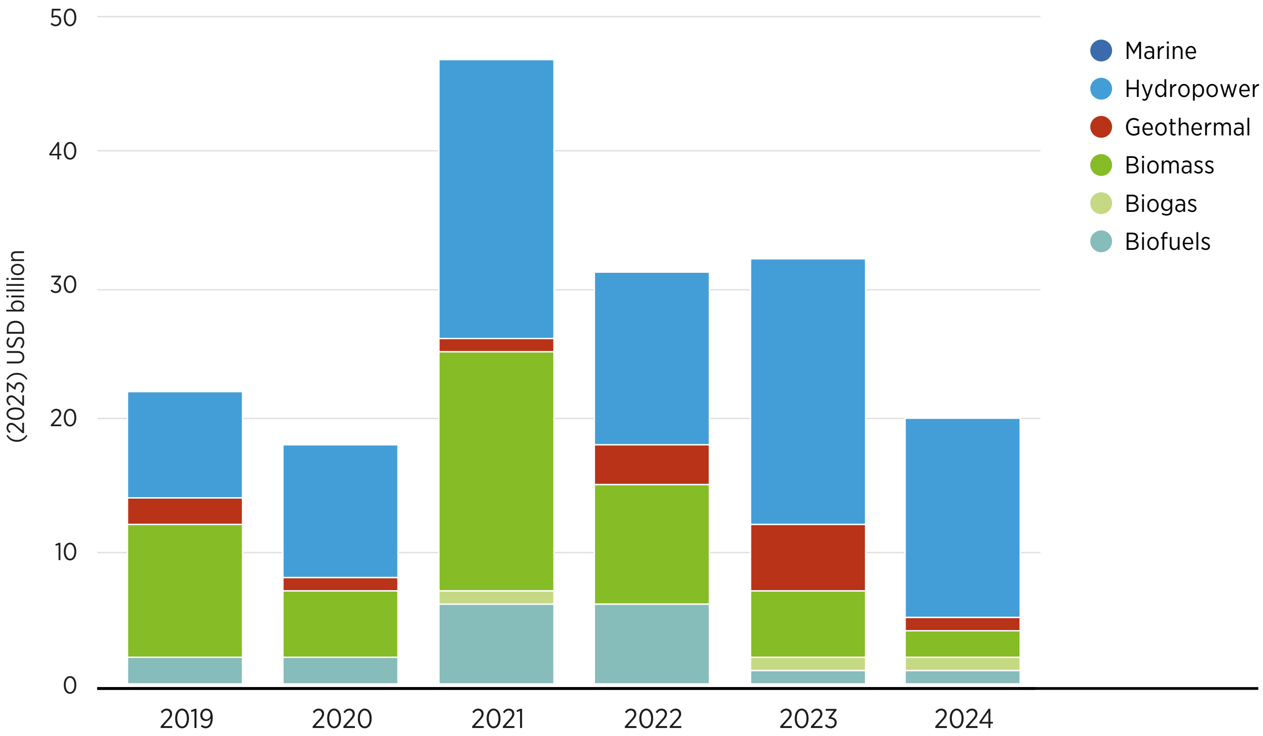
In the United States, an executive order was signed in January 2025 temporarily halting offshore wind lease sales in federal waters and pausing the issuance of approvals, permits and loans for both onshore and offshore wind projects (McDermott, 2025a). In July, the US administration cancelled plans to use more than 3.5 million acres of federal waters deemed most suitable for offshore wind development, and the Bureau of Ocean Energy Management proceeded to rescind all designated wind energy areas in federal waters (McDermott, 2025b). In August 2025, Ørsted A/S, the global leader in offshore wind and one of the largest renewable energy companies in the world (Ørsted, 2025), was downgraded by S&P Global Ratings to the lowest investment grade tier of BBB–, just one step above the "junk" rating, due to challenges including the Danish company's inability to carry out project refinancing and divest 50% of its US-based Sunrise wind projects (Mathis *et al.*, 2025).

The decline in offshore wind investments in 2024 was recorded across all major geographies. Based on preliminary data, Europe saw the largest drop year-on-year (approximately 80%), followed by China (approximately 65%) and the United States (approximately 40%). While investments in China have been declining since 2022, the decrease recorded in Europe and the United States followed record high investments in 2023 (USD 36.2 billion and USD 20.3 billion, respectively). In 2023 specifically, Europe overtook China as the largest recipient of offshore investments, driven by strong growth in the United Kingdom – Europe's largest offshore wind market – together with France, Germany and Poland. China's offshore wind slowdown is more a consequence of a maturing project development pipeline and an expected post-boom slowdown following the phase out of national subsidies at the end of 2021 (Bloomberg News, 2025a).

2.1.3 Other renewable energy technologies

Investment in other renewable energy technologies (hydropower, bioenergy, geothermal power and marine energy) fell to USD 19 billion in 2024, a 39% drop from USD 31.5 billion in 2022/2023 (Figure 2.8). The share of total investments in renewable energy going to these technologies has consistently declined in recent years, reaching 2% in 2024 (down from 5% in 2022/2023), even though under IRENA's 1.5°C Scenario around 27% of annual investments in renewables will be required for technologies other than solar and wind (IRENA, 2023b), including for power generation and end uses.

Figure 2.8 Annual investments in bioenergy, hydropower, geothermal and marine energy technologies (power and end use), 2019-2024



Notes: Investments are tracked at the time a project reaches financial close, rather than when project is commissioned. A decrease in investments in a given year may not translate into a decrease in the capacity installed in that same year. The average lag is estimated to be about 0.9 years for onshore wind, and 2 years for offshore wind.

Hydropower continues to be the third largest technology in terms of both investment (and cumulative renewable capacity additions) after solar and wind. In 2024, hydropower received USD 14.8 billion, slightly below the USD 16.5 billion annual average recorded in 2022/2023. In 2022/2023,[21] China remained the largest hydropower market, accounting for 73% of global flows. China's share has slightly declined since 2020/21 (78%), reflecting the increasing challenges of identifying suitable sites for projects and heightened environmental concerns, such as the extreme droughts experienced in early 2023 (WEF, 2024a).

After China, Angola was the largest destination for hydropower investments in 2022/2023, accounting for 5% of the global total, with USD 1.7 billion committed in 2023, largely aimed at the construction of the 2 172 MW Caculo Cabaça power plant, expected to enter commercial operation in 2026 (Power Technology, 2024). India accounted for 2.6% of global hydropower investments in 2022/2023, with 44.5 GW of pumped storage hydropower already in development and with plans to add 51 GW by 2032 (Energy Live News, 2025). Meanwhile, Brazil's A-5 energy tender attracted BRL 8 billion (USD 1.5 billion)[22] in commitments for 65 hydroelectric projects totalling 816 MW, signalling continued confidence in new-build hydro capacity (BNamericas, 2025).

[21] *Country-level data for 2024 are not currently available.*

[22] *Per the exchange rate on 14 October 2025.*

Investments in bioenergy declined to USD 4 billion in 2024, from USD 10.7 billion annual average in 2022/2023 (Figure 2.8). Barriers that will need to be addressed include ongoing policy volatility, increasing levelised electricity costs and rising feedstock costs (IRENA, 2022a).

Investments in geothermal and marine energy remain low compared with other technologies. Geothermal investments declined from USD 4.2 billion in 2022/2023 to USD 576 million in 2024. Funding for geothermal power was provided for projects such as the Maasdijk & Warmte Netwerk Westland 60 MW Geothermal Project and the Geysers Power Company Green Loan (DNV, 2022; U.S. Department of the Treasury, 2025), but this funding is constrained due to high upfront costs, lack of incentives and inherent uncertainty during exploration and production phases (Adam *et al.*, 2025). **Marine** energy received USD 93 million in 2024, in line with 2023 investment levels.[23] High upfront costs combined with exploration and technology risks still limit the availability of funding for these technologies. For instance, funding for marine technologies continues to mainly go towards demonstration-scale projects, primarily due to persistent barriers such as high capital costs, limited private investment and regulatory complexities (Wiegele and Jones, 2024). Despite these hurdles, initiatives such as the US Water Power Technologies Office's USD 141 million allocation for wave and tidal energy in 2024 and the European Union's continued support through grants from the EU Innovation Fund and the European Climate, Infrastructure and Environment Executive Agency are expected to boost investments further (Ocean Energy Europe, 2025).

2.1.4 Renewable energy investments: power and other end uses

In 2024, 96% of renewable energy investments went to the power sector, a continuing trend from 2022/2023, while end-use applications received just 1% (USD 10 billion), down from 3% in 2022/2023. The remaining share could not be attributed to either power or end uses (Figure 2.9).

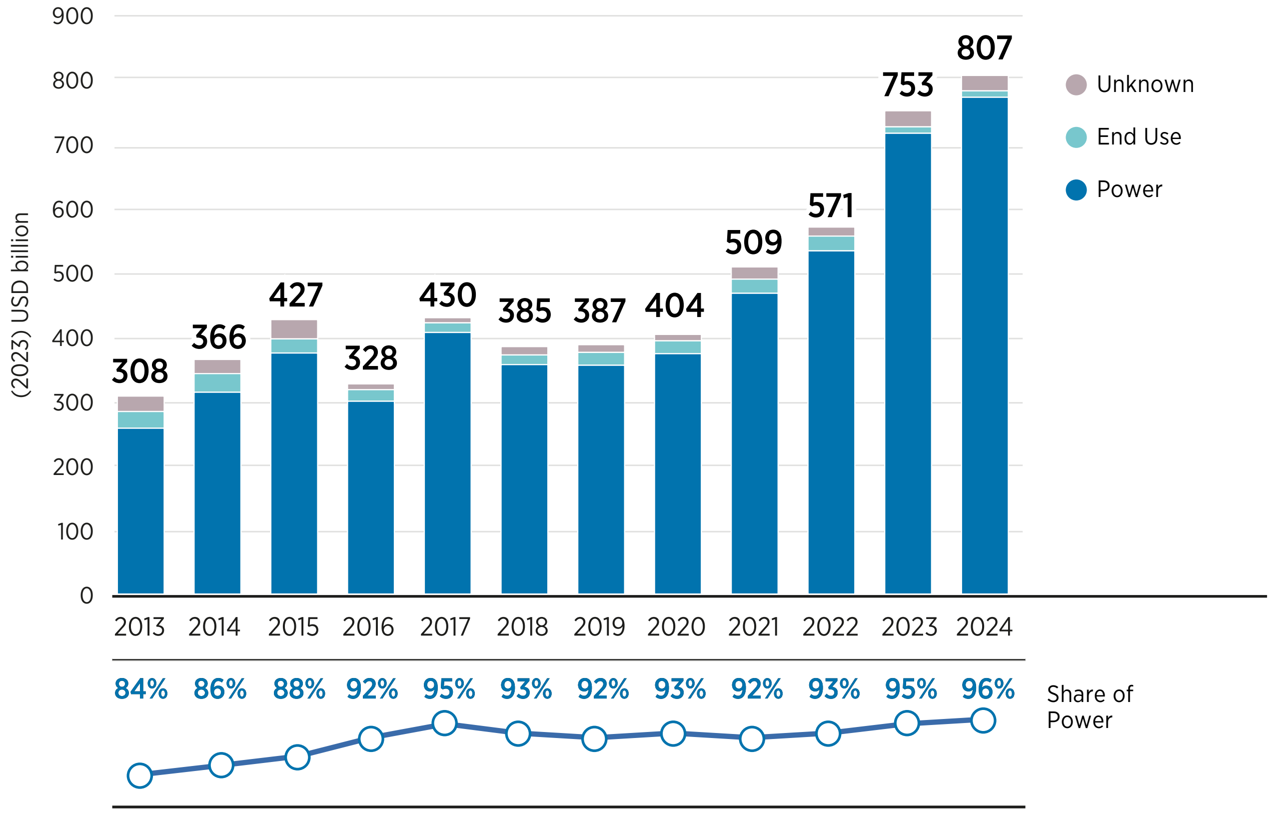
End-use sectors like heating and cooling, and transport currently struggle to attract large-scale investments due to less standardised business models and the continued reliance on fossil fuels in many regions (IRENA, 2023c).

In the future, increased electrification of end uses combined with higher uptake of renewable power will support the decarbonisation of these uses. However, direct renewables applications are expected to play a key role, especially in replacing direct uses of fossil fuels in these sectors (IRENA, 2024a).

The adoption of direct renewables for end uses requires cross-sector planning combined with targeted policy support including financial incentives, awareness programmes, research and development funding, and targets and mandates. For instance, the EU's REFuelEU Aviation regulation mandates minimum shares of sustainable aviation fuels in all jet fuel supplied at EU airports (2% by 2025, scaling up to 70% by 2050). By creating guaranteed demand and long-term market certainty, the scheme aims to stimulate investments into advanced biofuels and synthetic fuels production, infrastructure and supply chains (European Hydrogen Observatory, 2025).

[23] *No investments were recorded in 2022.*

Figure 2.9 Annual investments in renewable energy by application, 2013-2024



Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025a).

Note: The category "unknown" includes investments that could not be attributed to either the power sector or end use.

2.2 Renewable energy investments by region

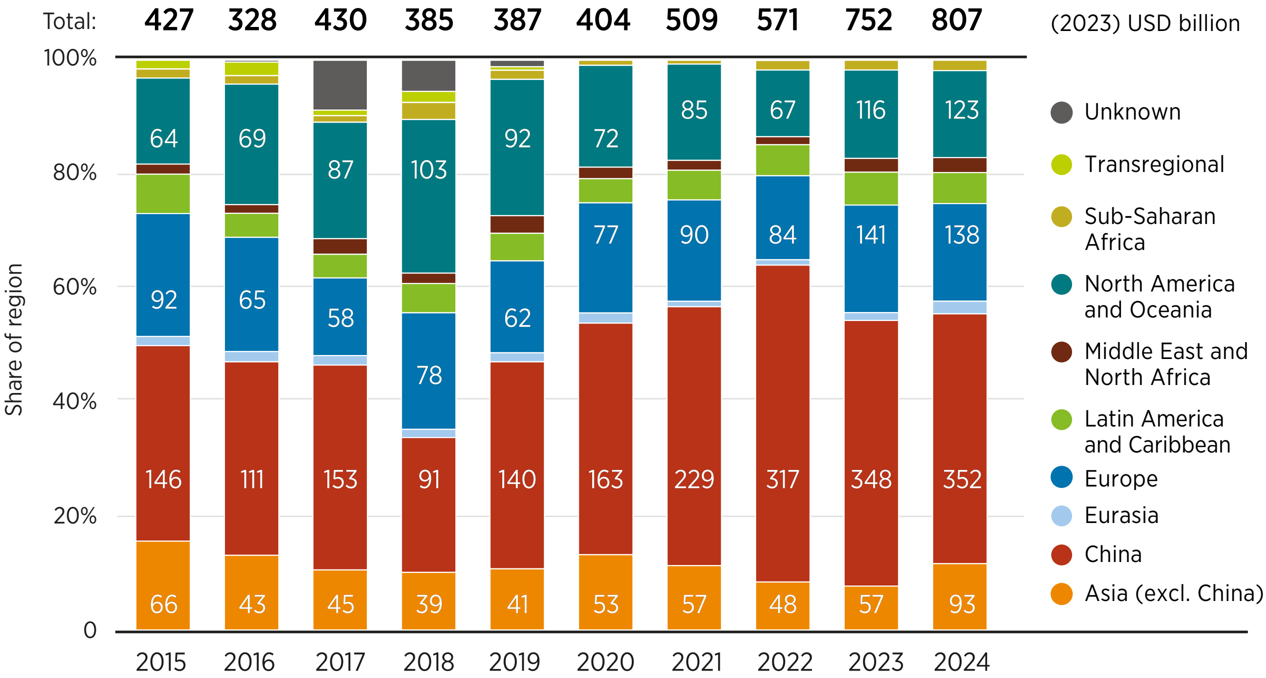
2.2.1 Investment by destination

Investment by geographic destination

This section analyses most recent trends in the geographical destination of renewable energy investments, using preliminary data for 2024 in comparison with the 2022/2023 biennial average.

Investments grew across almost all regions between 2022/2023 and 2024, with China remaining the largest market[24] (Figure 2.10).

Figure 2.10 Annual investments in renewable energy by region, 2015-2024



Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-24 trends from (BNEF, 2025a).

Notes: The category "unknown" includes investments that could not be attributed to a specific region. The category "transregional" includes investments that go to multiple regions and that cannot be attributed accurately to specific regions.

China's share of global investments slipped from 50% to 44% between 2022/2023 and 2024, but China continues to be the largest market for renewable energy (Figure 2.11). Investments in China increased by only 6% between 2022/2023 and 2024 as rapid renewable expansion has run against limited transmission and distribution capacity (Bloomberg News, 2024), an issue faced by many other countries.

Between 2022/2023 and 2024, investments in **Europe and in North America and Oceania** grew by 22% and 34%, respectively, resulting in only a marginal change in their combined share of global investments, from 31% to 32% (Figure 2.11).

[24] *China's continued dominance of global renewable energy investments merits its disaggregation from the rest of Asia; representing it separately enables a more accurate analysis of regional flows.*

The **rest of Asia (excluding China) share of global investments grew from 8% to 11.6% between 2022/2023 and 2024, reaching USD 93 billion. In dollar terms, this is an increase of more than USD 40 billion** (or 77% growth rate). The top three recipients were India, Pakistan and Japan, together accounting for around half the flows in the region. Household-led funding for decentralised solar PV drove a large part of the region's growth.

Investments in **Latin America and the Caribbean** grew by 18% between 2022/2023 and 2024, although the region's share of global investments held steady, moving marginally from 5.6% to 5.4% (Figure 2.10), driven almost entirely by small-scale solar. In Brazil (the region's largest regional recipient, making up 81% in 2024), relatively high retail power prices, net-metering incentives and the availability of low-cost Chinese solar modules have led to a solar boom for small-scale solar systems of 5 MW or less (which are eligible for the net-metering scheme) (Ellis, 2024). Regional investments in utility scale projects continue at a slower pace and are outsized by small-scale solar due to factors including transmission constraints and curtailment issues (BNEF, 2024b).

In the **Middle East and North Africa (MENA)**, renewable energy investment grew by 62% between 2022/2023 and 2024, from USD 13 billion to USD 21 billion. This represented 2.6% of total global flows in 2024, slightly up from 2% in 2022/2023. Saudi Arabia received 30% of regional investment in 2022/2023, followed by Israel (16%) and Egypt (13%).

Eurasia saw noteworthy growth in renewable energy investments between 2022/2023 and 2024, increasing by around 130% from USD 7.8 billion to USD 17.9 billion. While still a small fraction of global flows, its share of global investments increased from 1.2% to 2.2% over the same period. Türkiye received 86% of the regional flows in 2022/2023, indicating the unequal distribution of renewable energy investment in the region.

Investments in **Sub-Saharan Africa** grew from USD 14 billion to USD 18 billion between 2022/2023 and 2024. This represents a 2.3% share of global investments in 2024, stable from 2022/2023 (Figure 2.11). This chronic lack of investment continues despite Sub-Saharan Africa's immense renewable energy potential and pressing energy needs, with more than 600 million people still without electricity at the end of 2023 (Cozzi *et al*., 2024). Although some countries in the region are making progress, high cost of capital, limited grid infrastructure, and weak financial health of utilities pose significant constraints to investments.

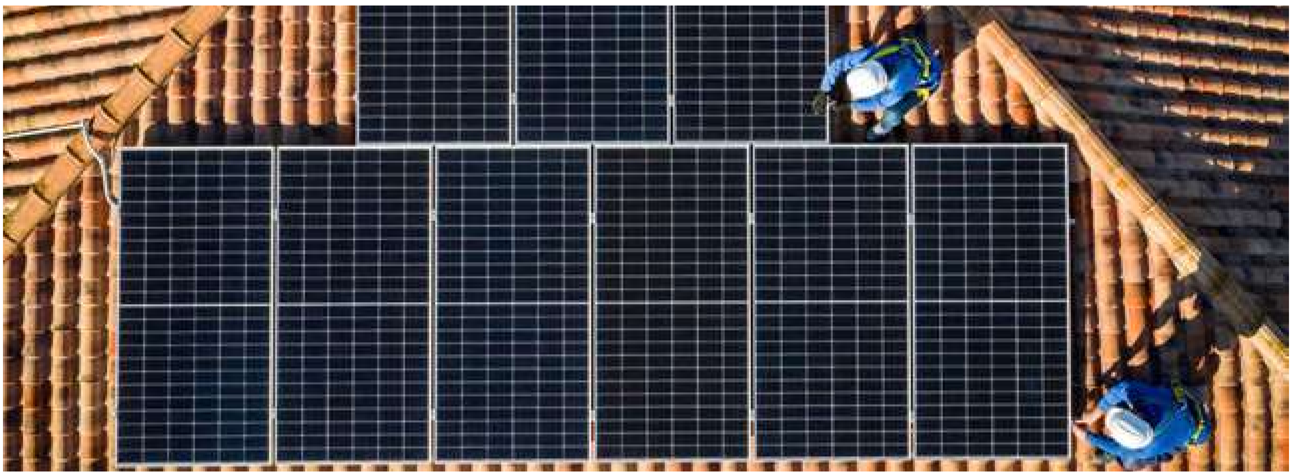
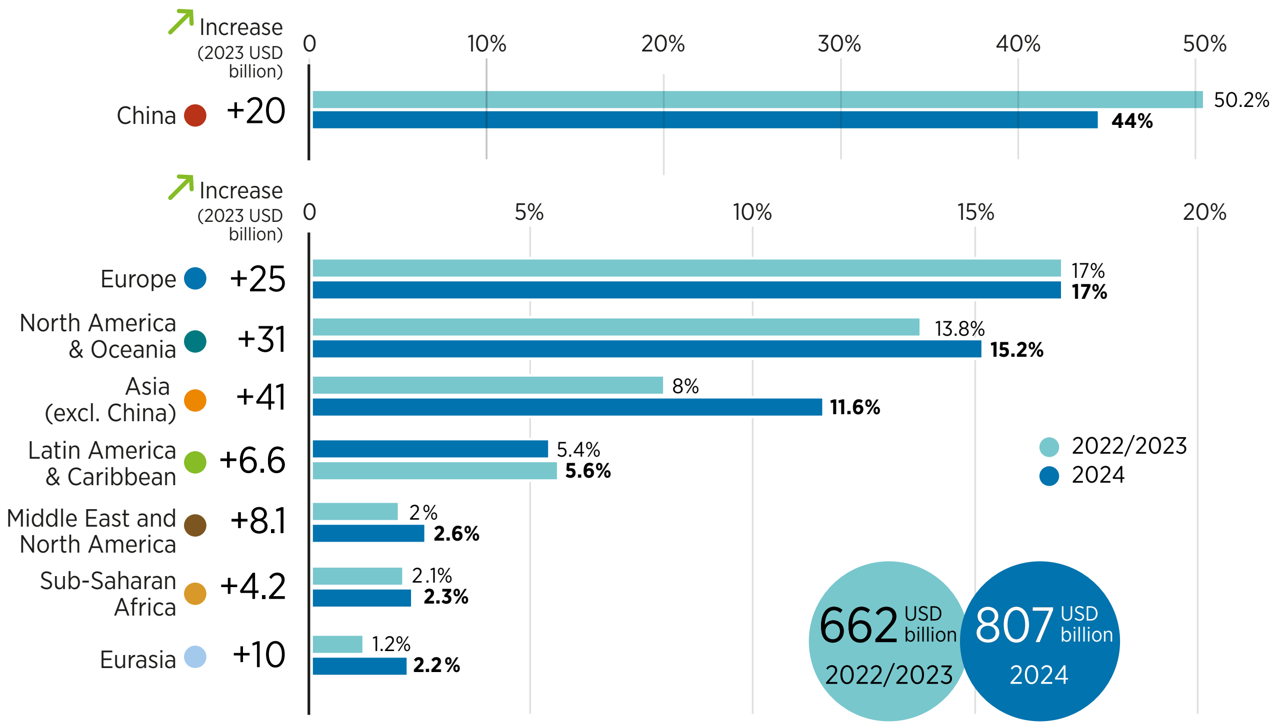


Figure 2.11 Share of global renewable energy investment by region of destination, 2022/2023 average and 2024, and increase in amount invested



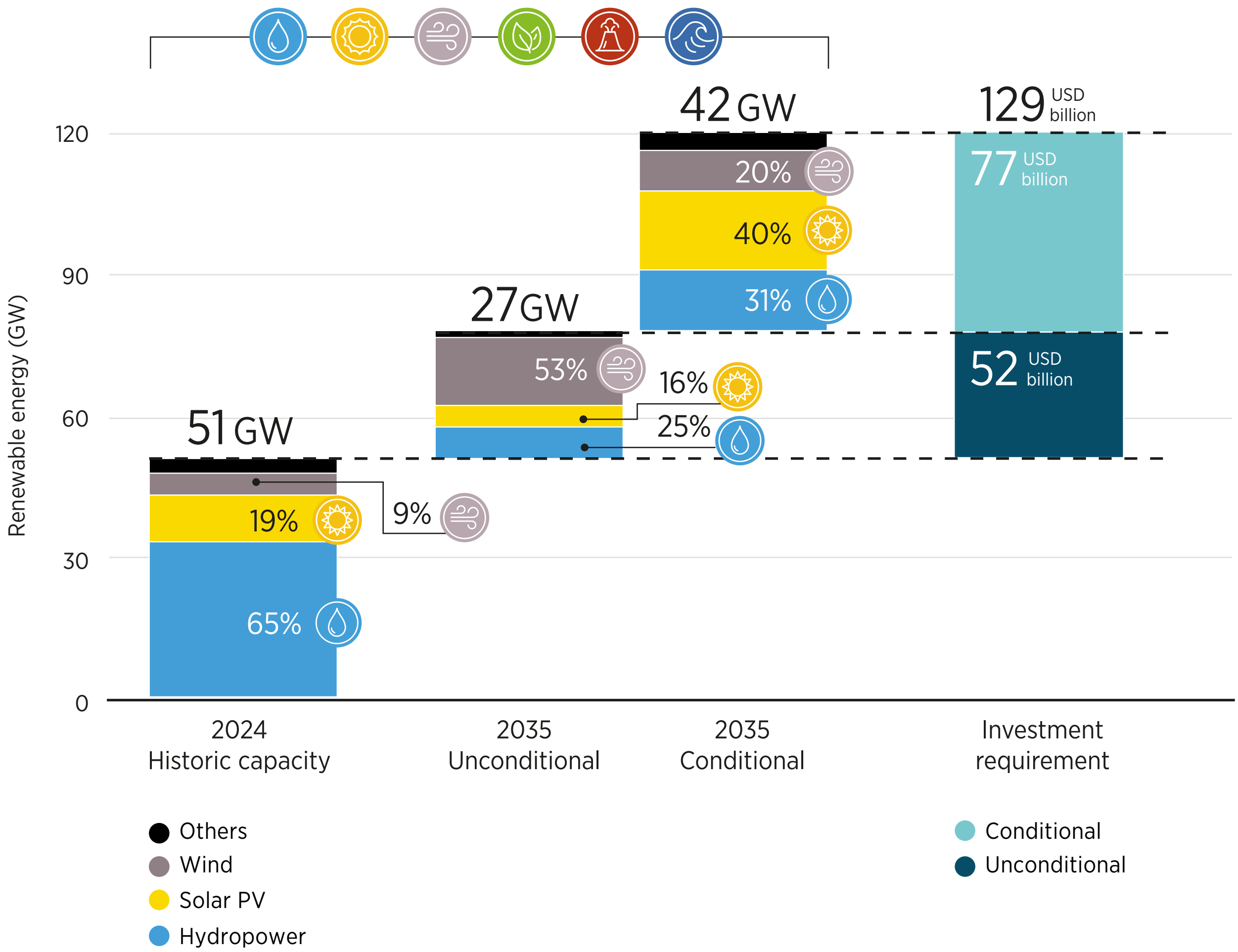
Source: CPI analysis based on (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025a).

Based on IRENA's analysis of NDC targets submitted by countries in Sub-Saharan Africa,[25] these countries plan to install at least 120 GW of renewable energy capacity by 2035, of which 61% is conditional on international financial assistance, as well as technology transfer and capacity building. This translates to at least USD 129 billion required for renewable energy technologies alone,[26] of which at least USD 77 billion would come from international sources (Figure 2.13). The actual investment needs for Sub-Saharan Africa are much higher when overall energy needs for the region are considered, including energy access (off grid and on grid), grid infrastructure and supply chain development, in addition to renewable deployment (IEA, 2024c). While Sub-Saharan countries make up less than 5% of the additional capacity targeted by 2035 according to all active NDCs, they account for more than 15% of the required conditional investment globally.

[25] *This is based on all active NDCs submitted as of September 2025.*

[26] *The investments required for achieving overall NDC targets are much higher, as this analysis does not quantify the investment needs for the broader energy sector such as access, grids, energy efficiency, and non-energy related climate change mitigation and adaptation.*

Figure 2.12 Conditional and unconditional renewable energy targets and minimum investment required by 2035, as per NDCs of Sub-Saharan African countries

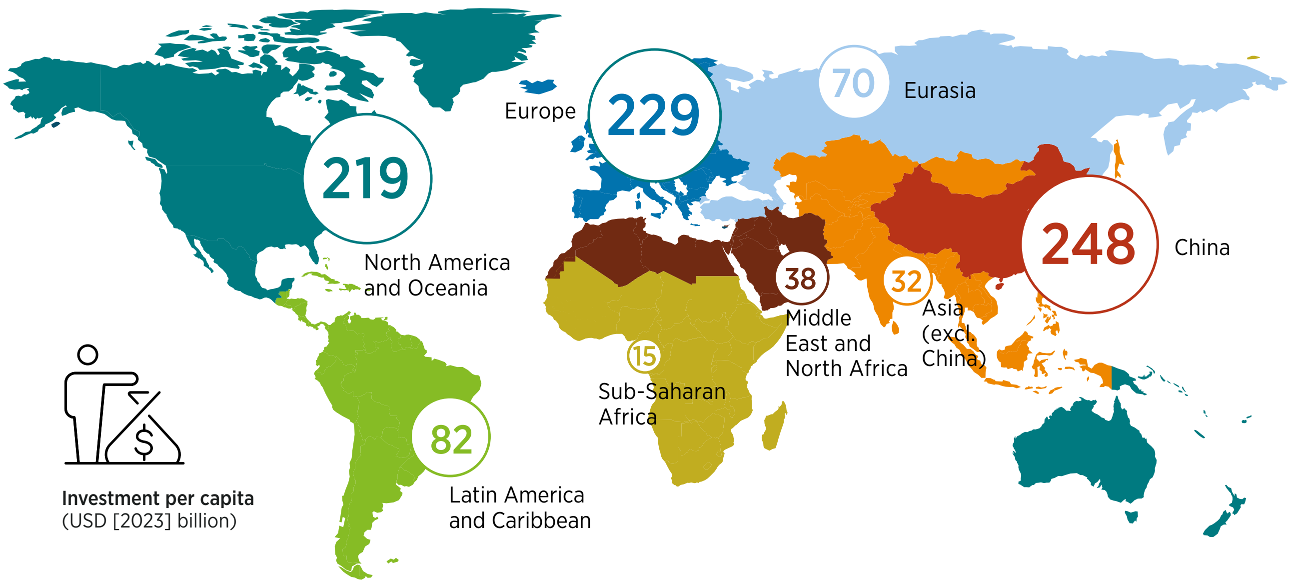


The distribution of renewable energy investments remains disproportionate, especially relative to regional shares of the global population. In 2024, **Sub-Saharan Africa** was home to 15% of the world's population but only received 2.3% of total renewable energy investment (equivalent to USD 15 per capita; see Figure 2.13), whereas Europe was home to 7.4% of the world's population yet received 17% of global renewable energy finance (USD 229 per capita) (Figure 2.13).

North America and Oceania – which includes the United States – makes up 15% of global renewable energy investments. The top three recipients were the United States, Australia and Canada. Going forward, this share may decline given the renewed prioritisation of fossil fuels in the United States.

On a per-capita basis, China, Europe and North America and Oceania receive around 15 times more investment than Sub-Saharan Africa. Investments in Sub-Saharan Africa are heavily concentrated in just two countries, South Africa and Nigeria, which received half of all flows in 2024, corresponding to USD 76 and USD 9 per capita, respectively.

Figure 2.13 Regional shares of renewable energy investments, global population and GDP; and renewable energy investment per capita (USD [2023] billion), 2024



Share of global (2024)

Region	Investment	Population	GDP
North America and Oceania	15%	7%	33%
Europe	17%	7%	23%
China	44%	18%	18%
Latin America and Caribbean	5%	7%	5%
Middle East and North Africa	3%	7%	4%
Asia (excl. China)	12%	36%	12%
Sub-Saharan Africa	2%	15%	2%
Eurasia	2%	3%	3%

Based on: (CPI, 2025) and (World Bank, 2025b).

Notes: GDP = gross domestic product; USD = United States dollar.

Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Investment destination by economic group

This section analyses global renewable energy investments according to income groups to provide an alternative structure for understanding how economic development, institutional capacity, resilience and income levels affect levels of investment, as opposed to the regional analysis in the previous section. Five income groups are discussed:

Advanced economies: Fifty-three countries making up 17% of the world's population and representing 61% of global GDP accounted for USD 271 billion in renewable energy investments in 2024: 34% of the global total (Table 2.1; Figure 2.15). Investments have been led by the European Union and the United States.

In 2024, 44% of global investments went to **China**, while the eight other EMDEs in the G20, **Argentina, Brazil, India, Indonesia, Mexico, Saudi Arabia, South Africa** and **Türkiye**, which represent 28% of the world's population and 12% of GDP, made up 12% of renewable energy investment. Of these eight G20 EMDEs, Brazil and India continue to dominate the share of total investments, with Türkiye seeing the greatest amount of annual fluctuation (Figure 2.14).

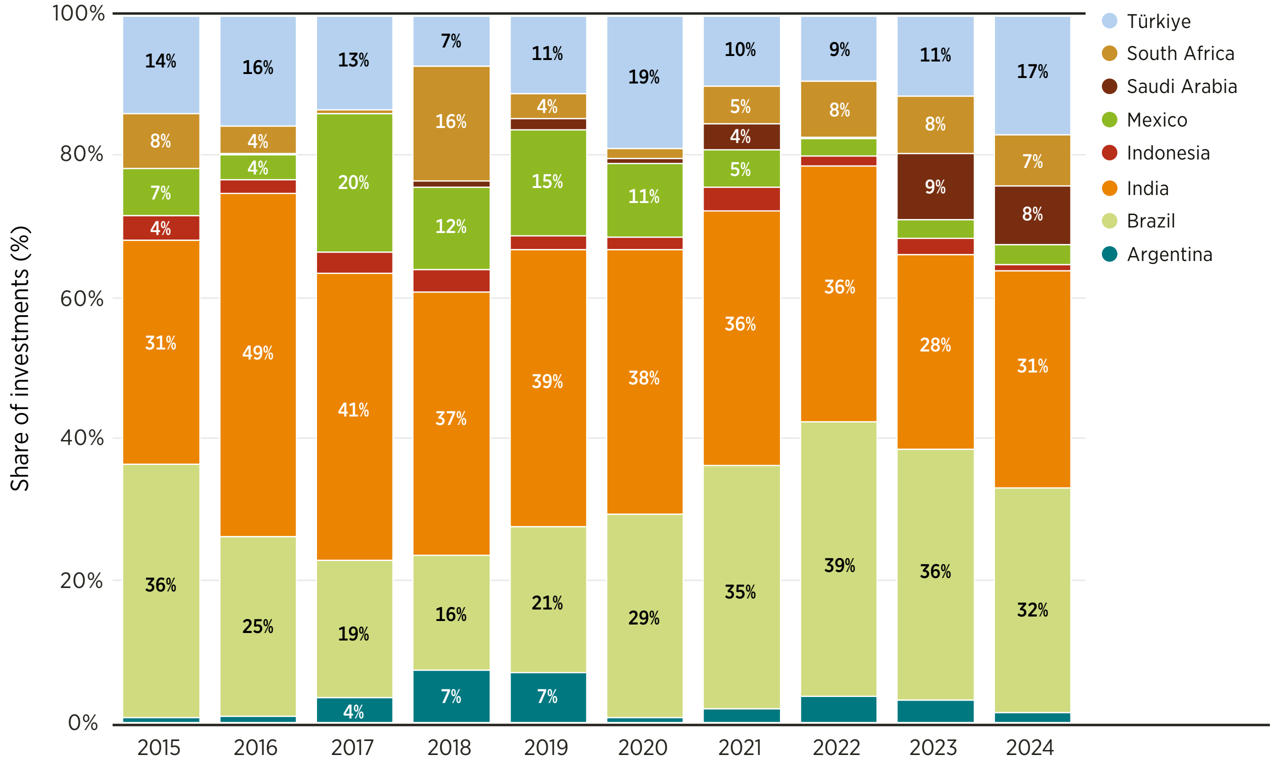
Table 2.1 Shares of global population, GDP and renewable energy investments across country groups, 2024

Country groups by development status	Share of global population (%)	Share of global GDP (%)	Share of global renewable energy investment (%)	Renewable energy investment per capita (USD)
Advanced economies	17	61	34	201
China	17	18	44	248
G20 EMDEs (excl. China)	28	12	12	42
non-G20 EMDEs	24	8	9	35
LDCs	13	1	2	17

Based on: (CPI, 2025) and (World Bank, 2025b).

Notes: EMDE = emerging market/developing economy; LDC = least-developed country.

Figure 2.14 G20 EMDEs excluding China, share of renewable energy investments by country, 2015-2024

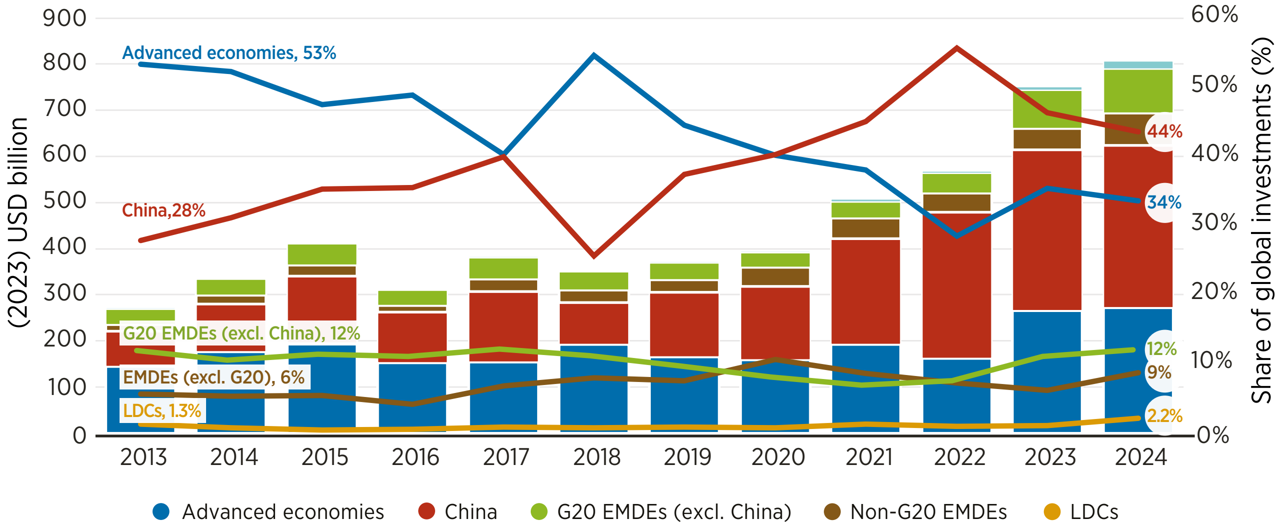


Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025a).

Around 37% of the world's population lives in **EMDEs excluding those in the G20**. These 150+ non-G20 EMDEs (which include 44 LDCs) combined received just 11% of the world's renewable energy investments in 2024 (Table 2.1). Even this small share of investments was concentrated in a few markets, including Chile, Kenya, Pakistan, Uzbekistan and Viet Nam.

LDCs specifically are home to 13% of the world's population, they received only 2.2% of the global renewable energy investments in 2024, a concerningly small share that has only slightly increased since 2013 (Figure 2.15). LDCs received just USD 17 per capita, less than half of the USD 35 per capita that EMDEs excluding those in the G20 received and considerably less than was received by China (USD 248 per capita) and advanced economies (USD 201 per capita).

Figure 2.15 Global renewable energy investment by country group, 2013-2024



Based on: (CPI, 2025). Investments for 2024 are estimates based on 2023 CPI data and 2023-2024 trends from (BNEF, 2025h).

Notes: EMDE = emerging market/developing economy; LDC = least-developed country.

IRENA's analysis of NDCs submitted by LDCs showed that LDCs plan to install 126 GW of renewable energy capacity by 2035, of which 63% is conditional on international assistance. This means that at least USD 145 billion is needed for renewable energy technologies alone, of which at least USD 91 billion must come from international sources. For small island developing states (SIDS), 63% of additional targeted capacity (3.3 GW out of 5.2 GW) is conditional, translating to an investment requirement of minimum USD 7.4 billion by 2035, out of which at least USD 4.6 billion is conditional on international assistance.

2.2.2 Investment by country or region of origin

This section compares the biennial time frames of 2020/2021 and 2022/2023 as no data for 2024 are available at the time of writing.

Origins of global investments by country or region

Half of global investments originated from China in 2022/2023. Of these, 99% were invested domestically, in line with data from 2020/2021 (Figure 2.16). This demonstrates the central role of state-led initiatives and strong domestic credit markets (as discussed in Section 2.3). China's tracked overseas investment in renewable energy deployment totalled USD 2.8 billion in 2022/2023. More than 60% (USD 1.7) billion of this went other Asian countries, representing 3.3% of total investments made in Asia (excluding China). Most of these overseas flows were from public institutions in China. In addition, the country has invested substantial volumes in the manufacturing of solar PV, wind, battery and EV technologies abroad. Investments in manufacturing are not included here and are discussed further in Chapter 4.

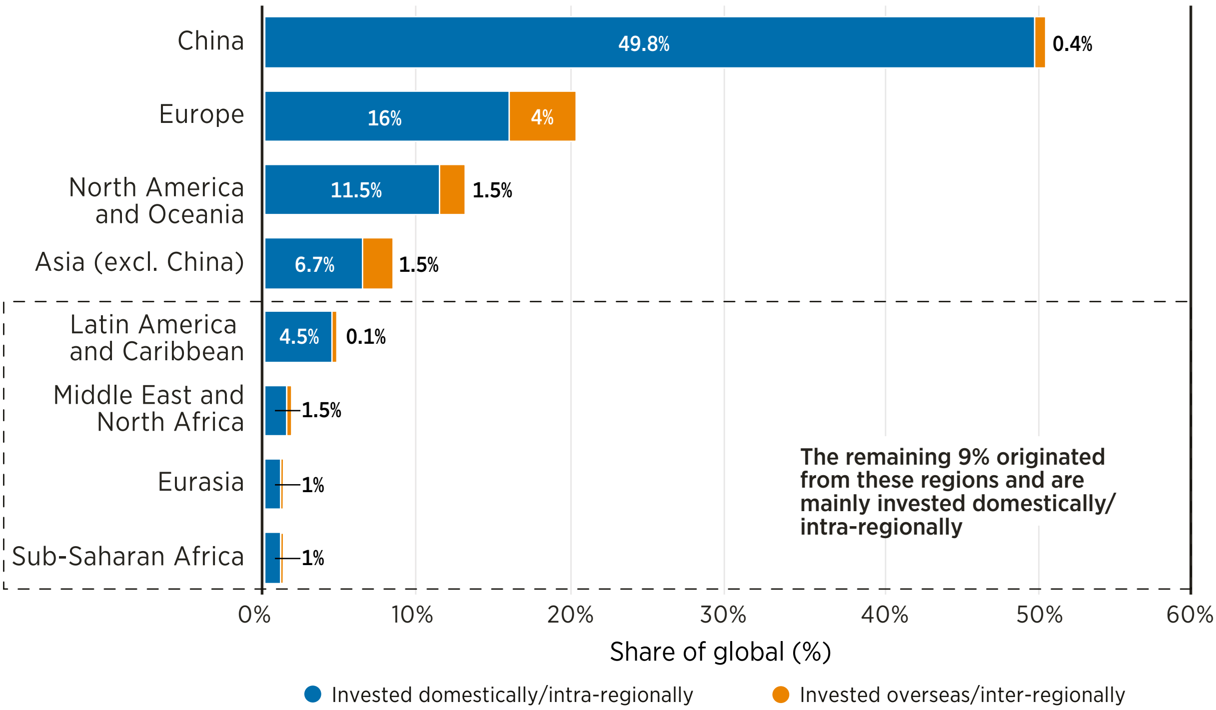
Twenty percent of global investments originate from Europe, equivalent to USD 332 billion. Of these, 80% are invested within the region and 20% outside the region. Europe provided the largest inter-regional flows observed in 2022/2023: from Europe to North America and Oceania (USD 9.1 billion, of which 70% went to the United States and 18% to Australia), followed by flows to Latin America and the Caribbean, at USD 5.1 billion, and to Sub-Saharan Africa, at USD 4.2 billion. In 2022/2023, Germany was the largest international renewable energy investor in Sub-Saharan Africa.

Thirteen percent of global investments originate from North America and Oceania, equivalent to USD 86 billion. Of these, 90% are invested domestically and 10% outside the region. Recent policy shifts in the United States may impact the funds invested both domestically and overseas, as already seen with the cancellation of the US Agency for International Development's funding for renewable energy projects, amounting to at least USD 150 million as of February 2025 (Siken, 2025).

Eight percent of global investments originated from Asia (excl. China), equivalent to USD 54 billion, with almost one-quarter invested overseas/inter-regionally (Figure 2.16). Other regions were responsible for 9% of global investments combined in 2022/2023. The **Middle East and North Africa** provided USD 1.7 billion for countries outside the region. About USD 430 million went to Eurasia – 5% of the region's total investment – driven mainly by the United Arab Emirates energy company Masdar's investment in solar PV plants in Azerbaijan. An additional USD 836 million went to Sub-Saharan Africa, mainly from Algeria, Egypt and Saudi Arabia to Kenya and South Africa.

Around 1% of global investments originated from Sub-Saharan Africa, largely driven by South Africa's domestic investments, and some cross-border flows to other countries in the region.

Figure 2.16 Origin of global investments by region, and share invested domestically/intra-regionally versus overseas/inter-regionally, 2022/2023 average

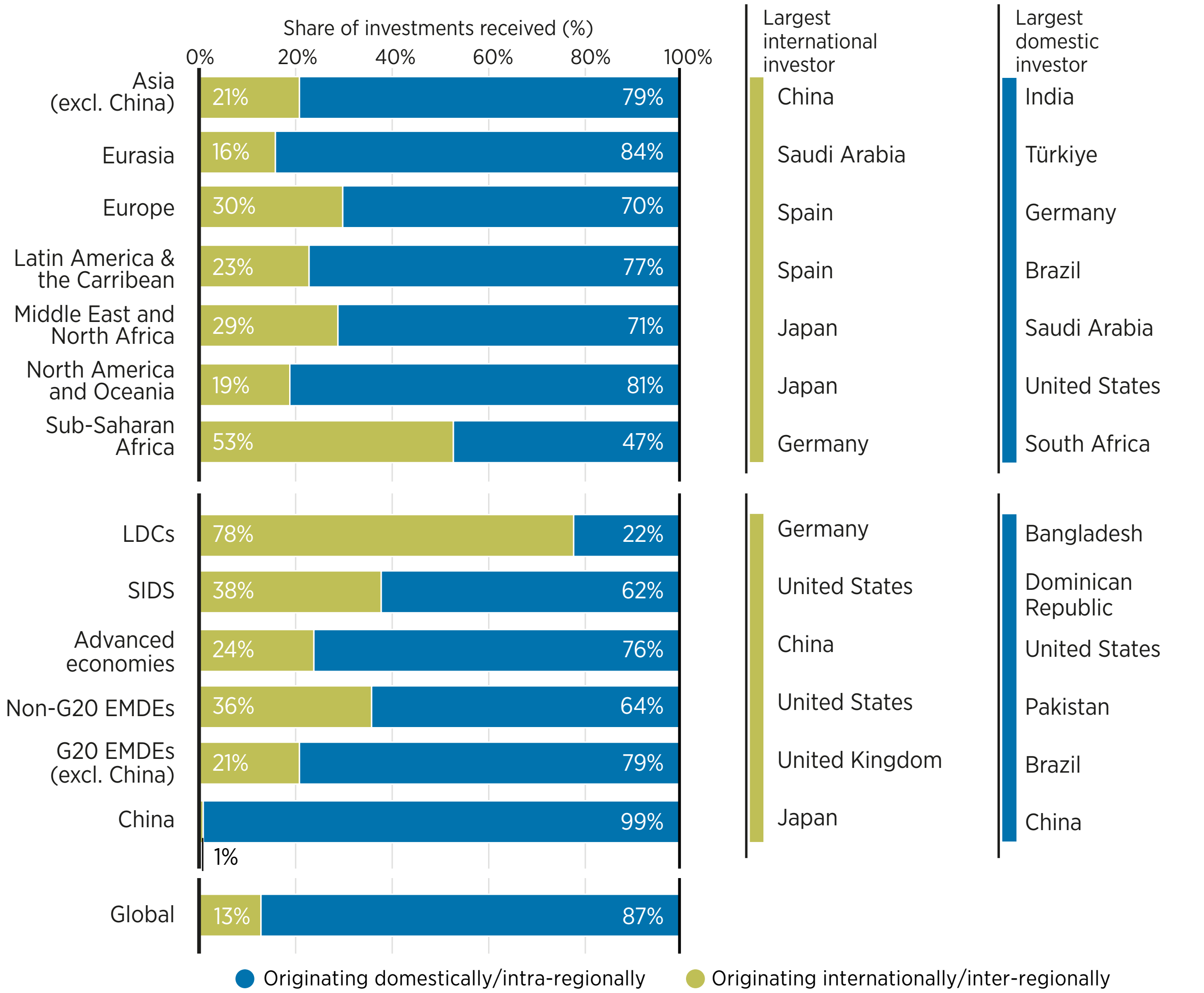


Based on: (CPI, 2025).

Origins of global investments by destination

Sub-Saharan Africa is the only region where the majority of the investment received originates from international rather than domestic sources, with 53% coming from outside the region compared with 47% from within (Figure 2.17). Domestic investments in the region are catching up, increasing from 35% of total investment (USD 2.1 billion) in 2020/2021 to 47% (USD 6.6 billion) in 2022/2023. This is largely due to South Africa, which is the largest recipient within the region, with more than two-thirds originating domestically in 2022/2023.In 2020/2021, the largest international sources were bilateral and multilateral DFIs (42%, or USD 1.6 billion). In 2022/2023, there was an increase of 150%, to USD 4 billion, from these sources. In September 2025, African DFIs and leading commercial banks committed to mobilise up to USD 100 billion for green industrialisation, including for renewable power, critical materials and battery manufacturing (Office of the President of the Republic of Kenya, 2025). This could help mobilise more domestic and international capital for renewables going forward.

Figure 2.17 Share of investments received from domestic/intra-regional versus international/inter-regional sources, by region and economic group, 2022/2023 average



Based on: (CPI, 2025).

Notes: EMDE = emerging market/developing economy; LDC = least-developed country; SIDS = small island developing states.

G20 EMDEs (excluding China) had the second highest share of domestic investments after China, at 79% for 2022/2023. In **advanced economies**, 76% of the investments originated domestically in 2022/2023, in line with 2020/2021. In **LDCs**, the majority of investment (78%) originated from international sources, with only 22% coming from domestic sources in 2022/2023, broadly consistent with 2021/2022. In SIDS, 62% of investments originated domestically in 2022/2023, decreasing from 70% in 2020/2021.

This contrast underscores a consistent trend: while advanced and major economies are largely able to draw on domestic financial resources to fund their energy transitions, lower-income countries remain acutely dependent on external support, often due to deeper structural constraints such as high cost of capital, underdeveloped financial markets, limited fiscal capacity, debt vulnerabilities, and policy and regulatory constraints.

03 RENEWABLE ENERGY INVESTMENT SOURCES AND FINANCIAL INSTRUMENTS

As 2024 data on sources of finance and instruments are not available, the analysis in this chapter relies on average annual investments in 2022/2023 compared with previous years. Section 3.1.1 compares the biennia 2017/2018 and 2022/2023 to highlight the substantial shifts in public and private relative investments over the five-year period. These time frames were selected to capture longer-term trends while avoiding the distortions caused by the COVID-19 pandemic.

3.1 Renewable energy investments by source of investment

Globally, the public sector accounted for 40% of total renewable energy investments in 2022/2023, up from 31% in 2017/2018, largely driven by developments in China. Excluding China, public investments accounted for just 17% of investments, down from 28% in 2017/2018. This shows the dominance of private investments in most countries outside of China.

3.1.1 Investment sources across different contexts

This section explores investment sources (public and private) across different contexts, represented by four main groups: **China, advanced economies, G20 EMDEs excluding China, and non-G20 EMDEs**. The analysis also focuses on specific trends for LDCs and SIDS given their vulnerability and specific investment challenges. While significant differences may exist within a group, many countries share characteristics (*e.g.* global GDP ranking, strategic importance (as measured through G20 membership), and LDC status).

China

In China, the public sector's share of overall financing grew from 38% in 2017/2018 to 64% in 2022/2023 (Figure 3.1). National DFIs, SOEs and state-owned financial institutions (SOFIs) in the country collectively invested USD 208 billion in renewable energy infrastructure in 2022/2023. This is almost a third (31%) of all renewable energy financing globally in 2022/2023 (USD 662 billion).

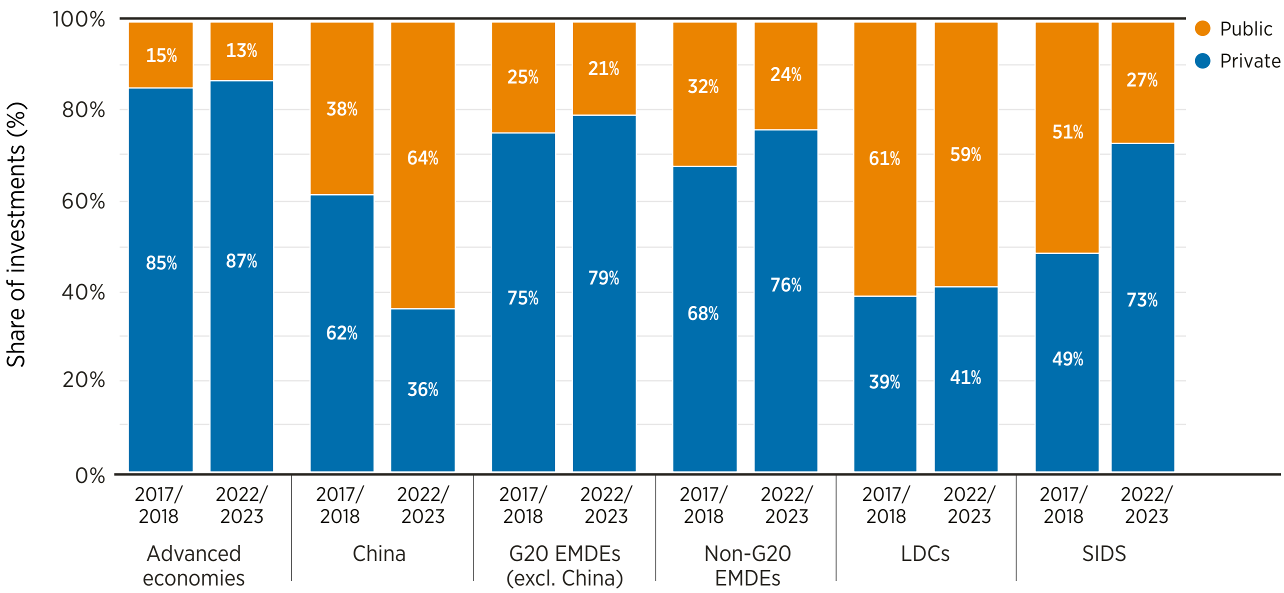
Domestic public finance accounted for a significantly higher share of overall investment in China during 2022/2023 (64%) than in any other group of countries, underscoring the central role of state-led investment in driving the country's energy transition (Figure 3.1). Domestic private finance provided 35% of investment in 2022/2023, owing to strong domestic credit markets and green monetary policy measures, which have helped stimulate commercial bank lending to green technologies (Stylianou *et al.*, 2025). The remaining 1% comes mainly from international private actors, which makes China's renewable energy sector the least reliant on international sources across all groups (based on 2022/2023 figures) (Figure 3.2).

In China, **the public sector's share** of overall investment grew from an average of 38% in 2017/2018 to 64% in 2022/2023

Advanced economies

In advanced economies – representing more liberalised power markets, strong institutional capacity, lower investment risk, and stable and conducive policy – the private sector provided 87% of investments in 2022/2023, consistent with the 2017/2018 public-private mix (Figure 3.1). The presence of strong domestic financial markets enabled domestic private finance to contribute 70% of investments in 2022/2023 (higher than any other country group) (Figure 3.2). An additional 17% comes from international private actors; primarily from advanced economies investing in other advanced economies.[27] For example, European private investors directed USD 24 billion on average in 2022/2023 to the advanced economy group. Public sources provided 13% (USD 28 billion), split almost evenly between domestic and international sources, again mainly coming from other advanced economies. Although public sources make up a relatively smaller share compared with other blocs, they still play a catalytic role in advanced economies.

Figure 3.1 Share of public and private investment in renewable energy by country group, 2017/2018 and 2022/2023 annual average

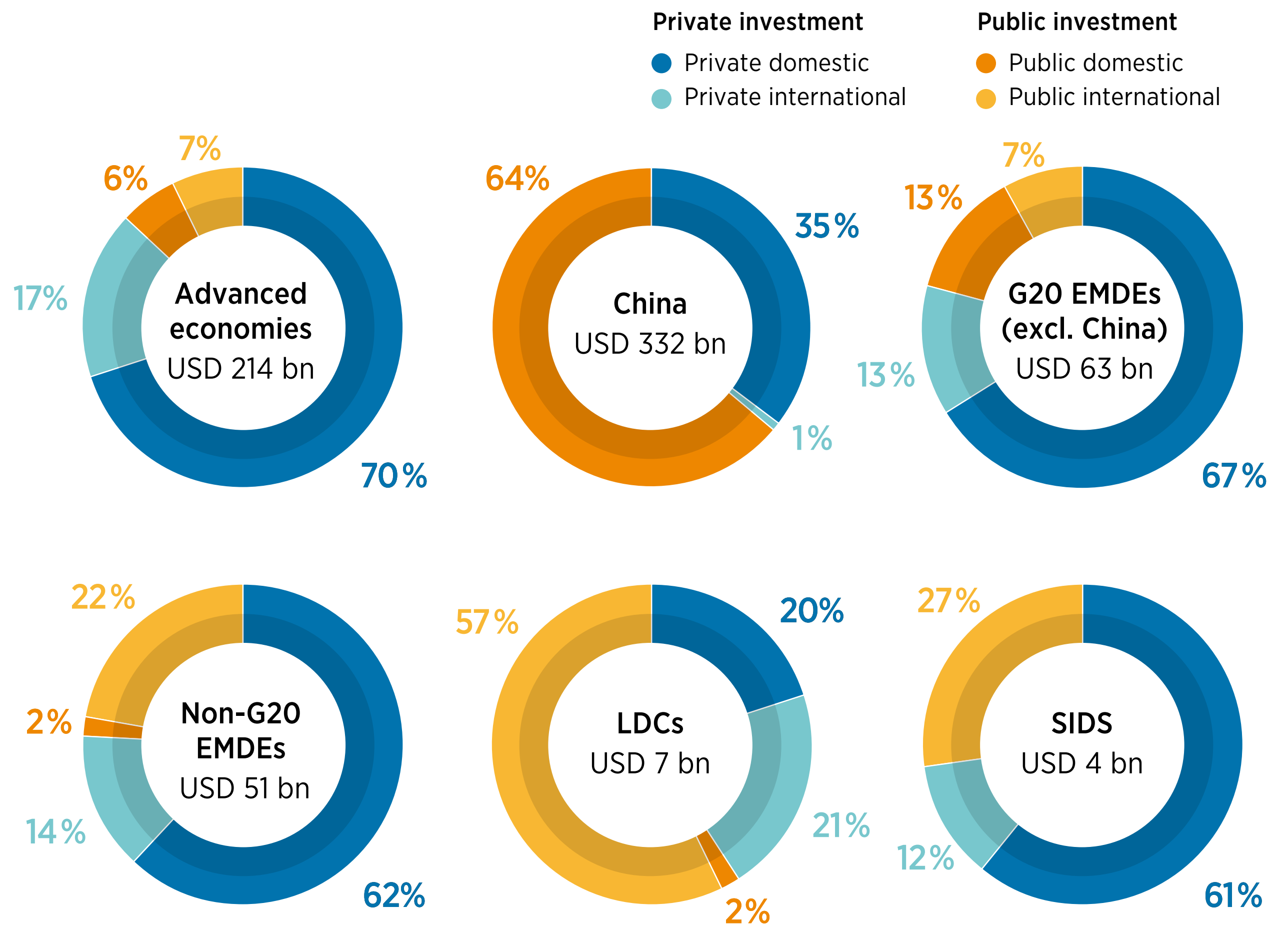


Based on: (CPI, 2025a).

Notes: EMDE = emerging and developing economy; LDC = least-developed country; SIDS = small island developing states.

[27] *"Domestic" and "international" are assessed at the country level, so capital flowing from Germany to Denmark, for example, would be classed as international*

Figure 3.2 Share of public and private, and international and domestic investment in renewable energy by country group, 2022/2023 annual average



Based on: (CPI, 2025).

Notes: EMDE = emerging market/developing economy; LDC = least-developed country; SIDS = small island developing states.

G20 EMDEs excluding China

In the eight G20 EMDEs excluding China,[28] the private sector dominated investments, accounting for 80% in 2022/2023, as these countries have introduced policies designed to attract private players, both domestic and international, and offer sizeable and growing energy markets. For the group as a whole, the public-private mix remains unchanged since 2017/2018, but individual countries exhibit considerable variation (Figure 3.1).

Brazil and India are the two largest investment recipients (67% of the total investment in 2022/2023). Historically, Brazil had a higher reliance on public sources, but private sources have grown from 51% in 2017/2018 to 80% in the 2022/2023 period. The growing private sector influence in Brazil is largely attributed to policies such as auctions and increasing domestic household investment (classified as private in this report),[29] which grew from USD 391 million in 2017/2018 to USD 6.7 billion in 2022/2023. Small-scale solar PV technologies are a key driver of this trend (as discussed in Section 2.1.1). In India, private investments have always been more prominent, but their share fell slightly, from 82% to 77%, in the same time period. Public investment growth outpaced that of private (23% versus 4% between 2017/2018 and 2022/2023, respectively). Public sector growth was led by a significant increase in domestic government investment, aided by a sovereign green bond issuance in 2023 (Hussain and Dill, 2023).

Domestic public sources provided 13% of investments in G20 EMDEs, excluding China, compared with 6% in advanced economies, signalling the key role of governments, SOEs and national development banks in renewable energy project development (Figure 3.2). Beyond investments, these public entities often initiate and facilitate projects in contexts with relatively higher perceived investment risks than advanced economies, less mature financial markets, barriers to foreign direct investment, currency reliability or inconvertibility, and other issues that deter private investors. **Indonesia** is a notable exception. It receives the least private investments and has the highest rates of public investment (both domestic and international) of all the G20 EMDEs (excluding China) (Figure 3.3). Domestic public sources made up 18% and international public sources 38% of renewable energy investment in Indonesia in 2022/2023, together accounting for more than half of all renewable energy investment in the country. Total renewable energy investment in Indonesia has remained flat since 2017.

With the exception of Indonesia, domestic private sources make up at least half of overall investments in each G20 EMDEs (excluding China) (from 54% in Saudi Arabia to 88% in Türkiye) (Figure 3.3).

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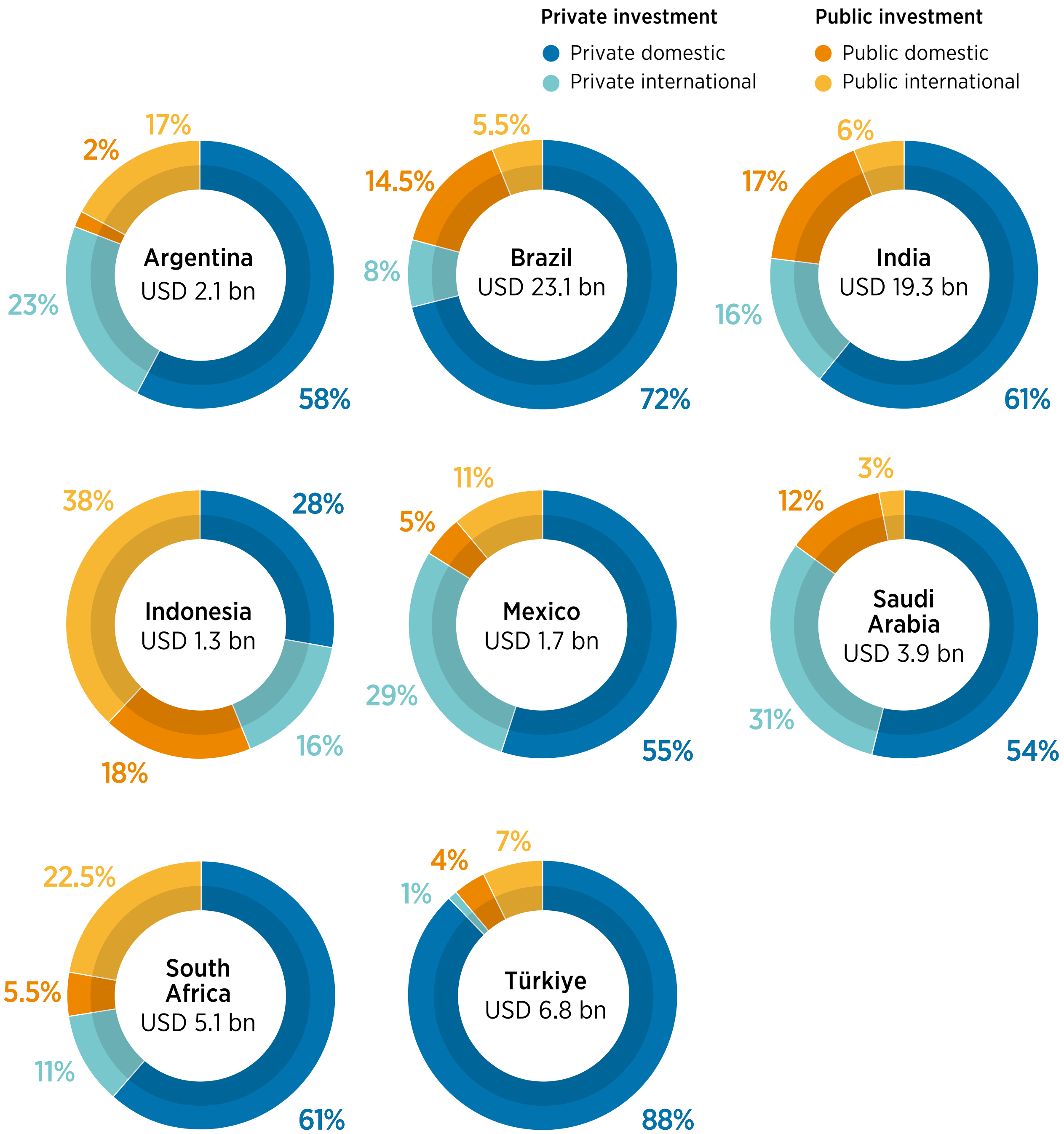
[28] *Argentina, Brazil, India, Indonesia, Mexico, Saudi Arabia, South Africa and Türkiye.*

[29] *Households – including individuals installing small-scale renewable systems (e.g. small scale solar panels) – are classified as private investors in this report. Their investment decisions are generally driven by self-consumption, energy access and energy cost savings rather than by the financial or strategic objectives that guide corporate or institutional investors.*

Figure 3.3 Share of public and private, and international and domestic investment in renewable energy for G20 EMDEs excluding China, 2022/2023 annual average



Based on: (CPI, 2025).

EMDEs excluding the G20

Among the more than **150 EMDEs outside of the G20, including LDCs,** the share of private finance has increased from 68% to 76% between 2017/2018 and 2022/2023 (Figure 3.1). Notably, domestic private investment has increased from 44% to 62%. Pakistan and Viet Nam are key contributors to this trend, representing a combined almost-quarter of the group's total investment in 2022/2023. Both countries saw their share of domestic private financing rise – to 97% and 85%, respectively.

Investment in small-scale solar PV in **Pakistan** has grown significantly over the last few years, led by households (see Box 2.2). In addition, an estimated 40-50% of industries in Pakistan rely on captive power plants (generation for self-consumption) despite being connected to the grid (WEF, 2024b). In **Viet Nam**, renewable energy investment peaked at USD 21 billion in 2020, driven by an attractive domestic policy mix that sparked a solar boom in the country (Shani and Suryadi, 2021; Ember *et al.*, 2022); 84% of this investment came from domestic private sources. Challenges with grid infrastructure capacity resulted in a significant slowdown in solar PV development in subsequent years (CPI, 2024), with a total renewable energy investment in 2022/2023 of USD 4 billion. Despite this decline, domestic private actors still account for the majority of investment in the country (85%) in 2022/2023.

Compared with G20 EMDEs, excluding China, **this group of countries relies just as heavily on public funds but is significantly more dependent on international sources.** In 2022/2023, international public sources accounted for 22% of renewable energy investment in EMDEs, excluding the G20 (USD 11.2 billion), while domestic public sources contributed only 2% (USD 1 billion) (Figure 3.2). Most international public funds originated from bilateral government partners and multilateral development banks MDBs and climate funds. The share of domestic private investment was relatively similar across both groups – 67% in G20 EMDEs, excluding China and 62% in non-G20 EMDEs.

Least-developed countries

LDCs have high reliance on public finance, mostly from international sources. Domestic public capital is most constrained in LDCs, which grapple with much higher inflation and limited fiscal bandwidth (FRED, 2025). As a result, 57% of funding in 2022/2023 came from international public sources, while domestic public sources made up just 2% (Figure 3.2). This trend is particularly pronounced in Sub-Saharan Africa, which accounts for 59% of LDC investment in 2022/2023 and has more than two-thirds of financing coming from public international sources (67%) and less than 1% from domestic public sources.

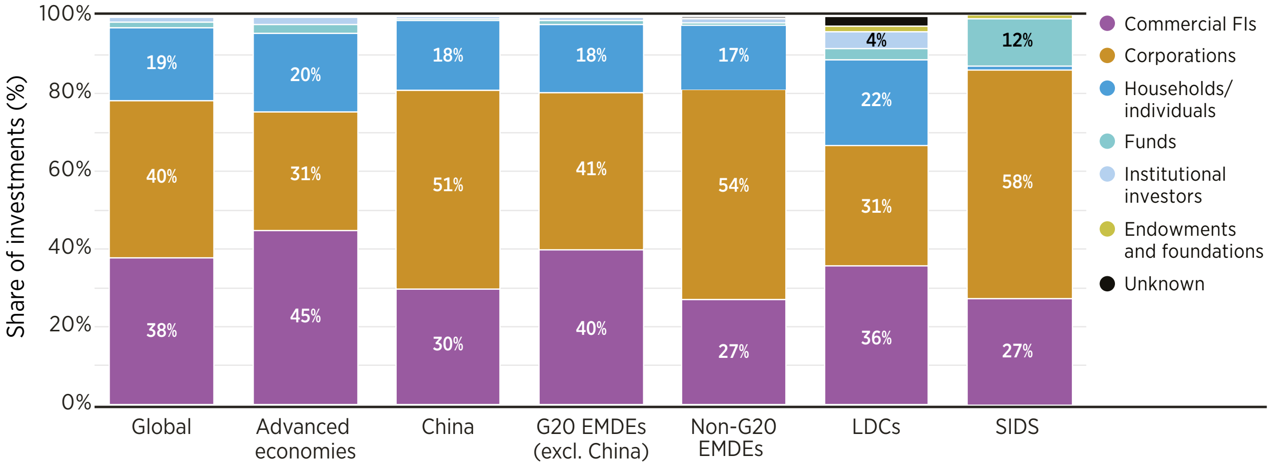
Small island developing states

In SIDS, the share of domestic private investments grew from 35% in 2017/18 to 61% in 2022/2023 (Figure 3.2). This was driven by high investments in solar PV projects in the **Dominican Republic** – USD 1.9 billion on average in 2022/2023, constituting 49% of total investment for all SIDS. Since 2019, the Dominican Republic has consistently served as a key driver of investment across SIDS, with the majority of investment originating from corporate investors (IEA, 2025b). Many other SIDS, however, face shared challenges in mobilising investment, including high transaction costs due to small project sizes and technical capacity constraints (United Nations, 2022). SIDS' relatively smaller populations and geographic sizes naturally limit the scale of domestic markets and project pipelines. As a result, SIDS have called for more targeted international support (Alliance of Small Islands States, 2023), particularly given their high climate vulnerabilities and low contributions to global greenhouse gas emissions, even if such support may not align with conventional profit-driven incentives.

3.1.2 Private finance

Investment by private investors compares the biennia 2020/2021 and 2022/2023 as no data for 2024 are available. Across all six groups of countries analysed, corporations and commercial financial institutions contribute approximately 70-80% of all private investment (Figure 3.4). While corporations almost entirely use equity (approximately 99%), commercial financial institutions almost exclusively use market rate debt[30] (approximately 99%) (Figure 3.3.5). The remaining private sector funds are attributed to households, institutional investors, and foundations and philanthropies (Box 3.1).

Figure 3.4 Share of private investment in renewable energy by investor type and country group, 2022/2023 average

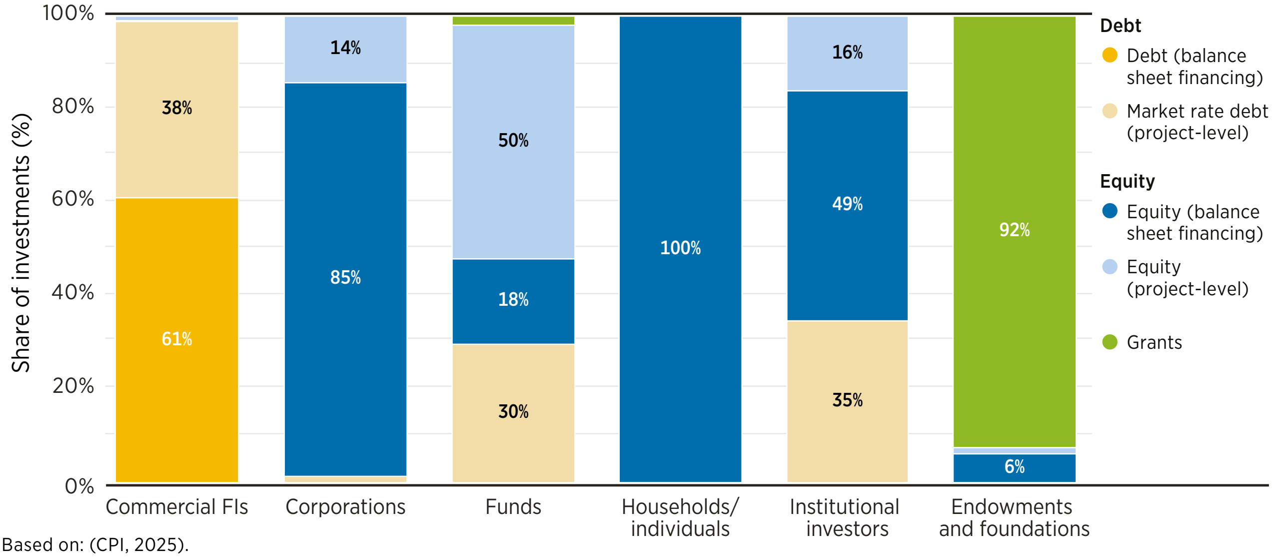


Source: CPI analysis based on (CPI, 2025).

Notes: EMDE = emerging market/developing economy; FI = financial institution; LDC = least-developed country.

[30] *Market rate debt is debt extended at regular market conditions. When classifying market rate debt and low-cost debt (one of the impact-driven financial instruments; see section 2.4.2 for details), the criteria used have considered the interest rate and the discount rate of different countries.*

Figure 3.5 Private investment in renewable energy by financial instrument and type of investor, 2022/2023



Based on: (CPI, 2025).
Note: FI = Financial institution

Commercial financial institutions

Commercial financial institutions[31] provided 38% of private investments and 23% of overall investments in 2022/2023, globally.

In **advanced economies**, commercial financial institutions accounted for 45% of private investment in 2022/2023 (the largest share in any of the country groups discussed in this report). In **G20 EMDEs** excluding China, commercial financial institutions' share of private investments increased from 35% in 2020/2021 to 40%, mainly for solar PV projects in Brazil and India. In **China**, commercial financial institutions provided less than one-third of private investment. In **LDCs**, commercial financial institutions' share of private investment increased from 26% to 36%, but most of this is attributed to one hydropower plant in Angola that reached financial close in 2023. **Non-G20 EMDEs** and **SIDS** had the lowest participation from commercial financial institutions, making up 27% of private investment in 2022/2023.

Corporations

Corporations[32] provided 40% of global private investments and 24% of overall investments in 2022/2023, globally.

They make up the majority of private financing in **China** (51%), **non-G20 EMDEs** (54%), and **SIDS** (59%) in 2022/2023. In **advanced economies and G20 EMDEs excluding China,** corporations' share of private investment has fallen since 2020/2021, even though total corporate investments rose in absolute terms, reflecting much higher growth in investments coming from commercial financial institutions and households.

[31] *Providers of private debt capital (and occasionally other instruments), including commercial and investment banks.*

[32] *Includes corporations engaging in self-generation of renewable power and developers of renewable energy projects. The corporations may have activities in the energy sector, other sectors, or both (e.g. a large water utility company installing both hydropower generation and water treatment facilities).*

Non-G20 EMDEs (including LDCs) were the only country groups to see investments from corporations decline in absolute terms in 2022/2023, although corporations still account for more than half of private investment in non-G20 EMDEs and 31% in LDCs. This decline in non-G20 EMDEs stems mainly from Viet Nam, where solar PV investments dropped sharply from 2022 onwards after previous incentives expired, in addition to persistent grid infrastructure issues (CPI, 2024). In **LDCs,** the decline stems from the Lao People's Democratic Republic, which had previously seen onshore wind projects reach financial close during 2020/2021 – investments that have since declined.

Going forward, corporations that engage in self-generation are expected to significantly increase investments in renewables and battery storage. Electricity demand from data centres is expected to double between 2024 and 2030 (IEA, 2025c), driven in part by the uptake of AI technologies, necessitating access to low-cost and reliable electricity. This demand is projected to remain concentrated in China, Europe and the United States. However, some other regions, such as Southeast Asia, are expected to play increasingly important roles, primarily due to artificial intelligence-related developments in Malaysia and Singapore (IEA, 2025c).

Households

Households[33] provided 19% of private investments and 11% of overall investments in 2022/2023, globally.

In **advanced economies, China and EMDEs (both G20 and non-G20),** households contributed a 17-20% share of private investment in 2022/2023, up from 10-14% in the previous biennium. Ninety-five per cent of the recorded investment is for small-scale solar PV, and the remaining 5% is for solar water heaters. In G20 EMDEs excluding China, Brazil accounts for 74% of household investment, driven by net-metering incentives (see Section 2.1.1). In non-G20 EMDEs, the largest contributors to this growth are Pakistan and Lebanon where electricity access is unreliable and/or expensive and household investment attempts to fill these gaps, contributing 31% and 59% of total private financing respectively in 2022/2023.

In **LDCs,** 22% of private investment comes from households (the largest share in any of the country groups discussed in this report), again for small-scale solar technologies. Seventy-two per cent of this investment is concentrated in Asia (excluding China), 14% in Sub-Saharan Africa and 12% in the Middle East and North Africa. Among Asian LDCs, Cambodia and Bangladesh saw the largest growth in household solar investment between 2020/2021 and 2022/2023 (55% and 9%, respectively). Such investments have been crucial in helping address the energy access deficit in LDCs (IEA, 2024e).

In **SIDS**, 12% of private investment came from households (the smallest share of all the country groups).

[33] A household consists of one or more persons who live in the same dwelling. It may be of a single family or another type of person group.

Institutional investors

In 2022/23, institutional investors – including asset managers, insurance companies and pension funds – made direct investments of USD 3.7 billion in new renewable energy projects, less than 1% of total renewable energy investment for 2022/2023. Seventy-three percent of the investment was directed towards advanced economies, 12% towards China, 9% towards G20 EMDEs excluding China, and the remaining 6% towards non-G20 EMDEs. As a share of private investments, institutional investors provided 1% of such investments globally.

Investments increased by 15% in 2022/2023, as strong growth in investment from asset managers (concentrated in European onshore wind and solar PV projects) counteracted a decline in investment from pension funds (primarily in European offshore wind). The large spike in investment from pension funds in 2021 is due to a one-off investment of USD 2.8 billion in an offshore wind project in France. Asset managers' investments grew 159% between 2020/2021 and 2022/2023, from USD 1.1 billion to USD 2.9 billion. While institutional investors funded projects across a range of technologies in advanced economies in 2022/2023, including solar, wind, biofuel, geothermal and hydro power, outside advanced economies, solar PV and wind technologies make up majority of the investments.

While this analysis focuses on institutional investors' direct investments in new projects, a significant portion of their capital can be deployed indirectly through intermediaries. These indirect channels, such as infrastructure funds and securitisation structures, could enable capital recycling and institutional investment (Grimm and Boukerche, 2020). As projects mature and are sold or refinanced, the capital can be redeployed into new ventures, amplifying the investors' overall contribution to project development and scaling (Singh *et al.*, 2019).

Endowments and foundations

In **advanced economies,** the private sector provided an average of USD 109 million in grants during 2022/2023. Most of this funding was attributable to one offshore wind farm in Norway and comes from a domestic energy fund. China received USD 38 million in grants in 2022/2023, provided by foundations based in the United Kingdom and the United States. Philanthropies are playing a key role in financing renewable energy projects, particularly small-scale solar with an energy access component (Box 3.1).

G20 EMDEs excluding China received grants of USD 61 million in 2022/2023. Approximately half these grants were deployed to India by a range of foundations, most with the purpose of expanding rural access to solar home systems. Non-G20 EMDEs received USD 93 million in 2022/2023, provided by a range of international foundations, predominantly for solar PV projects. In addition, USD 3 million of low-cost project debt was invested in 2022/2023 for solar PV projects in Sub-Saharan Africa.

Grants of USD 43 million constituted 2% of **LDCs'** total investment from private institutions in 2022/2023, provided entirely by international foundations. The majority of these grants were distributed to countries in Sub-Saharan Africa for the purposes of increasing energy access to low-income communities. Similarly, **SIDS** received USD 5 million as grants from international foundations, representing 0.2% of their overall investment received from private sources in 2022/2023. Majority of this funding is attributable to the development of one solar PV plant in Palau in 2022.

BOX 3.1 The rising role of philanthropy in financing sustainable energy

In 2023, total philanthropic giving by foundations and individuals worldwide across different philanthropic causes reached an estimated USD 885 billion. This is nearly nine times the past decade's developed countries' pledge of USD 100 billion per year for climate action in developing countries and nearly three times the New Collective Quantified Goal on Climate Finance's total USD 300 billion goal of annual climate finance agreed at COP29 in Baku, Azerbaijan, in November 2024.

Historically, private philanthropy has focused on three areas: education, public health and religion (Indiana University Indianapolis, 2024). Philanthropic funding for climate mitigation – including sustainable energy – constitutes a relatively small but increasingly significant component of global philanthropic efforts. Philanthropic funding towards climate change mitigation represented less than 2% of total philanthropic giving worldwide in 2023, or an estimate of between USD 9.3 billion and USD 15.8 billion. This is a 20% increase from 2022, and more than ten times the 2015 amount of USD 900 million. This growth reflects a widening circle of climate-focused philanthropies driven by new entrants and the rise of cross-sector collaborations.

The three areas of climate change mitigation with the highest amounts of philanthropic funding are clean electricity (which received USD 1.8 billion from 2019 to 2023); forests (USD 1.3 billion); and food and agriculture (USD 1.0 billion). This makes renewable energy projects, with the aim of improving livelihoods, a small but important part of philanthropic work.

Many of these projects overlap with existing mainstream areas of philanthropic work, including education and health, where clean electricity provides vital services in rural health centres and clinics, schools and homes. Renewable energy projects also form a vital part of many rural projects aimed at improving food security and productivity and reducing food waste, for instance in the fishery and agriculture sectors, where electricity supports irrigation and food storage (IRENA, 2025c, 2025d, 2025e, 2025f).

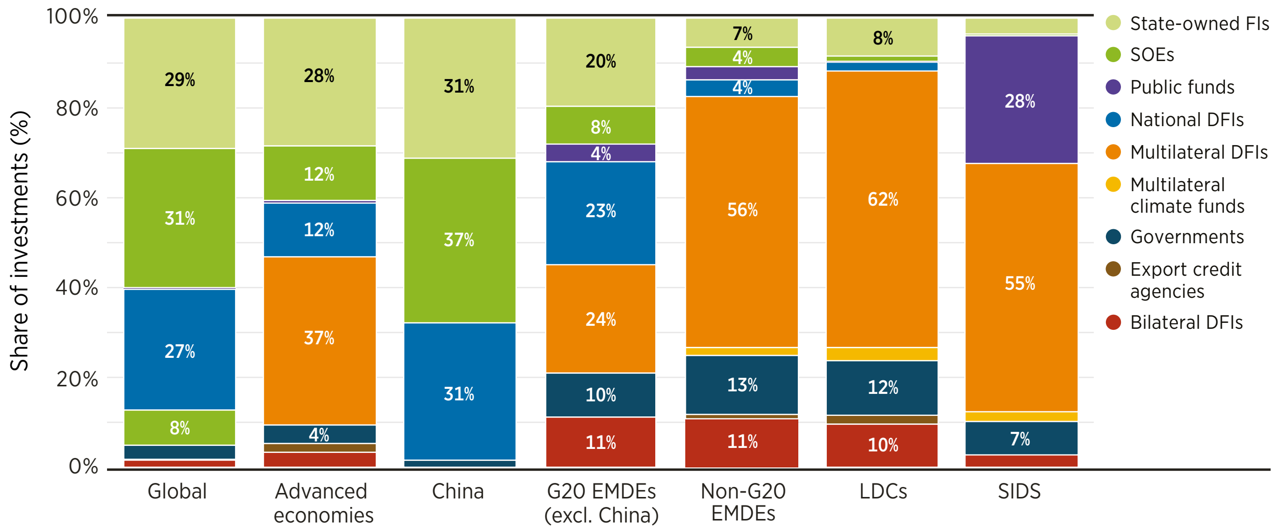
Source: (ClimateWorks, 2024).

3.1.3 Public finance

Investment by public investors[34] compares the biennia 2020/2021 and 2022/2023 as no data for 2024 are currently available. In 2022/2023 biennia, public investment in renewable energy assets reached USD 266 billion, constituting 40% of total renewable energy investment, up slightly from 38% in 2020/2021 (USD 174 billion).

There is significant variation in the composition of public finance provision between the six groups of countries analysed. As expected, SOFIs and SOEs have a much larger role in advanced economies, China, and the G20 EMDEs excluding China, while multilateral DFIs and governments have a much larger role in EMDEs outside the G20, including LDCs (Figure 3.6).

Figure 3.6 Public investment in renewable energy by country group and investor type, 2022/2023 average



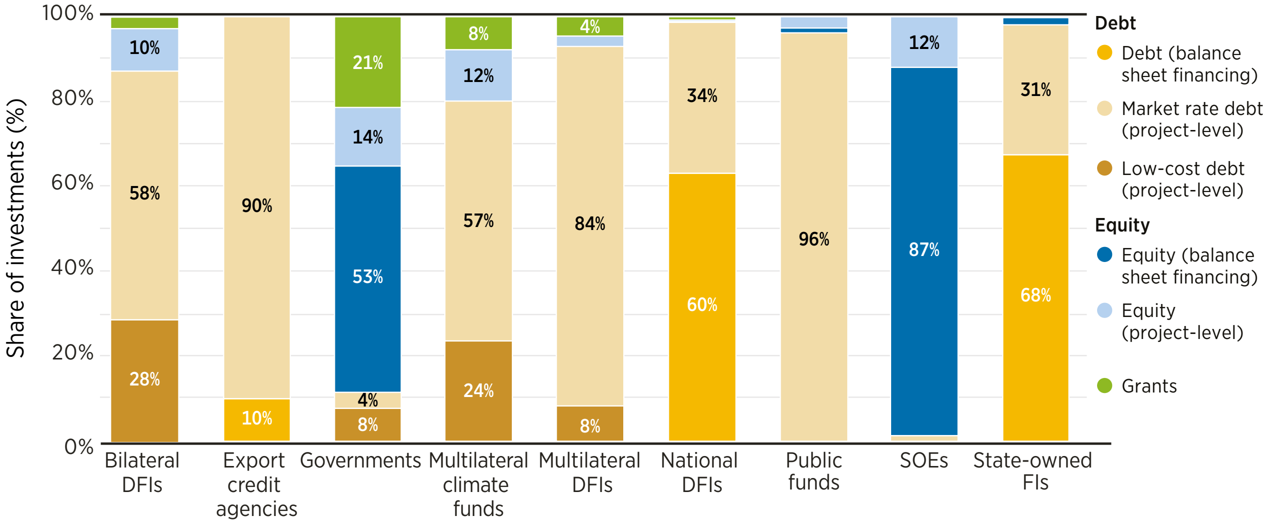
Based on: (CPI, 2025).

Notes: DFI = development finance institution; EMDE = emerging market/developing economy FI = financial institution; LDC = least-developed country; SIDS = small island developing states; SOE = state-owned enterprise.

With the exception of governments and SOEs, which invest primarily through equity, public institutions mostly invest through debt instruments, low cost and market rate, making up 81-100% of their investments in 2022/2023. Grants account for 21% of government investments and 8%, 4% and just 2% of multilateral climate funds, multilateral DFIs and bilateral DFIs, respectively (Figure 3.7).

[34] *To avoid double counting, investments are attributed solely to the entity executing the investment; for example, multilateral development bank investments are not also ascribed to their government contributors.*

Figure 3.7 Public investment in renewable energy by financial instrument and type of investor, 2022/2023



Based on: (CPI, 2025).

Notes: DFI = development finance institution; FI = financial institution; SOE = state-owned enterprise.

National development finance institutions

National DFIs[35] made up 27% of all public sector investment in renewable energy (USD 71 billion) and 11% of overall investment in 2022/2023 at the global level (Figure 3.6). National DFIs continue to be the main provider of investments for hydropower projects, contributing 86% of total public funding for hydropower in 2022/2023. Most of this funding comes from Chinese DFIs that invest domestically. Some Chinese national DFIs have also invested in hydropower projects internationally, across advanced economies, EMDEs (G20 and non-G20), and LDCs.

In **advanced economies**, national DFIs' share of public sector investment more than halved, from 29% in 2020/2021 to 12% in 2022/2023, with Germany continuing to be a major recipient. More than half (52%) of national DFI funding was in the form of impact-driven instruments;[36] the remainder was through market rate debt.

In **G20 EMDEs, excluding China,** national DFIs' share of public sector investment increased from 17% in 2020/2021 to 23% in 2022/2023. Almost two-thirds of this investment (64%) was in the form of impact-driven instruments; the remainder was through market rate debt.

In **non-G20 EMDEs,** national DFIs provided a total investment of USD 437 million in 2022/2023, 62% of which came from Chinese DFIs. This included USD 86 million for LDCs, with the majority going to Myanmar. Only 5% of such investment in non-G20 EMDEs and 1% in LDCs was made through impact-driven instruments, with the balance made through market rate debt instruments. This pattern reflects the limited engagement of Chinese national DFIs in impact-oriented investing and underscores a gap in access to impact capital for resource-constrained countries.

[35] Defined as a single country owning the institution; finance is typically directed domestically. In China, national DFIs have also redirected finance overseas.

[36] Grants and low-cost debt; see section 3.2.2 for additional analysis.

Governments

Direct investments from governments in renewable energy projects grew by 22% in 2022/2023 compared with the previous biennium, contributing USD 8.3 billion (3.1% of total public investments, and 1.2% of total investments). This included bilateral climate-related development finance and domestic financing through public budgets carried out by central, state or local governments.

Government investment as a share of total public investment in 2022/2023 varies widely between country groups, with China having the lowest proportion (1.5%), followed by advanced economies (4%) and SIDS (7.5%). G20 EMDEs excluding China, non-G20 EMDEs, and LDCs had higher proportions: 10%, 13% and 12%, respectively.

In **advanced economies**, 77% of direct government investments are made domestically. The remaining 23% are made internationally, almost all by Western European governments investing in Eastern Europe and Central Asia.

In **G20 EMDEs excluding China,** direct government investment as a share of overall public investment was 10% in 2022/2023 (Figure 3.6). India received almost 80% of all direct government investment among G20 EMDEs excluding China, mainly through a green bond facility issued in 2023.

Government investments in **non-G20 EMDEs** predominantly came from overseas governments (86%), with just 14% coming from domestic governments 2022/2023. Viet Nam was the largest recipient (14%) of international government investment. The European Union committed more than EUR 500 million in support of Viet Nam's Just Energy Transition Partnership (European Commission, 2023).

LDCs received USD 491 million in 2022/2023 from governments, nearly all from abroad, with approximately two-thirds originating from Western European governments who invested primarily through impact-driven instruments (91%). The modest scale of these flows underscores the limited commitment of donor governments to support LDCs in meeting climate and sustainability goals.

SIDS received USD 80 million of direct government investment on average in 2022/2023 (7.5% of total public investment), all from abroad, through impact-driven instruments.

Multilateral development finance institutions

Multilateral DFIs[37] accounted for 7.8% of public investments in 2022/2023 and 3% of the global total, equivalent to USD 21 billion. Investments grew by 60% compared with 2020/2021. Half of this funding was in advanced economies - with Spain, France, and Italy accounting for 55% of the group's investment – mainly for solar PV and offshore wind projects and provided mainly through market rate debt (98%).

Multilateral DFIs are the largest provider of public investment across all country groups except China, providing 62% of overall public investments in LDCs, 56% in non-G20 EMDEs, 55% in SIDS, 37% in advanced economies, and 24% in G20 EMDEs excluding China (Figure 2.23).

In **G20 EMDEs excluding China**, multilateral DFI investments primarily go to Brazil, India and South Africa, and most of those investments (93%) are in the form of market rate debt.

[37] *Multilateral DFIs have multiple shareholder countries and direct finance flows internationally.*

In non-G20 EMDEs, multilateral DFIs provided USD 6.8 billion in 2022/2023, with their share of public investment expanding from 37% in 2020/2021 to 56%. This expansion was driven primarily by onshore wind investments in Uzbekistan. More than one-third of the multilateral DFI investments in this country group were made through impact-driven instruments, 60% through market rate debt, such as the Inter-American Development Bank's USD 150 million non-concessional debt financing to the government of Uruguay for the modernisation of a national hydropower complex (IDB, 2023), and the remainder through equity.

In **LDCs** and **SIDS**, multilateral DFIs account for 62% and 55% of public investments, respectively. The share of these investments made through impact-driven instruments is 58% and 45%, respectively. Around half of multilateral DFI funds are channelled as market rate loans, which in these contexts can often mean high debt servicing costs (Independent Expert Group, 2023). Examples of such transactions include the Asian Development Bank's provision of debt financing for renewable energy and energy efficiency infrastructure in Bangladesh, to the value of USD 278 million, of which 94% was at market rates (ADB, 2025).

Bilateral development finance institutions

Investments in renewable energy from bilateral DFIs[38] totalled USD 4 billion in 2022/2023 at a global level, constituting 1.5% of the total public investment and 0.6% of the global total. More than one-third (36%) of this investment went to G20 EMDEs excluding China. One-third went to all other non-G20 EMDEs (33%) – of which LDCs received 30%. Advanced economies received 23% of bilateral DFI investment, while SIDS received less than 1%.

In advanced economies, bilateral DFIs constituted just 3% of total public investments, while in G20 EMDEs excluding China, non-G20 EMDEs and LDCs, they represented larger shares, at around 10% (Figure 3.6).

While **advanced economies** receive bilateral DFI investments from both in-country institutions and international sources (predominantly European institutions), bilateral DFI investment in **all EMDEs (G20 and non-G20), excluding China** was almost all from international sources in 2022/2023 (primarily from institutions in Europe and North America). India and South Africa received 36% and 33% of all investment from bilateral DFIs in G20 EMDEs excluding China in 2022/2023. Among non-G20 EMDEs, Côte d'Ivoire, Egypt and Uzbekistan collectively received over one-third of all bilateral investment in the group. Across these three country groups, approximately one-third of bilateral DFI funding is impact driven, and two-thirds is made through market rate instruments.

LDCs and **SIDS** received small amounts of bilateral DFI investment in 2022/2023: USD 395 million and USD 29 million, respectively. The majority of this investment in LDCs was impact driven (61%); however, almost all investment in SIDS is through profit-driven instruments (97%) in the form of project-level debt, owing to investment by European and North American institutions in solar PV development in the Dominican Republic.

[38] Bilateral DFIs are owned by a single country and direct finance flows internationally.

Multilateral climate funds

Multilateral climate funds[39] invested only USD 238 million in renewable energy on average across 2022/2023, accounting for less than 1% of total public sector investment, similar to 2020/2021 in both share and amount. Globally, multilateral climate funds make up less than 0.1% of direct investments. Investments are concentrated in non-G20 EMDEs. The amount contributed in 2022/2023 marks a continued decline in renewable energy investment from these institutions, which peaked at USD 1.3 billion in 2016/2017. This decrease is driven primarily by the decline in investment from two institutions, which in 2016 contributed 89% of all bilateral DFI funding.

In **non-G20 EMDEs,** multilateral climate funds represent 2% of total public investment in renewable energy in 2022/2023, with almost half going to Mozambique, Nepal and Nigeria. More than a quarter (26%) of their overall investment is made through impact-driven instruments.

Limited flows were tracked from multilateral climate funds to LDCs and SIDS in 2022/2023 (USD 119 million and USD 23 million, respectively). In LDCs, only 12% of multilateral climate fund investment was made through impact-driven instruments in 2022/2023, compared with 94% in SIDS.

State-owned enterprises

Investments in renewable energy from SOEs[40] totalled USD 83 billion in 2022/2023 at a global level, constituting 31% of the total public investment and 12% of the global total.

The share of SOEs in public investment in renewable energy continues to rise, growing from 22% in 2020/2021 to 31% in 2022/2023. Globally, SOE investment is predominantly provided to domestic markets, while international flows represent less than 1% of total flows (69% of international flows are provided by a handful of European firms, and the remainder by Chinese SOEs mainly to other Asian countries). All the SOE transactions in 2022/2023 used profit-driven instruments: 99% was equity and 1% was through debt.

Investments from **Chinese SOEs** (more than 1 900 institutions) dominate global trends, accounting for 94% of all global SOE renewable energy investments in 2022/2023. The share of SOEs in public investments in China continues to rise, growing from 25% in 2021/2022 (USD 33 billion) to 37% in 2022/2023 (USD 78 billion).

In **advanced economies**, SOEs invested USD 3.3 billion on average in 2022/2023 representing 12% of public investments in these countries. Forty-two percent of this investment represented international flows made in Europe, concentrated mainly in offshore wind projects in the United Kingdom, and another 19% in the United States. These flows predominantly come from a single European SOE.

In **G20 EMDEs excluding China,** SOE investment equalled USD 1.1 billion in 2022/2023 (8% of total public investment in that country group), 72% of which was made by domestic SOEs in India and Saudi Arabia. In **non-G20 EMDEs**, SOE investment equalled USD 528 million in 2022/2023 (4% of total public investment), with 60% coming from overseas SOEs, mainly from China (93%) to other Asian countries.

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[39] *Owned by the collective of countries that contribute to them. Multilateral funds are typically managed by an international organisation, often in conjunction with an overseeing board or committee.*

[40] *SOEs are at least majority owned by a government or government agency. Although they are classified as public sector institutions, they often undertake activities of a commercial nature. The same applies to SOFIs.*

State-owned financial institutions

Investments from SOFIs reached USD 77 billion in 2022/2023, constituting 29% of total public investment and 12% of all global direct investments. Globally, 97% of SOFI investments are deployed domestically, and the remainder 3% internationally.

Much like SOEs, global investment from SOFIs is dominated by **China,** which accounted for 85% of global SOFI investment in 2022/2023, equivalent to USD 66 billion, representing 31% of total public investment in the country.

In **advanced economies,** SOFI investment rose to USD 7.9 billion in 2022/2023, accounting for 28% of total public investment. This is up from 11% in 2020/2021 and underscores the growing role of SOFIs in public capital deployment. Seventy-seven percent of SOFI investment in advanced economies was made domestically in 2022/2023. Investment was concentrated in the United States (63%) and Europe (29%). These flows come from fewer than 20 entities, investing primarily in solar PV (45%) and onshore wind (25%).

In **G20 EMDEs excluding China,** total SOFI investment as a share of public investment decreased between 2022/2023 and 2020/2021, from 32% to 20%, as growth in investments from other types of public investor outgrew that of SOFIs. Ninety-three percent of this investment was made domestically by Brazil, India and Saudi Arabia. Indonesia, India and South Africa received small investment volumes from international SOFIs, primarily from Chinese and European institutions.

Non-G20 EMDEs received USD 798 million in SOFI investment in 2022/2023 (6.5% of total public investment), just over half the USD 1.5 billion received in 2020/2021. This drop can be traced back to significant decreases in domestic SOFI investment in Viet Nam after 2020/2021, particularly in solar PV projects. Forty-six percent of the SOFI investment to the group in 2022/2023 were made domestically – mainly by the Land Bank of the Philippines for two domestic renewable energy projects (Chandak, 2023; Philippine Information Agency, 2023). Of the 54% international investments received from SOFIs by non-G20 EMDEs in 2022/2023, German institutions provided 73% for projects in Sub-Saharan Africa, and Chinese institutions provided 16% for projects in Asia (excluding China).

SOFIs invested USD 341 million in **LDCs** in 2022/2023, accounting for 8% of total public investment in the country group, up from 5% in 2020/2021. These investments are often driven by big projects, such as a German-financed hydropower project in Angola, which received the majority of these tracked flows. **SIDS** received USD 37 million in SOFI investment in 2022/2023 (3% of total public investment), all of which went to Singapore. There were no tracked SOFI flows to SIDS in 2020/2021.

Less than 1% of global tracked flows for SOFIs in 2022/2023 were made through impact-driven instruments.

Sovereign wealth funds

About USD 508 million of flows towards renewables were tracked for sovereign wealth funds (SWFs) on average in 2022/2023, with the majority (73%) allocated domestically by institutions in India and Saudi Arabia.[41] Between 2018 and 2023, the share of SWF direct investment allocated to renewables increased from 2% to 7%, reflecting a shift towards sustainable investment priorities (TheCityUK, 2024).

[41] *A common challenge in analysing SWFs is their limited transparency, with many offering minimal disclosure. This analysis includes only investments made directly by SWFs. Investments undertaken through subsidiary entities are attributed to the subsidiary providing the capital. Consequently, CPI's database captures a subset of reported direct investments. Although not exhaustive, this tracking offers an indicative snapshot of sectoral trends and emerging investment priorities.*

Examples of direct SWF transactions in 2022/2023 include the following: Saudi Arabia's National Development Fund provided debt financing of USD 450 million for the Al Shuaibah 1 and Al Shuaibah 2 solar projects, co-financed with other domestic investors including ACWA Power Co. and Aramco, raising total project debt of USD 1.63 billion in 2023 (ACWA Power, 2023); the Government of Singapore Investment Corporation invested internationally in TagEnergy, a Portugal-headquartered company, to fund its global pipeline of renewable energy projects (TagEnergy *et al.*, 2023).

No SWF investments were recorded in non-G20 EMDEs, including LDCs and SIDS. in 2022/2023. In smaller markets, individual project sizes may not meet SWFs' investment ticket size criteria and often require considerable technical, commercial and legal due diligence requirements. As a result, most SWFs invest indirectly through partnerships with specialised managers or platform investments where projects or companies are aggregated (OPSWF, 2022).

Tracking SWFs' climate-related investments is critical given their substantial assets under management, which not only render them influential actors in advancing global decarbonisation goals but also expose them to significant climate-related risks. Such monitoring is integral to fulfilling their fiduciary responsibility to safeguard long-term portfolio resilience and to protect the economic interests of the citizens and governments they serve (OECD, 2020).

3.2 Renewable energy investments by financial instrument

3.2.1 Debt and equity funding

Globally, nearly half (49.4%, or USD 327 billion) of total investment in 2022/2023 was provided as debt, most of which was provided at market rate. The rest was invested through equity (50%) and grants (0.6%).

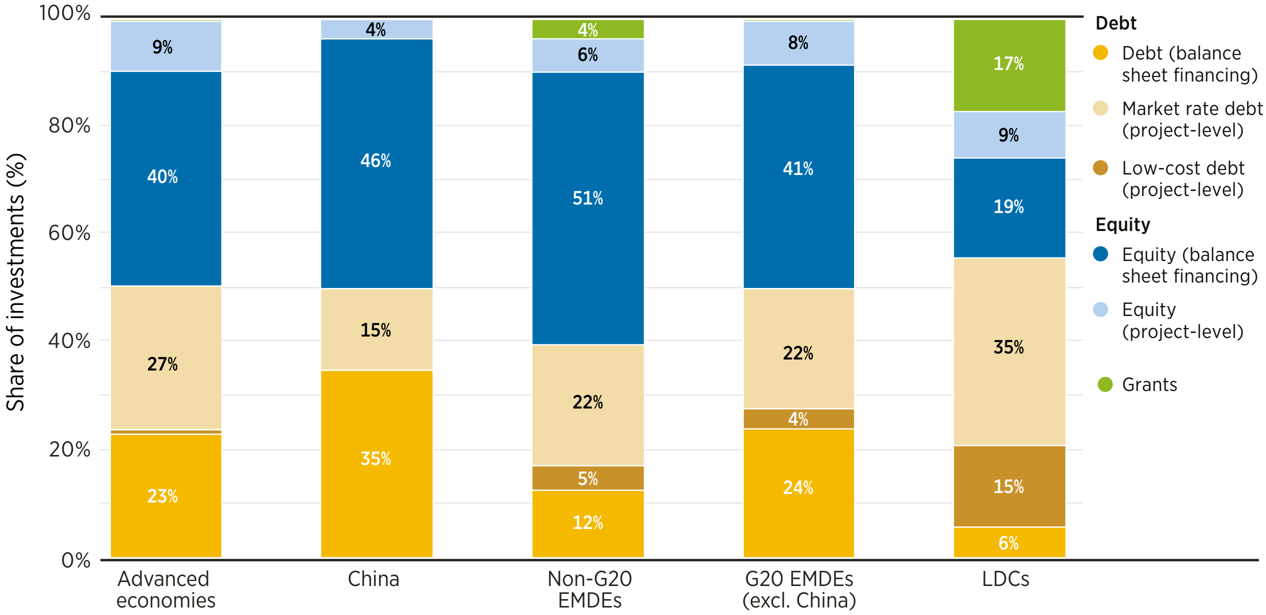
This half-to-half debt-equity ratio was consistent across **China, advanced economies and G20 EMDEs excluding China** (Figure 2.25).

In **non-G20 EMDEs**, the share of debt financing was 39% of overall investment in 2022/2023 – the lowest among all the country groups (Figure 3.8). This is because more than three-quarters of investment in these countries comes from private sources, typically corporations and households, that largely invest through balance sheet equity. In addition, debt from commercial financial institutions may be unavailable or expensive in many of these countries.

LDCs had the lowest share of equity funding across all country groups (28%) in 2022/2023 owing to limited participation from large corporate project developers that invest through their own equity. LDCs also had the highest share of debt (56%) across all groups, of which a little more than a quarter was concessional and the rest was at market rate.

In 2022/2023, 40% of investments in LDCs came from bilateral and multilateral DFIs, 70% of which was in the form of debt, 26% in the form of grants and 4% in the form of balance sheet equity. Although the shares of low-cost debt and grants in LDCs were higher than in any other group – accounting for 15% and 17% of total renewable energy investments in 2022/2023, respectively (Figure 3.8) – the dominance of market rate debt, which makes up more than 40% of total investment, is increasingly concerning from a debt sustainability perspective. This underscores the need for more flexible instruments to support LDCs' repayment capacity. Debt for climate swaps, along with broader debt relief measures, could be instrumental in this respect (see Conclusion section).

Figure 3.8 Shares of financial instruments across country groups, 2022/2023 average



Based on: (CPI, 2025).

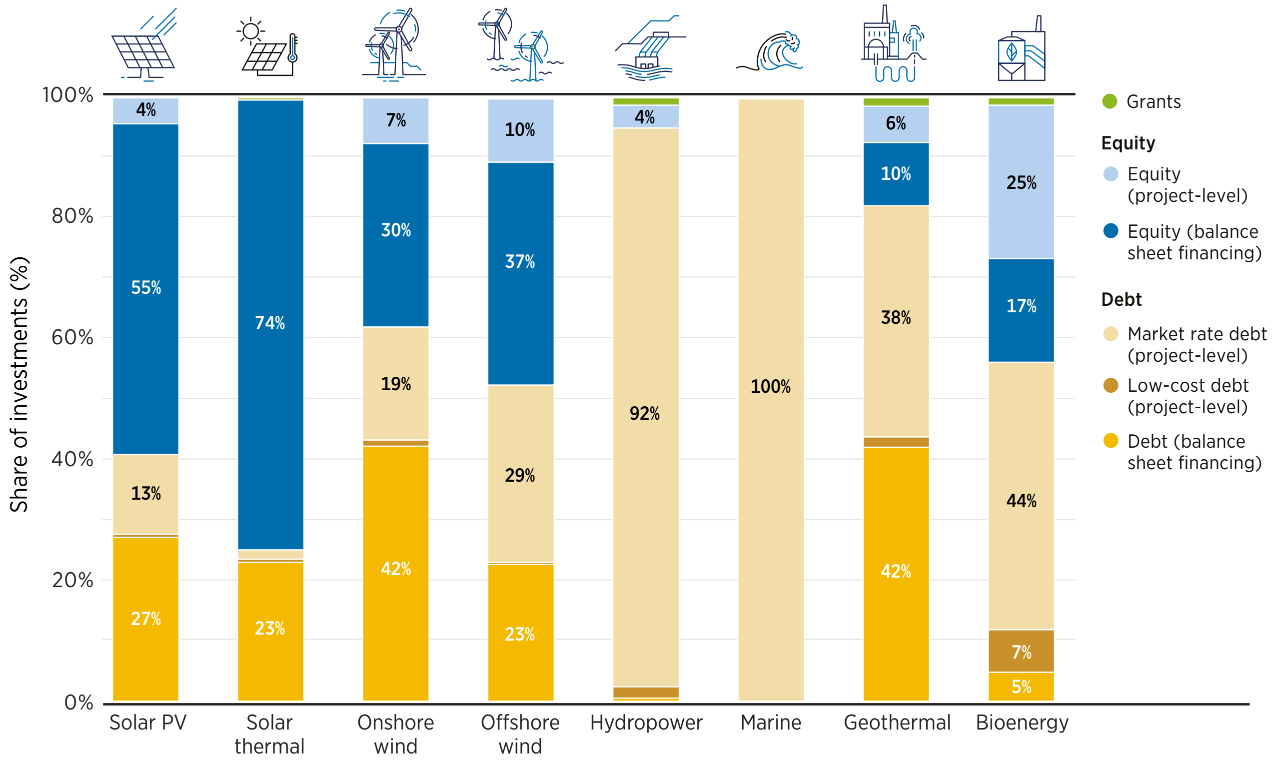
Notes: EMDE = emerging market/developing economy; LDC = least-developed country.

Globally, the split between debt and equity varies across technologies (Figure 3.9). Solar technologies are predominantly financed through equity, with balance sheet equity making up 68% of total investments in 2022/2023. Small-scale solar PV plays an important role in driving this trend, accounting for 37% of total solar PV investments and entirely funded through balance sheet equity, with household and corporate investments contributing almost equally. Twenty-eight percent of large-scale solar is also funded through balance sheet equity. Compared with other mature technologies, such as onshore and offshore wind, solar is more modular in nature, allowing households and corporations to invest their own funds for self-consumption; therefore, higher shares of equity are to be expected. For solar thermal, a higher portion of balance sheet equity is observed for a similar reason, as nearly 70% of all solar thermal investment is used for solar water heating.

By contrast, hydropower is dominated by debt financing. As discussed earlier, these are complex projects that typically rely on project-level debt to adequately ring-fence risks. Geothermal presents a more balanced structure, with debt financing split between project-level and balance sheet sources.[42]

[42] Marine energy is not discussed due to the limited number of project samples, although available data indicate that it is entirely financed through project-level debt.

Figure 3.9 Shares of financial instruments by technology, 2022/2023 average



Based on: (CPI, 2025).

Notes: There are a limited number of project samples for marine energy, but available data indicate that it is entirely financed through project-level debt. CSP = concentrated solar power; PV = photovoltaic.

3.2.2 Profit versus impact-driven investments

Growing debt burdens mean that many EMDEs outside the G20 cannot sustain their energy transitions on market rate terms alone. Many countries are already trapped in debt and poverty cycles, preventing public funds from being used for development such as for health and education.

The urgent need to mobilise renewable energy investments, combined with a scarcity of impact-driven capital such as low-cost debt and grants, risks exacerbating debt burdens. For countries already in debt distress, this can accelerate a vicious cycle of higher costs of capital, reduced access to finance, and constraints on delivering renewable energy projects. This dynamic illustrates the "debt paradox" of renewable energy finance and underscores the critical importance of impact-driven capital, particularly in the form of concessional loans and grants. Impact-driven instruments play a key role in de-risking projects in EMDEs, mobilising additional capital and funding projects for just transitions and sustainable development.

While impact finance has been used for finance that is intended to generate profit while at the same time meeting environmental, social, and governance (ESG) standards, in this report, such investments are classified as profit-driven, while impact-driven investments refer to financial instruments that are not aimed at generating profit as their primary goal, but at creating impact – such as grants and low-cost project debt – provided on concessional terms, including lower interest rates, longer repayment periods and greater flexibility.[43] These more favourable terms grant these investments the status of “impact-driven” as opposed to “profit-driven” commitments, for which market-level profit is the primary motive.

In 2022/2023, impact-driven investments[44] made up just 1.6% (USD 10.5 billion) of global renewable energy investments, down from 2.3% in 2020/2021 (USD 10.6 billion) (Figure 3.10).

The distribution of impact-driven capital slightly improved between 2022/2023 and 2020/2021. Sub-Saharan Africa received the largest amount in 2022/2023, accounting for 26% of all impact-driven investments in renewable energy, followed by Europe (22%), Latin America and the Caribbean (20%), and Asia (excluding China) (11%), together accounting for around 20% of the global total. The remaining 20% was spread across other regions. This contrasts with 2020/2021, when impact-driven capital was more concentrated, with Europe alone representing 53%, followed by Sub-Saharan Africa (16%) and Asia (excluding China) (12%). While the shift towards less-developed regions such as Sub-Saharan Africa is encouraging and desirable to support their development, the absolute amounts remain insufficient relative to needs.

Impact-driven finance by region

In **Sub-Saharan Africa**, impact-driven finance accounted for 20% of the region’s total renewable energy investment in 2022/2023, down from 28% in 2020/2021 (Figure 3.10). Still, in absolute terms, the volume reached USD 2.7 billion in 2023, an increase of around 60% compared with 2020/2021 levels (USD 1.7 billion), although it declined by 28% in 2023 compared with 2022. Overall levels are far from sufficient to meet the region’s financing needs.

For **Europe**, impact-driven capital became more visible from 2017 onwards, with a marked increase in 2021 when it rose to 12%, largely driven by low-cost project debt from a German national DFI to its domestic market. In 2022/2023, the volume declined but remained primarily driven by the same institution.

In **Latin America and the Caribbean**, impact-driven capital accounted for over 50% in 2013/2014 but declined rapidly thereafter to only around 6% of the total by 2022/2023. This is likely because in 2017, the Brazilian Development Bank shifted from providing loans under a subsidised interest rate to more market-aligned interest rates under the *Taxa de Longo Prazo* (World Bank, 2017).

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[43] The definition of impact-driven investments follows the approach used by the OECD which defines concessional funds as those that meet the Official Development Assistance (ODA) grant equivalent threshold with economic development and welfare as the main objective. Concessionally is evaluated by calculating the “grant element”, which considers four main factors: the interest rate, the grace period, the maturity, and the discount rate. A loan is deemed concessional if its grant element surpasses 10% for Upper Middle-Income Countries (UMICs), 15% for Lower Middle-Income Countries (LMICs), or 45% for Least Developed Countries (LDCs) and other Low-Income Countries (LICs)(OECD, 2020). Loans to the private sector need to convey a grant element of at least 25% to be concessional.

[44] Some impact-driven financing may also seek market rate returns (e.g. capital driven by environmental, social, and governance considerations).

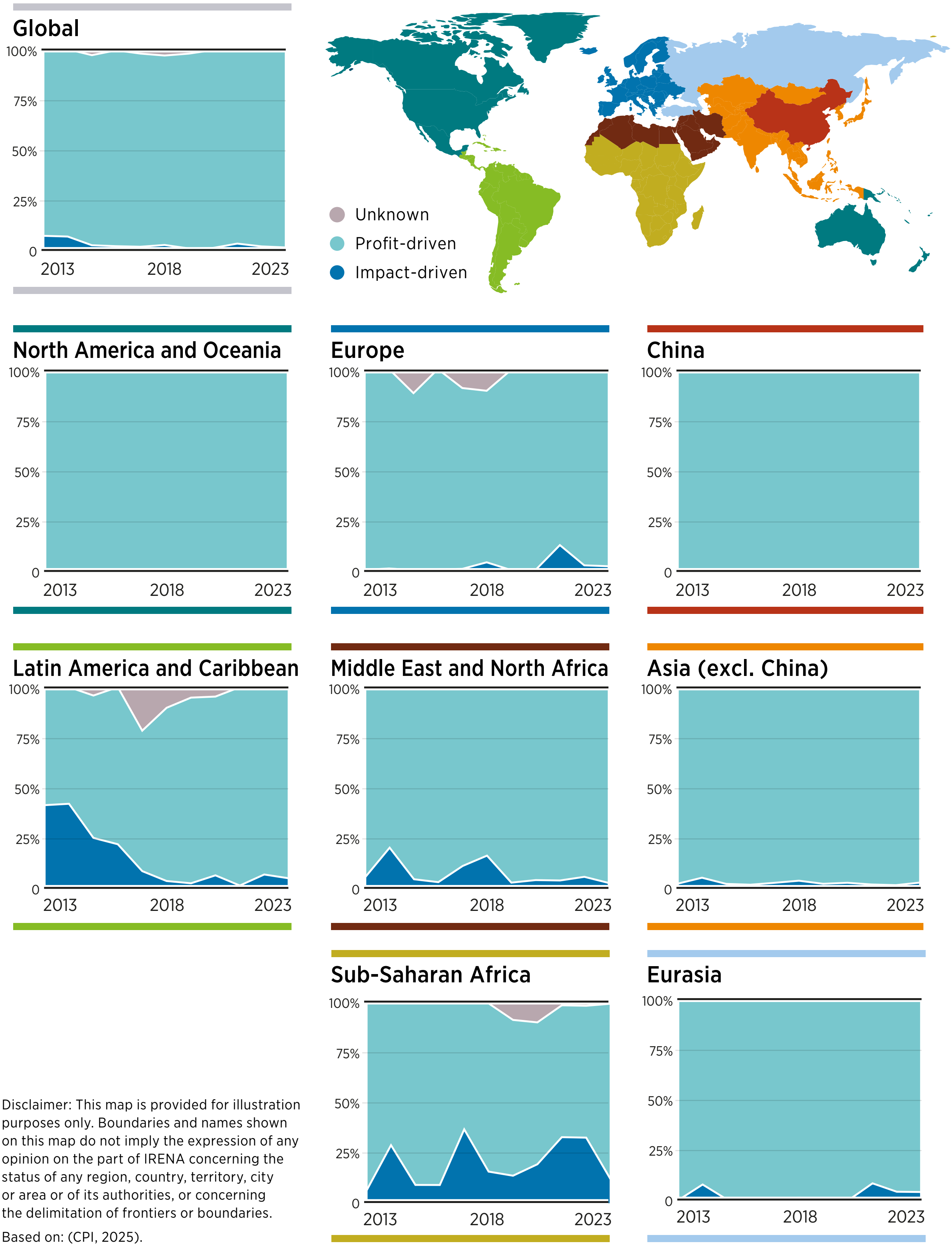
In **Asia (excluding China)** profit-driven finance has consistently made up 97-98% over 2013-2023, with impact-driven finance making up the remainder (aside from a slight uptick in 2014). In 2022/2023, impact-driven capital in this region was concentrated in Bangladesh, India, Indonesia, Pakistan, Tajikistan and Uzbekistan, together accounting for around 80% of total investment in the region.

For **Eurasia**, renewable energy investment before 2020 was also almost entirely profit driven. The notable uptick came in 2021, when impact-driven finance rose to 8.5%, driven by low-cost project debt from a Turkish national DFI to its domestic market for multiple technologies, with a similar dynamic continuing in 2022/2023.

In the **Middle East and North Africa**, impact-driven capital briefly rose to around 15-20% of total investment in certain years, such as 2014 and 2018, but in recent years (2020/2021 and 2022/2023) it has remained at around 3%. In 2014 and 2018, a large share was provided by European multilateral DFIs and European national DFIs for solar PV, concentrated in a handful of countries such as Morocco. Although the share declined in 2022/2023, the regional and technological concentration persisted. A significant project during this period included capital from a Japanese bilateral DFI to Egypt for solar PV, with some small contributions from other institutions spread across additional Middle East and North African countries.

For **China**, from 2013 to 2023, there were almost no tracked impact-driven investments based on the official development assistance standards established by the Organisation for Economic Co-operation and Development's Development Assistance Committee (IEA, 2024f); capital has been mobilised primarily through commercial incentives with strong state-led support including through its comprehensive industrial policy. Similarly, in **North America and Oceania**, the share of impact-driven capital has remained negligible over the past decade, reflecting the region's relatively higher level of economic development as a whole and availability of commercial sources of investment.

Figure 3.10 Share of impact-driven and profit-driven capital in renewable energy investment, by region, 2013-2023



Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Based on: (CPI, 2025).

Impact-driven finance by country group

In 2022/2023, **non-G20 EMDEs** received 40% of impact-driven investments (USD 4.2 billion), with half going to LDCs within this group. Among **LDCs,** 50% of impact-driven investments were concentrated in six countries: Bangladesh, Chad, Ethiopia, Mozambique, Tanzania and Uganda. In both 2020/2021 and 2022/2023, more than 99% of impact-driven capital in LDCs originated from international sources, the majority of which came from European public institutions.

Among **non-G20 EMDEs**, 14% of impact-driven capital was received by high-income and upper-middle-income countries, with half this capital received by Armenia, Chile, the Dominican Republic and Guyana. The majority of these investments were provided by international multilateral DFIs.

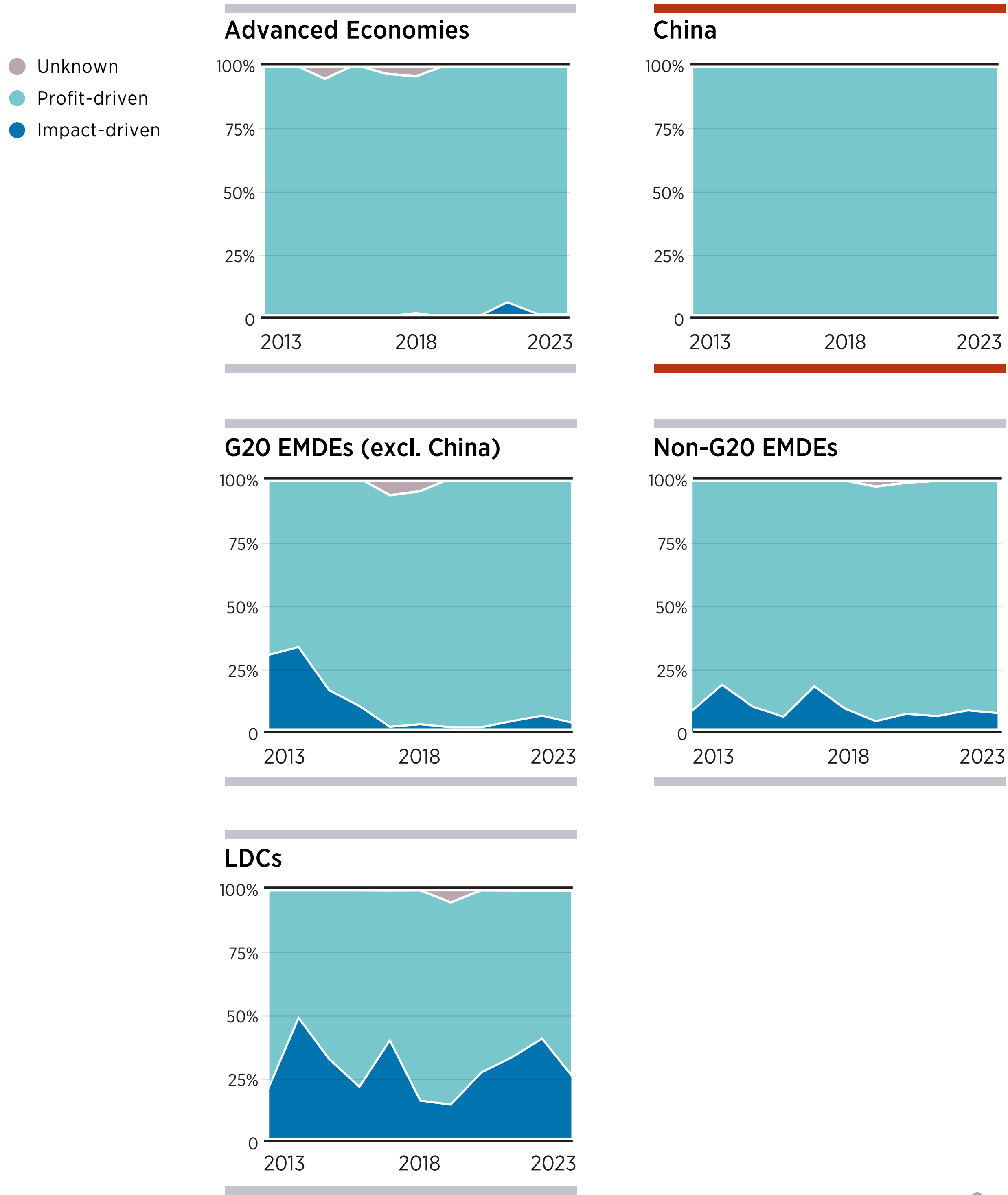
G20 EMDEs (excluding China) received 24% of global impact-driven capital (USD 2.6 billion), driven by Brazil which accounted for 61% of the total in 2022/2023, with investments provided domestically by the Brazilian Development Bank. The second largest recipient was India (12%), followed by South Africa (10%) and Türkiye (9.7%).

Advanced economies received the remaining 23% of impact-driven capital (USD 2.5 billion). Germany was the primary destination (77%), with concessional capital provided domestically by its own national DFI. Norway followed (5.5%), with the majority of investments coming from a domestic fund.

China received minimal impact-driven funding (USD 47 million; 0.45% of the global total), partly explained by nearly 95% of energy-related financing coming from major national DFIs – such as CDB and CHEXIM – which is non-concessional, based on the official development assistance standards established by the Organisation for Economic Co-operation and Development's Development Assistance Committee (IEA, 2024f). In addition, as China is now classified as a major emerging economy, it no longer qualifies as a recipient of impact-based funding from international aid programmes targeted at low-income countries.

Further breakdown of impact versus profit driven investments in country groups is provided in figure 3.11.

Figure 3.11 Share of impact-driven and profit-driven capital in renewable energy investment, by country group, 2013-2023



Based on: (CPI, 2025).

Notes: EMDE = emerging market/developing economy; LDC = least-developed country.

Impact-driven finance by financial instrument

Impact-driven finance in 2022/2023 was largely made up of low-cost project debt (65%), with grants accounting for the remainder. However, across the country groups analysed, the split between low-cost project debt and grants varies significantly, mirroring different levels of economic development: economies with relatively higher development levels tend to receive fewer grants, with some exceptions.

In **G20 EMDEs excluding China**, more than 90% of impact-driven investments took the form of low-cost project debt, whereas in **advanced economies** the share was 68%, with the higher proportion of grants largely driven by a German national DFI. Non-G20 EMDEs displayed a more balanced mix of these instruments, with 57% of impact-driven investments made through low-cost project debt. In **LDCs**, 53% of impact-driven investments were provided as grants, reflecting the financing needs and development context of these countries. This distribution across country groups in 2022/2023 was broadly consistent with that of 2020/2021.

Providers of impact-driven finance

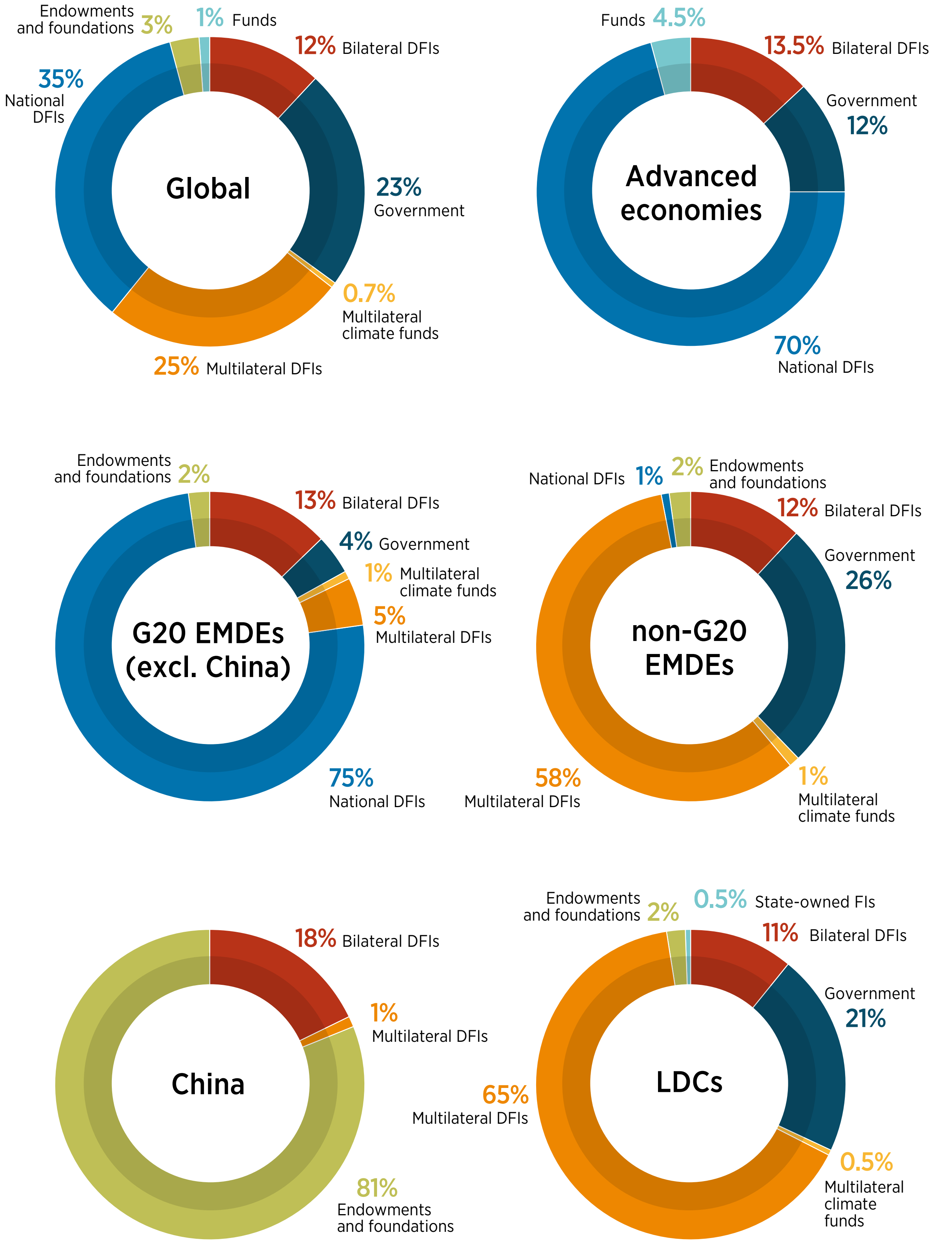
The provision of impact-driven finance remains the purview of public institutions which accounted for 96% of the total in 2022/2023 (or USD 10 billion) (Figure 3.12) as the following: DFIs provided 75%, followed by governments (24%), and multilateral climate funds provided 0.8%. The private sector provided 4.2% of global impact-driven investments in 2022/2023 (Figure 3.12).

Globally, 63% of impact-driven finance originated from international sources in 2022/2023. The main recipients were **non-G20 EMDEs** which received around 40% of total impact-driven finance, almost entirely from international providers such as multilateral DFIs and governments. The second-largest recipient group, **G20 EMDEs excluding China**, obtained around 25% of total impact-driven finance from international sources, of which roughly 70% came from DFIs from advanced economies such as France and Germany.

Across all country groups, impact-driven capital provided by governments comes almost entirely from international sources. Impact-driven capital represented 20% of total government financing, but made up 84% of governments' international flows, indicating that cross-border government support was provided mainly in the form of impact-driven investments. Of this, 83% originated from Europe and from North America and Oceania, with the majority directed towards EMDEs (excluding the G20), reflecting the North–South aid channels delivered through official development assistance.

When looking at domestic flows of impact-driven finance, it is mostly provided by national DFIs, which in 2022/2023 supplied 95% of impact-driven capital supplied to domestic markets.

Figure 3.12 Providers of impact-driven investments (global and by country group), 2022/2023 average



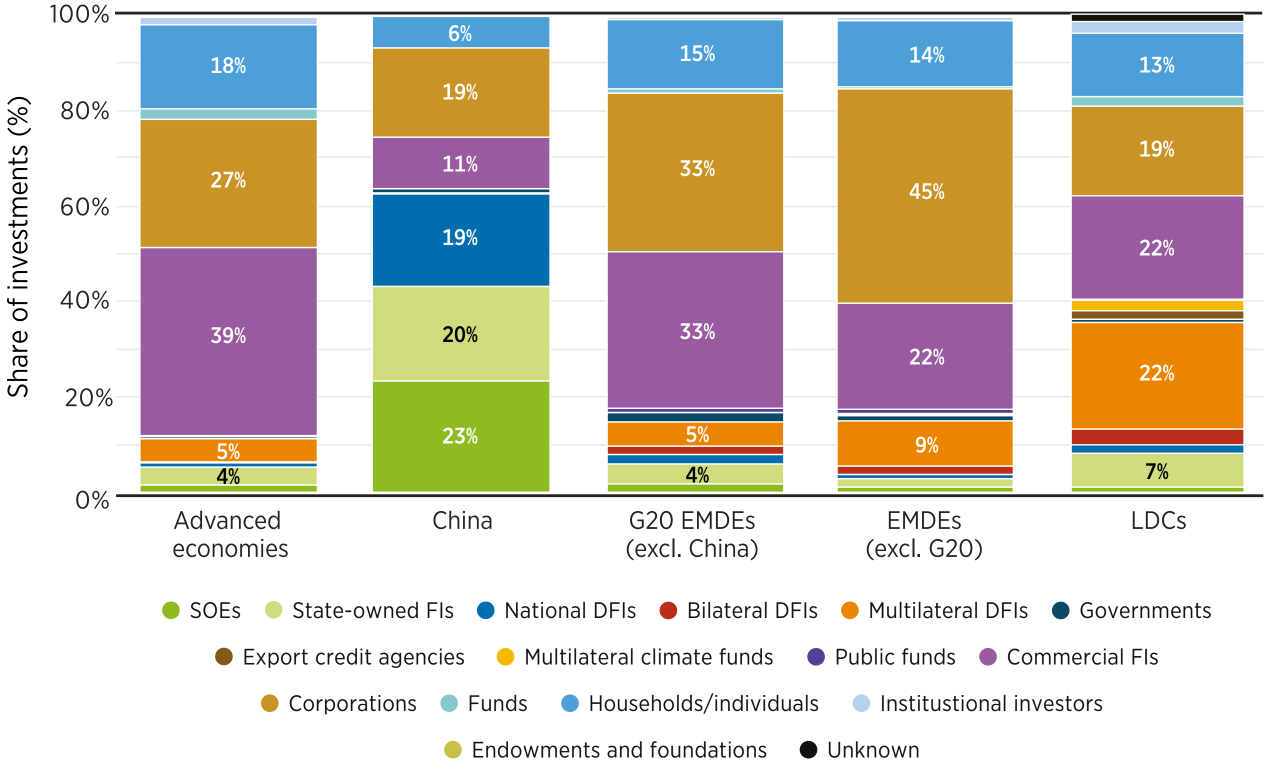
Notes: DFI = development finance institution; EMDE = emerging market/developing economy; FI = financial institution; LDC = least-developed country.

Profit-driven finance

Profit-driven investments provided at regular market conditions are unsurprisingly led by private sector financial institutions, which accounted for about 60% of the total profit-driven investment in 2022/2023 (and 86% when excluding China due to high investments from SOEs and SOFIs in the country, typically provided at market-rate), a share that has decreased since 2014. Among private sector investors, commercial financial institutions and corporations were responsible for more than 80% of profit-driven capital across the past decade (Figure 3.13), reflecting strong interest from banking and corporate actors in scalable renewable energy assets. Although such investments can pursue impact, their primary motive is typically to generate a profit.

Public sources provide the remainder 40% of profit-driven investments, again mainly due to high SOE and SOFI investment in China. In 2022/2023, 64% of profit-driven capital in China originated from the public sector, mainly from SOEs and SOFIs, which play an important role in the country's energy sector (WEF, 2019). Excluding China, the majority of profit-driven capital (86% in 2022/2023) in other regions was provided by the private sector, in line with previous years. In LDCs, public sector contributed 40% of profit-driven capital driven, mainly coming from multilateral DFI's in Africa and Europe.

Figure 3.13 Share of profit-driven investments, by type of investor across country groups, 2022/2023 average



Based on: (CPI, 2025).

Notes: DFI = development finance institution; EMDE = emerging market/developing economy; FI = financial institution; LDC = least-developed country; SOE = state-owned enterprise.

04 ENERGY TRANSITION SUPPLY CHAIN INVESTMENTS

Investments in energy transition supply chains – including for the mining and refining of critical materials such as lithium, cobalt and nickel and the manufacture of critical components (*e.g.* solar modules, wind turbines, batteries and hydrogen electrolysers) – are essential for meeting IRENA's 1.5°C Scenario. Mining and manufacturing capacity must keep pace with the unprecedented deployment of transition-related technologies envisioned in the Scenario. Moreover, the benefits of such investments need to be distributed equitably as they form a crucial building block in a just and inclusive energy transition.

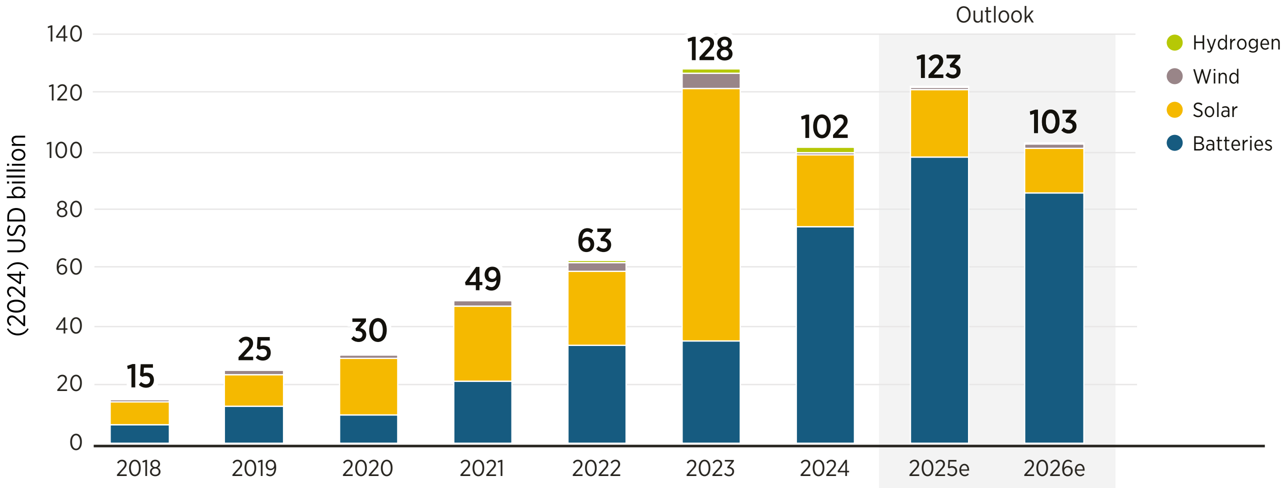
This section analyses investments in these supply chain components in relation to the latest trade policies and how they could influence investments in supply chains going forward.

4.1 Investment in manufacturing facilities for energy transition technologies

Investments in factories for manufacturing solar, wind, battery and hydrogen technologies dropped by 21% to USD 102 billion in 2024, after reaching a peak of USD 128 billion in 2023 (Figure 4.1) (BNEF, 2025i). This reduction is primarily driven by a 72% decline in investments in solar PV factories (after a record high reported in 2023) while battery factory investments more than doubled (BNEF, 2025i).

Cumulatively, more than USD 400 billion was invested in manufacturing facilities for solar, wind, battery and hydrogen technologies between 2018 and 2024, translating to about 1 TW/year of solar PV manufacturing capacity (Wood Mackenzie, 2025a), and 3 terawatt hours of battery manufacturing capacity (IEA, 2025d). China accounted for more than 80% of global investments between 2018 and 2024, as the country holds more than three-fifths of the world's manufacturing capacity for clean energy technologies such as solar PV, wind systems and batteries (IEA, 2023c). Europe and the United States attracted 7% and 4.5% of global investments, respectively, and the remainder was shared between Southeast Asian economies (2.6%), India (1%) and the rest of the world (3.6%).

Figure 4.1 Investments in manufacturing of solar, wind, battery and hydrogen technologies, historical and projected, 2018 - 2026



Source: (BNEF, 2025i).

Notes: (i) This figure includes factory investment across the manufacture of solar technologies (polysilicon, wafers, cells and modules), batteries (separators, electrolytes, cathodes, anodes and cells), wind turbines (nacelles only), and hydrogen electrolyser manufacturing (stack assembly only). While BNEF data are missing some parts of the supply chain, new data launched by the Net Zero Industrial Policy Lab in September 2025 capture a broader set of clean-tech manufacturing technologies for Chinese investments overseas (including for electric vehicles, electric buses and charging stations). These data suggest that overall investments in manufacturing may be far greater than stated in this figure. The data also confirm the decline in solar photovoltaic investments, although of lower magnitude (Xue and Larsen, 2025). (ii) e = estimate.

US investment in solar factories increased by 78% between 2023 and 2024 to reach USD 4.5 billion, and the country's investment in battery factories increased six-fold, reaching USD 5 billion. This was mainly due to the incentives offered by the Inflation Reduction Act, as well as tariffs that made domestic PV production more profitable.

Recent cuts to federal incentives and the enactment of the OBBBA may undercut the United States' earlier efforts to boost local manufacturing of energy transition technologies. BNEF estimates that domestic manufacturing subsidies for batteries, solar, wind and EVs would have totalled around USD 167 billion between 2024 and 2032,[45] almost three times of that of the European Union and Japan combined (BNEF, 2025d, 2025j). About 19% of these subsidies, equivalent to USD 32 billion, had been cancelled as of September 2025, and an additional 31% (USD 42 billion) is at further risk of being cancelled (BNEF, 2025k). These cuts could significantly affect both domestic and global progress (BNEF, 2025k).

Domestically, while the United States was expected to double its share of battery manufacturing investments from 5% in 2023/2024 to 10% in 2025/2026 (BNEF, 2025i), the country saw cancellations of more than USD 24 billion worth of new factories and energy transition-related projects between January and September 2025, forgoing the creation of 21 000 jobs (E2, 2025). While battery projects remain eligible for tax credits under the OBBBA, this does not apply to projects that are considered to have "prohibited foreign entity" involvement (Abramowitz *et al.*, 2025).

[45] *Subsidy estimations from China are not available from BNEF.*

The European Union has announced a range of polices and subsidies to boost domestic manufacturing, having set ambitious manufacturing targets, including 90% of the bloc's battery demand (or 550 GWh/year of capacity) and 40% of the bloc's solar and wind demand (European Union, 2024). Major European Union-based battery, solar and wind makers have faced significant financial headwinds in the last few years, which may limit expansion plans (BNEF, 2025d). Current investment levels remain insufficient to meet these targets and need to be considerable scaled up.

Going forward, global investments are expected to recover, with growth led mainly by battery storage manufacturing, while solar PV investments are expected to remain below 2022 levels. Much of the investment will continue to be concentrated in China, but developing economies (*e.g.* India, Southeast Asia, and other parts of the world (see sections 4.1.1 and 4.1.2) are also seeing the buildout of new manufacturing facilities – often through Chinese investment and technical expertise.

Foreign direct investment – provided primarily by Chinese companies – is helping build battery, solar, wind and EV manufacturing across the developing world. According to Net Zero Industrial Policy Lab, these overseas investments by China in the last four years even exceeded the overall US Marshall Plan over a four-year period, at a time when US manufacturing in key industries was dominant (NZIPL, 2025). This analysis shows that expanded from funding downstream renewable energy generation infrastructure (with USD 4.6 billion tracked to flow from China to other countries in 2022/2023) to upstream manufacturing, mining and refining of energy transition technologies.

These investments are enabling the geographic diversification of supply chains, local value creation and energy security globally. Meanwhile, such investments are also likely supporting China's objectives around gaining access to host and third-country markets, as well as access to raw material inputs (*e.g.* see Section 4.2) (NZIPL, 2025). Southeast Asia has traditionally been the main destination of investments in manufacturing, more recently joined by countries like Brazil, Egypt, Morocco and Gulf Cooperation Council countries, as well as some European economies like Hungary and Spain (GRI, 2025). Investments in mining and refining go to resource-rich countries such as the Democratic Republic of the Congo and Indonesia (see Section 4.2).

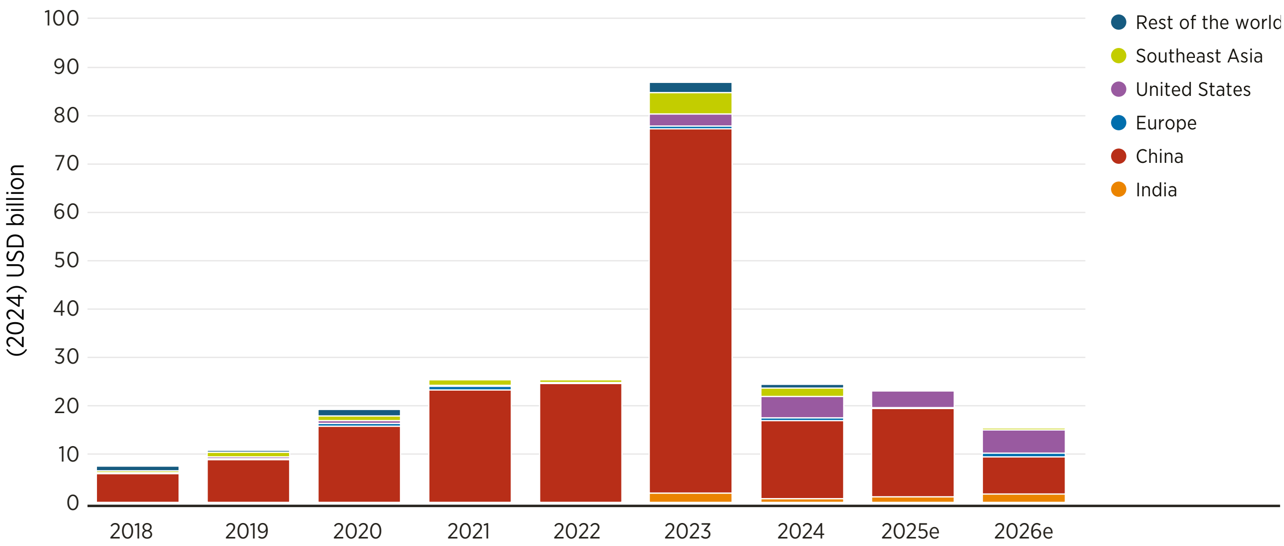
Many private automakers outside China are also building and co-financing a significant portion of battery manufacturing (see Section 4.1.2).

4.1.1 Investments in solar PV factories

In 2024, global investment in solar PV factories fell by 72%, driven primarily by an oversupply of manufacturing capacity worldwide and the proliferation of tariffs and non-tariff trade barriers on solar panel imports – particularly on those coming from China (Figure 4.2)[46] As module prices declined and market barriers increased, major manufacturers – again, particularly in China – saw profit margins more than halve in 2024 (BNEF, 2025l). Additional tariffs on imports have been imposed by the United States, while the European Parliament is also considering enacting tariffs on Chinese solar PV imports. Today, 98% of Europe's solar panels and parts are imported from China (Abnett, 2024). Similar to the United States, countries such as Brazil, India and South Africa have previously enacted a combination of restrictive import policies and supportive industrial policies and subsidies to boost domestic production of solar PV components (Jowett, 2024b; Wood Mackenzie, 2024).

Recent trade conflicts have similarly impacted solar PV manufacturers and assembly facilities in Southeast Asia, which is the largest solar PV manufacturer after China,[47] accounting for 6.5% of solar module, cell and wafer manufacturing in 2024 (Wood Mackenzie, 2025a). Investments in Southeast Asia declined by 62% in 2024, after a peak year in 2023, although they remain above pre-2023 levels. Over 2025 and 2026, investments are expected to remain limited as countries in the region have been subject to significant tariffs from the United States (at the time of writing) – their main export market for PV products.

Figure 4.2 Investments in solar PV factories, historical and projected, 2018 - 2026



Source: (BNEF, 2025h).

Notes: (i) These investment numbers do not reflect the latest policies from the United States since January 2025, which will likely have a downward impact on future investments globally. (ii) The 2023 peak may be explained by the fact that this is around when the mainstream solar cell technology started shifting from P-type PERC cells to more efficient N-type TOPCon cells. A lot of the big Chinese manufacturers invested in new facilities to have a head start in providing these new cells to their customers. (iii) e = estimate.

[46] *Some of the decline is likely a result of an expected correction from peak investment in 2023.*

[47] *On a strictly national basis, India is the second largest producer but is surpassed by the Association of Southeast Asian Nations collectively.*

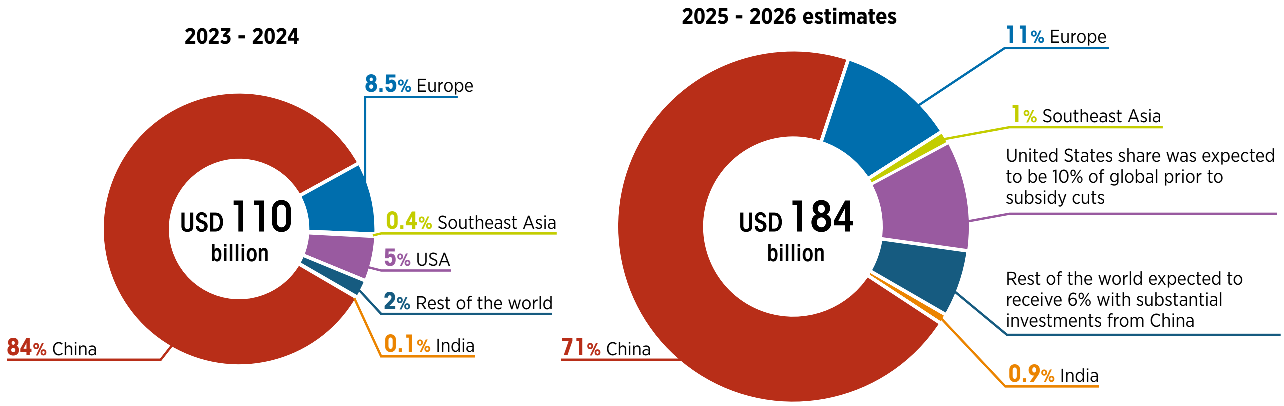
Solar PV manufacturing investments in 2025-2026 are expected to decline significantly to just one-third of the level seen in 2023-2024 (BNEF, 2025i). However, a higher portion of "new" factory investment and construction is expected to occur outside China and Southeast Asia, as other countries look to diversify their supply chains. For example, India is emerging as a major solar PV manufacturing and exporting hub, with domestic solar module manufacturing capacity growing from less than 5 GW in 2018 to more than 68 GW in 2024 (Wood Mackenzie, 2025a). Going forward, India's share of global investment is expected to more than triple, from 2.5% in 2023-2024 to almost 8% in 2025-2026, underpinned by the Production Linked Incentive scheme.

However, export-oriented manufacturers in India are facing significant hurdles, with the United States – a major trading partner that accounted for 97% of the Indian solar PV module export market in 2024 – imposing a total of 50% tariff on Indian goods as of August 2025. Prior to this, solar PV exports from India to the United States had increased by twenty-three times between 2022 and 2024. Margins on overall exports were 40-60% higher than domestic sales in 2024 (IEEFA, 2024). The latest tariffs may curtail India-US solar PV trade, diminish margins on exports, and even slow the buildout of new factories in India.

4.1.2 Investments in battery factories

Global investment in battery factories has almost doubled between 2023 and 2024, to reach USD 74 billion (Figure 4.1), driven by the growing demand for energy storage solutions for renewable integration, grid flexibility, EVs and data centres. China made up 84% of investments in 2023-2024 and is well established as the dominant hub for battery manufacturing (Figure 4.3). However, its share is expected to decline to 71% in 2025-2026, as other countries, including several developing economies, launch efforts to localise battery production. India plans to develop a battery gigafactory in Jamnagar, Gujarat, by 2026, with an annual production capacity of 30 GWh, positioning it among the largest battery manufacturing plants in the country (Manufacturing Today, 2024). Indonesia also aims to launch its first EV battery manufacturing plant, with an annual capacity of 10 GWh of battery cells (Agarwal, 2024).

Figure 4.3 Share of battery manufacturing investments, by country/region, 2023-2024 versus 2025-2026



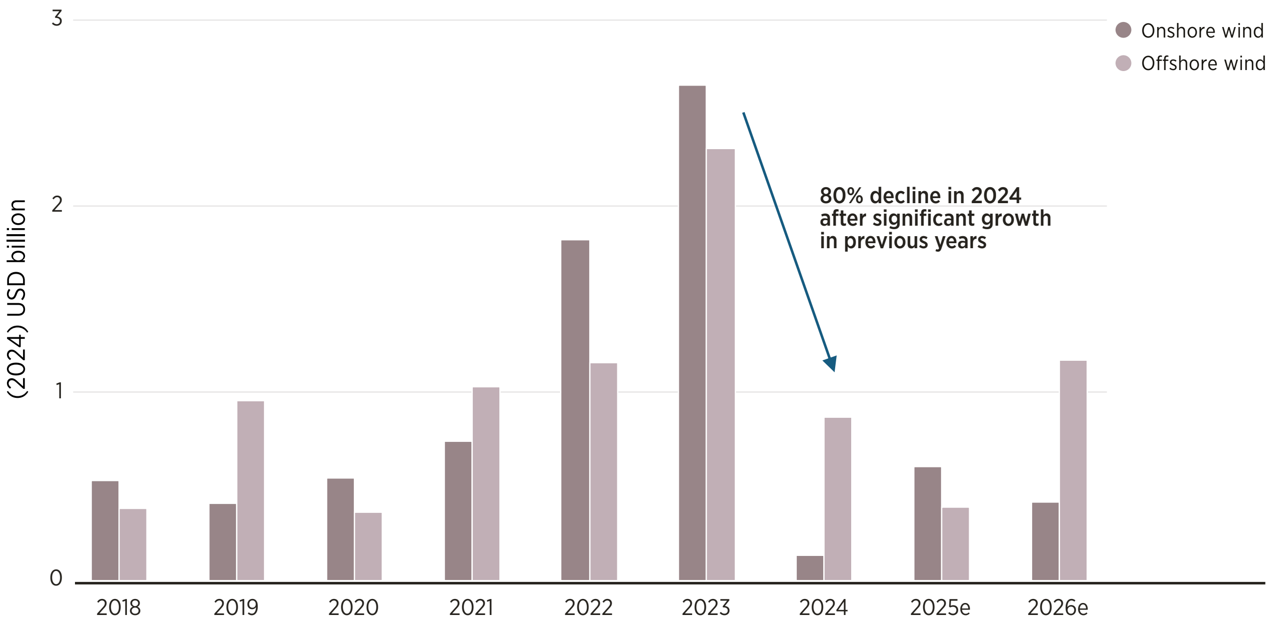
Based on: (BNEF, 2025h).

A significant portion of battery manufacturing is being built or co-financed by automakers, likely in attempts to secure battery supply, reduce costs through vertical integration and comply with any domestic content requirement regulations. In addition to Tesla and BYD – the two largest EV producers – traditional automobile companies such as Ford, Hyundai, BMW and Toyota are setting up manufacturing plants globally. For instance, Hyundai's EV manufacturing plant in the United States (Georgia) has been built in partnership with another Korean conglomerate, LG Energy Solution; another battery manufacturing plant in an adjacent county in Georgia, set up by SK On, is expected to provide batteries for Hyundai's and Kia's locally manufactured EVs (Hyundai, 2022, 2025). These companies are also expanding their footprint in emerging economies such as Brazil, India, Indonesia, Thailand, Türkiye and Viet Nam (BMW Group, 2023; Carey, 2025; Cawthorn, 2024; PR Newswire, 2024).

4.1.3 Investments in wind factories

Investments in wind factories – although a smaller portion of overall supply chain investments – fell by almost 80% in 2024, and the future outlook remains well below 2022/2023 levels (Figure 4.4). The sector has faced significant deployment challenges due to inflation, permitting delays and supply chain pressures. As of 2024, a higher share of investments is going to offshore wind turbine manufacturing than to onshore. This is expected to continue in 2025 and 2026.

Figure 4.4 Investments in manufacturing of wind nacelles, historical and projected, 2018 - 2026



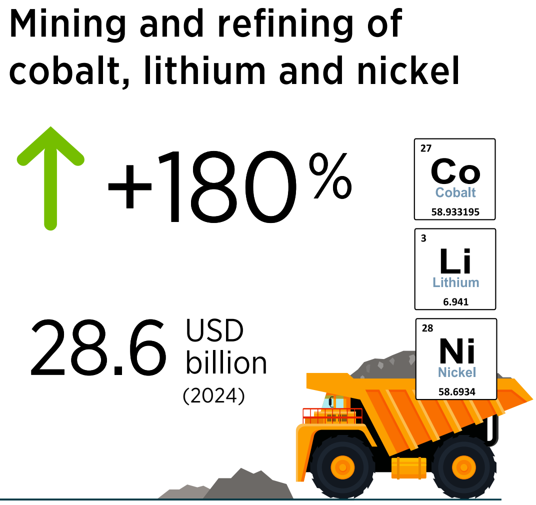
Based on: (BNEF, 2025h).

Note: e = estimate.

Unlike solar PV, the wind power industry faces a bifurcated supply chain structure. To some extent, this reflects the fact that some components (*e.g.* blades) are large and difficult or costly to transport over long distances. China is the largest manufacturer of wind towers, blades, nacelles and other components. In 2024, Chinese firms accounted for 70% of all turbine orders worldwide, ahead of companies headquartered in Europe (19.4%), the United States (6.5%) and India (0.8%) (Wood Mackenzie, 2025b). However, at present, Chinese companies' production is almost exclusively destined for the massive domestic market. European manufacturers remain in the lead in markets outside of China but struggle with rising costs. Vestas and Siemens Gamesa have the most geographically diversified portfolio. Their turbines have been deployed in more than 80 countries, compared with 51 for the US firm GE Vernova (Wood Mackenzie, 2025c).

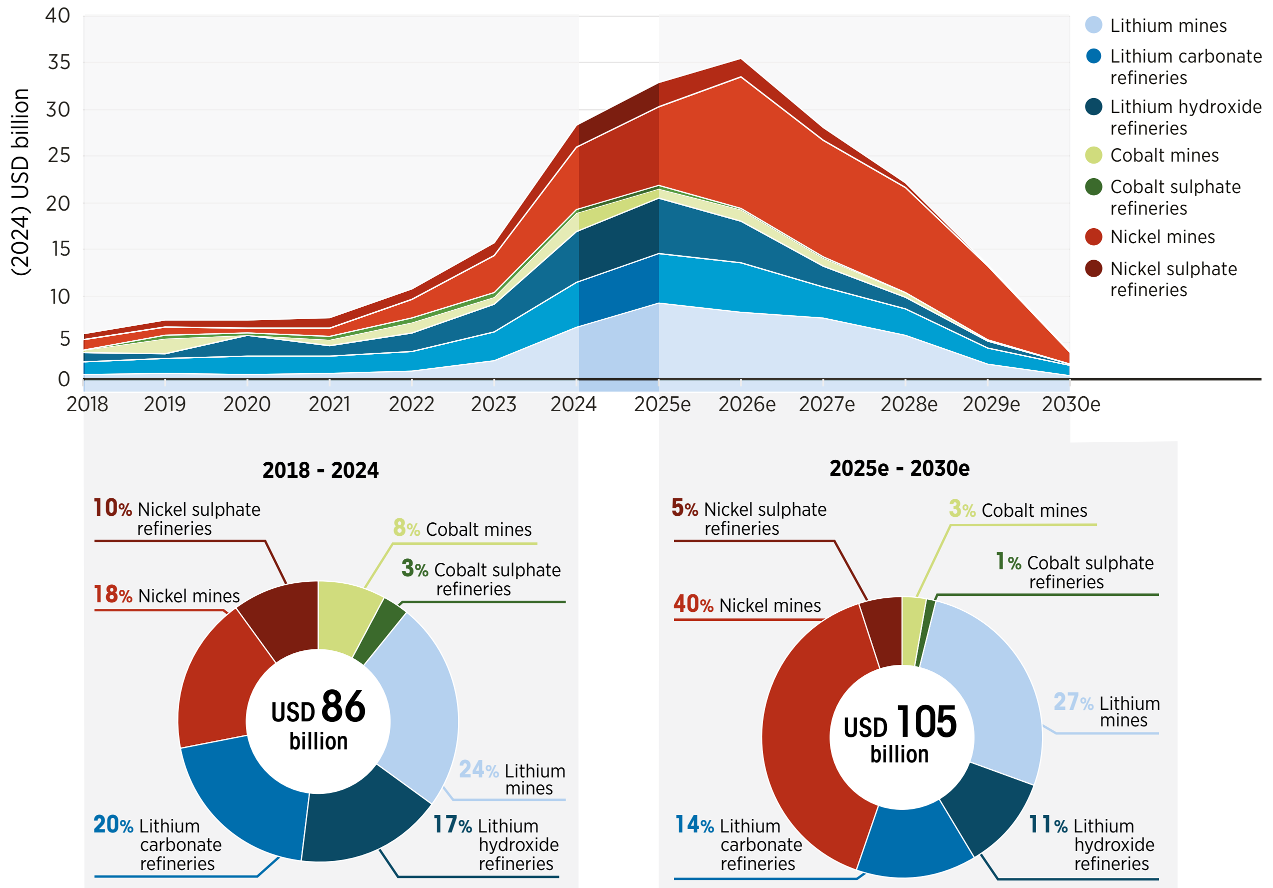
4.2 Investment in mining and refining (lithium, cobalt and nickel)

In 2024, investments in the mining and refining of critical materials such as lithium, cobalt and nickel[48] reached a record high of a combined USD 28.62 billion (one-third of the cumulative total of such investments since 2018) (Figure 4.5). Cumulatively, since 2018, at least USD 86 billion has been invested in mining and refining – split almost equally between the two. Almost two-thirds of this investment has taken place in 2022-2024, driven by the growing demand for battery technologies, EVs and other energy transition technologies.



[48] *Due to limited data availability and resources, this section does not explore investments in copper and rare earth elements.*

Figure 4.5 Investments in mining and refining of lithium, cobalt and nickel, historical and projected, 2018-2030



Based on: (BNEF, 2025h).

Note: e = estimate.

While country-specific data on investments are limited, mining and refining capacity provides a reasonable proxy for investment destination.

Mining is concentrated in a few countries, but refining is even more concentrated. Many resource-rich developing countries remain stuck in upstream segments of the value chain, while higher value-added refining is concentrated in fewer countries. In 2024, four countries – Australia (38%), Chile (30%), China (16%) and Argentina (8%) – accounted for 92% of global lithium mining capacity (BNEF, 2025m). Sub-Saharan African countries make up just 4%, almost all in Zimbabwe, which has the largest lithium reserves in the African continent, followed by Nigeria, Mali and South Africa. Refining is even more concentrated: China alone hosts more than two-thirds of lithium refining capacity in 2024, with the next largest capacities hosted by Chile, Argentina and Australia. Sub-Saharan Africa, despite its resources, has no lithium refining capacity – meaning these countries mainly export unprocessed ores.

Nickel mining is more diversified. It occurs across 26 countries and territories, with Indonesia (25% of the global total), the Philippines (15%), and New Caledonia (9%) the major players. Refining capacity is again more concentrated, with China (35.5% of global capacity) and Indonesia (30%) hosting the largest capacity.

Cobalt is the most concentrated of all: the Democratic Republic of the Congo produces 84% of mined cobalt yet has no domestic refining capacity. Most cobalt refining takes place in China (73%), followed by Finland, Canada and Norway (together approximately 15%). Only a handful of developing countries – Indonesia, Madagascar, Morocco and South Africa – host any significant refining facilities, representing around 6% of global capacity (BNEF, 2025n).

Resource-rich developing countries are taking steps to stimulate investments in higher value-added refining. Indonesia first banned the export of nickel ores in 2014. Later in April 2022, the ban was enacted again, requiring nickel to be processed domestically for export (IEA, 2025e; Medina, 2024a), a move that Zimbabwe has mirrored in the case of its lithium reserves. In mid-2025, Zimbabwe announced plans to partially ban lithium exports from 2027 onwards to promote local refining and generate additional revenues.

Indonesia also aims to be one of the top three producers of EV batteries in the world by 2027, while reaching a manufacturing capacity of 140 GWh per year by 2030 (from 10 GWh today) (Huber, 2022; Medina, 2024b). Global EV makers, which include China's BYD and Wuling and the Republic of Korea's Hyundai in partnership with LG Energy Solution, have invested in Indonesia, and their EVs are already in the market. The country is also developing lithium refineries and anode material production facilities to complement its nickel-based battery industry. However, compliance with environmental standards and labour rights may need to be enhanced, to attract a wider range of investors that are increasingly concerned with ESG standards.

Chinese mining companies, both private and state-owned, control large cobalt deposits in the Democratic Republic of the Congo (Rubbers, 2020). In 2018, the government declared cobalt a "strategic" resource and tripled export taxes (BBC News Afrique, 2018). Later in 2022, the government suspended exports from the largest Chinese-owned cobalt mine over financial disputes and temporarily halted about 10% of global cobalt production, being able to push for better terms in mining contracts and more domestic processing of minerals (Ross and Reid, 2025; Rubbers, 2020).

The future investment outlook for mining of lithium, cobalt and nickel remains positive over the long run, but the short-term volatility of commodity markets creates significant challenges for investors. Like most commodities, lithium, cobalt and nickel markets are highly reactive to short-term supply and demand dynamics, prices and resulting profit margins.

For lithium, for instance, previous expansion of mining and refining capacity has created an oversupply relative to current demand, although the world still lacks sufficient mining and refining capacity to meet demand under a net-zero scenario. Since late 2022, prices have dropped by 89%,[49, 50] squeezing profit margins (Bloomberg News, 2025b). This has prompted some investors – particularly non-integrated companies where a third-party offtaker is needed – to scale back operations or limit expansions. This is particularly the case outside China. Meanwhile, larger well-capitalised companies continue to leverage strategic partnerships and expand projects (Thomson, 2025). While long-term demand for lithium, cobalt and nickel remains strong, long-term supply adequacy depends on price stability and sustained investments.

[49] *Based on data between July 2022 and July 2025.*

[50] *Prices in China bounced back in August 2025 after the closure of a mine, but this recovery may be short-lived.*

Over 2025-2026, investments in lithium are expected to continue increasing, reaching a peak in 2026 (Figure 4.5). But most lithium refining expansion is expected to be in China, followed by Argentina and Australia. Rio Tinto – a large metal and mining multinational company – will invest USD 2.5 billion to expand lithium production at Argentina's Rincón mine, increasing it by twenty times, from 3 000 t/year to 60 000 t/year by 2028. This follows the Argentine government's new scheme offering reductions in corporate tax and sales tax rates to multinational companies investing at least USD 2 billion in the country. The scheme also removes some import and export regulations (Baker, 2024). In Australia, Global Lithium has secured a 21-year mining permit for an area of 51 million tonnes of lithium, which has the potential to boost the country's position in the mining supply chain (Alhan, 2025).

While investments in mining and refining capacity are critical to meet the demand for energy transition technologies, investments need to be balanced with concerns regarding the environmental impact of mining, the displacement of local communities and the need for sustainable manufacturing and recycling practices (IRENA *et al.*, 2024).

To ensure widespread social benefits, investments in, and financing of, mineral value chains need to be responsible and fair. This entails promoting strategies that favour enduring, sustainable and inclusive development by fostering local value creation, equitable benefit sharing, reduced market volatility, and supply chain resilience. Key players in the finance sector – including banks, insurers, investors, commodity exchanges, governments and businesses – should also focus on ensuring that financing is accessible and affordable for developing country participants in the mineral value chain. Financing should also include environmental, social and governance safeguards, aligned with internationally recognised sustainability standards and human rights law (The UN Secretary-General's Panel on Critical Energy Transition Minerals, 2024).

CONCLUSIONS

Investments in the energy transition continue to increase but not at the pace needed to achieve climate goals. Dedicated policy support and tailored financing solutions are needed to address the shortfall.

Global investments in energy transition technologies reached a record high of USD 2.4 trillion in 2024, a 9% increase from 2023. Growth in relatively mature technologies – renewable energy, energy efficiency, grids and electrified transport – continued in 2024, owing to strong policy support, market dynamics, and cost declines. Despite this progress, investments across key energy transition technologies still fall short of the level required to align with IRENA's 1.5°C pathway outlined in the report *Delivering on the UAE Consensus*: *Tracking progress toward tripling renewable energy capacity and doubling energy efficiency by 2030* (IRENA *et al*., 2025).

Average annual investments in renewable power and grids in 2025–2030 must almost double from current levels. Solar PV is the only renewable energy technology where current investment levels are approaching the annual average needed through 2030. Onshore and offshore wind require significant investment growth; current levels need to be scaled up by 3 and 8 times, respectively. Investment across other renewable technologies, including marine, geothermal, bioenergy and hydropower, remains far below what is needed. For hydropower, there is significant untapped potential, but projects often face high construction risks, require extensive environmental and social impact assessments and long loan tenors. For bioenergy, policy volatility and rising feedstock costs continue to be the main challenges. For marine and geothermal, less established supply chains and limited policy support compared to solar and wind have led to slower deployment and more cautious investor appetite.

The largest increase (in absolute terms) is required for investments in energy efficiency, which needs to grow by 7.5 times. Investment in green hydrogen, and carbon capture and storage (CCS) declined in 2024, and must increase by 8 and 7 times, respectively. Although battery storage investments sustained strong growth through 2024, they still need to triple.

Dedicated policy support and tailored financing solutions are needed for each technology and context to address the global investment shortfall.[51]

Investments in energy transition technologies and their supply chains remain concentrated. They must be distributed more equally if their benefits are to be shared across countries.

Significant disparity in the distribution of investments persists. China and advanced economies are the primary hubs for innovation, deployment and value creation, and accounted for more than 90% of investments in the deployment of energy transition technologies in 2024, while many emerging markets and developing economies (EMDEs) remain starkly underfunded. Africa has received less than 1% of investment in recent years, and least developed countries (LDCs) – 33 of which are located in Sub-Saharan Africa – received less than 0.5%. **Investments therefore need to be urgently scaled up to meet global climate, socio-economic and energy access goals.**

[51] *Detailed discussions on those policies are presented in: (IRENA, 2021b, 2022c, 2023b, 2024a).*

Investments in energy transition supply chains – manufacturing and mining - are also concentrated, limiting the number of countries that can access the potential benefits in terms of energy security and socio-economic development that the transition can bring. Between 2018 and 2024, China accounted for 80% of global investments in solar, wind, battery and hydrogen technology manufacturing facilities while Europe and the United States accounted for 7% and 5%, respectively. Southeast Asia represented 2.6%, India 1% and the rest of the world just 3.6%. A similar concentration exists in mining and is even more pronounced in refining facilities. Globally, investments in factories for manufacturing solar, wind, battery and hydrogen technologies had already dropped by 21% in 2024 after a record-high reported in 2023, primarily driven by a 72% decline in investments in solar PV factories, while battery factory investments more than doubled.

Foreign direct investment (FDI) – provided primarily by Chinese companies – is helping build battery, solar, wind and EV manufacturing across the developing world. While these investments support China to gain access to host and third country markets, as well as raw material inputs, they are also enabling the geographic diversification of supply chains, local value creation and energy security. Southeast Asia has traditionally been the main destination of Chinese investments in manufacturing, but more recently it has been joined by countries such as Morocco, Brazil and Egypt, while investments in mining and refining continue to be made in resource-rich countries such as Indonesia and the DRC. Indonesia is also taking steps to stimulate investments in higher value-added refining and manufacturing for batteries.

Supply chains must be developed, expanded and sustained across all regions. Strengthening international collaboration and forging new trade partnerships will be critical to expand existing supply chains and to building resilience. FDI in supply chains – particularly through joint ventures that facilitate technology transfer, knowledge sharing and local value creation – can play a key role in achieving a just and inclusive energy transition in EMDEs. This will require sustained international co-operation – including South-South collaboration – alongside dedicated policies to ensure such activities are undertaken in a socially and environmentally sustainable manner, and that their benefits are shared equitably.

Rising fossil fuel investments and shifting policies risk slowing the energy transition—redirecting public resources away from fossil fuels is essential.

Policy cut-backs – particularly in the United States – are undermining the country's existing efforts to deploy renewable energy. The 'Big Beautiful Bill' has slashed the US renewable energy and energy storage outlook to 2035 by 23%. Tax credits for wind and solar power projects have been scaled back considerably. Reprioritisation of fossil fuel generation, temporary halts on renewable project permitting on federal lands, a federal funding freeze and the imposition of new tariffs on key imports have affected renewable energy programs. Domestically, state-level policy should continue to support the deployment of energy transition technologies, especially given their cost-competitiveness and socio-economic benefits compared to fossil fuels. In addition, corporations, households and philanthropic foundations should continue to invest in these technologies. In 2023, corporations and households provided 40% and 19% of private investments globally (24% and 11% of the total, respectively). At the same time, philanthropic funding towards climate change mitigation was estimated at between USD 9.3 billion and USD 15.8 billion, a 20% increase from 2022, and more than ten times the 2015 amount (ClimateWorks, 2024).

US policy shifts are also expected impact energy transition financing overseas, with the cancellation of at least USD 150 million in USAID funding for renewable energy projects as of February 2025. Rising trade barriers are also straining the market share and profitability of export-oriented manufacturers in China, India and Southeast Asia. **International collaboration on trade and finance – with advanced economies playing a leading role – can help fill this void.** This could include increasing their contributions to financing energy transition projects in EMDEs – and particularly LDCs – for example through climate funds, in order to ensure balanced progress towards achieving energy, climate and socio-economic goals.

Meanwhile, fossil fuel investments – including upstream, downstream and infrastructure investments – have been increasing since hitting a low in 2020, driven by continued public financial support that consists of subsidies, capital investments made by state-owned enterprises (SOEs), and governments. The latest data show that in 2023, government support for fossil fuels exceeded USD 1.5 trillion, the second-highest annual total on record after 2022, with fossil fuel subsidies totalling USD 1.1 trillion. G20 governments provided three times more public financial support for fossil fuels than renewable power that year (IISD, 2024b). **Governments must phase out these subsides and redirect revenues to provide clean energy alternatives.**

Investments in renewable energy continue their upward trend globally, with further concentration in solar PV and wind technologies. Targeted policies are needed to drive investments in other technologies.

In 2024, global investments in renewables reached another record high of USD 807 billion. But year-on-year growth has slowed down; annual investments grew just 7.3% in 2024 compared to 32% in 2023. Solar PV and wind technologies continue to dominate investments, making up a combined share of 93% in 2024, up from 89% in 2022/2023. Meanwhile, investments in other renewable technologies – bioenergy, geothermal, hydropower and marine – have declined in both absolute and relative terms, with their share dropping to 7% from 11% in 2022/2023. **Public support for these technologies is still needed, especially to drive deployment in heating/cooling and transport.**

Distributed solar PV has seen remarkable growth. EMDEs such as Brazil, Pakistan and South Africa, as well as smaller markets such as Lebanon, have observed notable increases in investments, led in many cases by household funding for decentralised systems. Households make up a significant portion of investments in these countries – 65% in Lebanon, 43% in Brazil, 36% in Pakistan and 28% in South Africa. With grid electricity either being too expensive, unreliable or unavailable, households in these countries have been pushed to act, often supported by the availability of low-cost solar imports from China and in some countries, feed-in or net metering policies. **In these contexts, measures should be implemented to ensure the integration of distributed PV within the wider electricity grid, to complement – rather than compete with – utility services.**

Although most distributed PV owners stay connected to the grid and continue to benefit from its services, self-generation – especially by large consumers in industry – can strain utility revenues. Reduced overall demand for grid electricity may lead utilities to raise rates on all customers to make up for the shortfall, disproportionately affecting consumers who still rely solely on grid electricity. Often, these are less affluent households that are not able to procure their own self-generation assets, as evidenced in Pakistan and Lebanon. **National energy regulators and other policy makers must work towards providing more reliable electricity systems and affordable tariffs to ensure customers relying on power from the grid are not disproportionately burdened.**

In wind, investments in the two wind technologies – onshore and offshore – followed opposing trends. While onshore wind investments set another record at USD 157 billion in 2024, growing by 6% compared to 2022/2023, investments in offshore wind fell by 45% to USD 39 billion in 2024. The sector faced significant deployment challenges due to inflation, permitting delays, grid bottlenecks and supply chain pressures. These challenges are more pronounced for offshore wind, which has relatively longer permitting timelines (more than double on average) and lower geographic feasibility. **Permitting processes must be streamlined, whilst continuing to prioritise assessments of potential impacts on biodiversity and communities, and measures to ease supply chain hurdles and accelerate development must be implemented.**

Investments remain concentrated in China and advanced economies that have access to sufficient and affordable finance. Other countries are more reliant on international funds and continue to experience shortfalls. Domestic capital markets should be developed and additional sources tapped.

Significant disparity persists in the distribution of renewable energy investments. China remained the global leader in 2024, accounting for 44% of global investments and delivering the highest investment per capita at USD 248. Europe received 17% of global investments at USD 229 per capita, and North America and Oceania received more than 15% at USD 219 per capita. Sub-Saharan Africa was home to 15% of the world's population yet only received 2.3% of global investment – equivalent to USD 15 per capita. So, on a per capita basis, China, Europe and North America received around 15 times more investment than Sub-Saharan Africa. This is despite Sub-Saharan Africa's immense renewable energy potential and pressing energy needs, with more than 600 million people still without electricity at end-2023.

China relies almost entirely on domestic funding, with 99% of finance originating domestically in 2022/2023. With the exception of Sub-Saharan Africa, other regions followed the same pattern, with domestic financing covering between 71% (MENA) and 84% of funds (Eurasia). Advanced economies – mainly Europe and North America – received only a quarter of their investments from abroad, with

China being the largest investor. These countries have liberalised power markets, strong institutional capacity, lower investment risk and strong domestic financial markets. Sub-Saharan Africa is the only region where the majority of investment received originates from international rather than domestic sources, with 53% coming from outside the region. This reliance on international capital is more pronounced if South Africa is excluded, as the country makes up for a large portion of investments in the region and 67% of its investments in 2022/23 originated domestically. In LDCs, 78% originated from international sources. This contrast underscores a consistent trend: while China, advanced economies, and EMDEs with developed markets are largely able to draw on domestic financial resources to fund their energy transitions, lower-income countries remain acutely dependent on external support, often due to deeper structural constraints such as underdeveloped financial markets, limited fiscal capacity, high cost of capital, and policy constraints. This reliance on international funds exacerbates their levels of indebtedness, especially that these funds need to be repaid in hard currency.

Developing domestic financial markets is critical for ensuring that energy transition related projects have access to diverse funding sources and are not entirely reliant on foreign finance. Expanding local equity and bond markets can unlock additional financing, particularly in local currencies, to hedge against exchange rate risks. As domestic markets are still developing, international financing – particularly concessional funds from public sources – should continue playing an important role.

Other sources such as crowdfunding,[52] offer significant potential to unlock domestic (and international) funds for renewable energy projects. By bypassing traditional intermediaries such as commercial banks, crowdfunding offers easier and faster access to financing, lower transaction costs and marketing benefits. Such models have enabled the considerable deployment of distributed solar PV in countries such as Kenya and Lebanon. The microgrid of Baaloul in Lebanon represents a notable example of collectively financed and managed project showcasing how a rural community, through solidarity, diaspora contributions, and international grants, can create and sustain its own energy system when public supply and private operators fail to meet its needs. **To support crowdfunding, policy makers need to ensure stable and predictable regulatory frameworks for investors, empower communities and stimulate citizens' engagement in projects through dedicated schemes (*e.g.* dedicated auctions).**

Green bonds have also become a popular tool for raising capital for clean energy projects, enabling institutional investors who prefer to invest large amounts indirectly via bonds or funds rather than directly into renewable energy projects. Global issuance of green bonds grew 14% from 2023 to 2024 reaching USD 672 billion, reflecting investor preferences for financing environmentally aligned projects and issuer interest in accessing new sources of finance. Growth in this segment has also been supported by expanding regulatory coverage in developing economies and net zero commitments by corporates and sovereigns. Recent examples include the launch of Brazil's Sovereign Sustainable Bond Framework in September 2023 and India's 2022 adoption of a Sovereign Green Bond Framework. **To encourage further growth, policy makers and regulators can work together with development finance institutions (DFIs) and green bond organisations such as the Climate Bonds Initiative (CBI) to develop and adopt green taxonomies and bond issuance and rating rules, raise awareness, develop pertinent skills in local capital markets, and provide seed capital and targeted grants to lower transaction costs, among other undertakings.**

[52] *Financing an initiative, project or venture by raising relatively small amounts of capital from a large number of individuals or legal entities (the "crowd"), typically via an internet-based platform.*

Another source of potential funding is sovereign wealth funds (SWFs). EMDE project sizes typically do not meet SWFs' investment ticket size criteria for individual projects, or their often considerable technical, commercial and legal due diligence requirements. **To channel SWFs into renewable energy projects in EMDEs, countries can: implement stable and transparent policy frameworks such as a regular schedule of auctions; enable the participation of international investors; and structure public–private partnerships to mitigate risks (OPSWF, 2022).**

The continued reliance on private profit-driven capital is leaving some countries behind. The public sector must drive the transition in contexts where private capital is not available.

Globally, private sources accounted for 60% of total renewable energy investments in 2022/2023 but excluding China – where domestic public sources dominate – private investments accounted for 83% of global investments, up from the average of 72% in 2017/2018 This shows the increasing reliance on private investments in most countries outside of China and the use of public finance to mobilise private capital. In advanced economies, private capital accounted for 87% of investments in 2022/2023, almost in line with 2017/2018 shares. EMDEs show similar trends with 79% and 76% share of private capital in G20 and non-G20 EMDEs respectively. In LDCs, however, private capital does not flow and the little investment that takes place is dominated by public capital, mostly from international sources.

The 2015 Addis Ababa Action Agenda promoted the use of public funds to attract private investment for the SDGs through partnerships and blended finance, stressing the importance of equitable risk- and reward-sharing. However, these goals have not been realised everywhere – neither in terms of the amount of investment, nor the quality of its impact. The private sector's inherent focus on maximising financial returns prevents it from adequately funding transformative investments, especially those addressing social concerns, global public goods, or external factors that are not easily monetised.

Moreover, this prevailing narrative means that limited public funds should be used to minimise risks to investors – typically foreign – and pass them on to the host country government or consumers. This is typically done at a high premium, proportionate to the investment risks – real and perceived. The higher the risk, the higher the cost of capital, and the more resources are needed to guarantee the return on investment and render the project "bankable". Some of the most common risks identified include off-take risks or payment risks, currency risks (*i.e.* expertise, equipment and finance are all imported in hard currency and given the trends of depreciating currencies in developing countries, the payments, even if are made in full and on time, would lose value along the life of the project). Often, these risks are addressed through instruments that are paid for by the host government, drawing on more debt in already distressed contexts, limiting fiscal space for development priorities such as government-owned infrastructure including energy, healthcare, housing, education. IRENA's upcoming analysis on the design of auctions for risk allocation highlights the broader economic impacts of such risk mitigation instruments (IRENA, forthcoming).

To move away from this status quo, there is a need to embrace a model of public entrepreneurship in contexts where private capital does not flow, an approach that would leverage the transformative potential of governments to drive systemic change. The 2023 edition of this report highlighted the pivotal role of public funding to achieve just energy transitions and proposed a framework for channelling public resources towards transformative investments across the economy (IRENA and CPI, 2023).

To this end, national SOEs, state-owned financial institutions (SOFIs) and DFIs will need to continue to play a key role at the domestic level. Investments from SOEs constituted 12.5% of total investments in 2022/2023. Chinese SOEs accounted for 94% of these investments. Investments from SOFIs reached 12% of the total. Much like SOEs, these investments are dominated by China, which accounted for 85% of the total in 2022/2023. In advanced economies, SOFI investment accounted for 28% of total public investment, up from 11% in 2020/2021, underscoring their growing role in public capital deployment. National DFIs provided 11% of total investments globally and their role became more prominent in G20 EMDEs excl. China, where their share of public investment increased from 17% in 2020/2021 to 23% in 2022/2023.

International collaboration, including South-South collaboration, needs to considerably scale up.

International collaboration through multilateral and bilateral DFIs and multilateral climate funds will need to be scaled up. Multilateral DFIs accounted for 7.8% of public investments in 2022/2023, and 3% of the global total (private and public). Investments grew by 60% compared to 2020/2021. Multilateral DFIs are the largest provider of public investment across all country groups except China, providing 37% of overall public investments in advanced economies, 24% in G20 EMDEs excluding China, 56% in non-G20 EMDEs, 62% in LDCs, and 55% in SIDS. However, half of this funding was in advanced economies, such as EIB investing in Spain, France, followed by Italy, Germany, and other Western European countries with smaller shares. Investments from bilateral DFIs constitute just 1.5% of total public investment, and 0.6% of the global share (private and public). Most of this investment went to G20 EMDEs excluding China (36%), followed by non-G20 EMDEs (33%) – within which LDCs received 30% and non-LDCs received 70% – and advanced economies (23%). Key destinations for this investment were India and South Africa, receiving 36% and 33% of all G20 EMDE investment from bilateral DFIs in 2022/2023. **Moving forward, multilateral and bilateral DFI funding should increase in developing countries as renewable energy is essential for development and green industrialisation.**

Multilateral climate funds invested only USD 238 million on average across 2022/2023, accounting for less than 0.1% of investments, marking a continued decline in renewable energy investment from these institutions, which peaked at an average USD 1.3 billion in 2016/2017. Global climate finance in general is not flowing to developing countries. Although it hit an all-time high of USD 1.9 trillion in 2023, more than 75% of it was concentrated in North America, Western Europe and China (CPI, 2025), primarily because they are able to raise sufficient funds through national capital pools. **Developed countries must meet their commitments under the Paris Agreement, ensuring climate finance is directed toward mitigation, adaptation, and loss and damage.** As countries negotiate new climate financing targets, there is an urgent need for greater transparency, equity and accountability. Market-based instruments such as carbon markets are gaining traction in COP discussions but they require greater certainty regarding rules, processes and definitions including clarity on rules related to additionality, as well as measures to address data limitations, and institutional and legal capacity gaps.

Co-operation between developing countries (South-South collaboration) is crucial to address their development and finance needs. Institutions such as the New Development Bank (NDB) and the Contingent Reserve Arrangement (CRA) established by the BRICS can provide alternative financial mechanisms to reduce reliance on traditional institutions. The BRICS presents a platform for collaboration among Global South countries and promotes solidarity across various sectors, including finance, trade and the energy transition. Other examples of platforms for South–South collaboration include the G77, a group of 134 members that promotes their collective economic and development interests through joint negotiation and co-operation. The group works on a wide range of issues, including poverty, climate change, fair trade and access to technology. The G77 partnership with China enhances the group's negotiating power on the global stage.

Other areas include regional collaboration on manufacturing – crucial for localising value chains – grid integration/interconnections, and exchanges on past experiences and best practices.

More impact-driven finance is required, especially in high-risk contexts.

Growing debt burdens undermine the energy transition across EMDEs. Many countries are already trapped in debt and poverty cycles, preventing public funds from being used for development outcomes such as health and education. The urgent need to mobilise renewable energy investments, combined with a scarcity of impact-driven capital such as low-cost debt and grants, risks exacerbating debt burdens. For countries already in debt distress, this can accelerate a vicious cycle of higher costs of capital, reduced access to finance, and constraints on delivering renewable energy projects. This dynamic illustrates the 'debt paradox' of renewable energy finance and underscores the critical importance of impact-driven capital, particularly in the form of concessional loans and grants.

In 2022/2023, impact-driven investments made up just 1.6% of global renewable energy investments, down from 2.3% in 2020/2021. The rest was largely profit-driven,[53] even when coming from DFIs. In 2022/2023, multilateral and bilateral DFIs provided most of their financing in the form of market rate loans, at 84% and 58% respectively, with grants constituting only 4% and 2% of their finance and concessional loans accounting for just 8% and 28% respectively.

In G20 EMDEs excluding China, multilateral DFI investments flow mostly in the form of market rate debt (93%). In non-G20 EMDEs, two-thirds of multilateral funds flow in the form of market rate debt and the remainder through equity. An analysis of UN and OECD data shows that more than two-thirds of climate financing received by middle-income countries between 2015 and 2020 was loaned, even though many already faced staggering debt. During that period, developing countries received more than USD 18 billion in climate loans at market rate interest, out of which USD 11.5 billion went to 10 debt-distressed countries. Such loan repayments reduce fiscal space for essential social services and development priorities. In Sub-Saharan Africa, impact-driven finance accounted for just 20% of the region's renewable energy investments, down from 28% in 2020/2021. The rest was provided at market rate cost, which is typically high. In LDCs and SIDS, around half of DFI funds are channelled as market rate loans, which in these contexts can often mean high debt servicing costs.

Impact-driven finance, including concessional loans with low interest rates and long repayment periods, will be crucial to avoid exacerbating debt burdens in developing countries. Conditional aid that primarily benefits donor economies should be reconsidered, ensuring that climate finance effectively prioritises advancing climate action and supporting progress in delivering the SDGs.

[53] *These include investments that seek market rate returns while also pursuing impact.*

In contexts where private capital does not flow and where projects may not become bankable in the near term, public financing must play a larger role, and policy must be co-ordinated to shift the focus from project bankability to impact potential. **Investment decisions should be based on additional factors other than realising financial profits for private investors – additional factors that encompass short and longer-term climate, environmental, socio-economic and development goals, in addition to the project's potential to kickstart the development of a renewable energy sector.**

Moreover, transparent and robust frameworks are needed to channel impact financing such as grants into renewable energy projects. Competitive mechanisms – or auctions - offer a structured, transparent, and competitive process to efficiently allocate public and donor support where it will have the greatest impact according to the goals and priorities set. IRENA is currently developing a framework for the design of competitive mechanisms for the disbursement of funds and allocation of public finance to distributed renewable energy (DRE) projects by integrating lessons from IRENA's utility-scale auction framework (IRENA, 2025g).

Such mechanisms combine several policy instruments to allocate public support in line with electricity access and socio-economic development priorities through: direct financing (covering some or all project costs) through result-based financing; procurement whereby the process results in a contract between the auctioneer and the winner of the bid for the construction of systems, supply of equipment or delivery of services; and co-ordination whereby the auctioneer does not play the role of the buyer but only facilitates the process. In doing so, DRE auctions become more than a procurement tool, and have the potential to be a sector co-ordination mechanism, a bridge between policy ambition and project delivery, and a driver for equitable, scalable electrification aligned with both national development goals and the principles of a just energy transition. Competitive transparent frameworks designed to achieve socio-economic objectives can be applied for the deployment and development of technologies needed for the energy transition beyond renewable power. One case in point is auctions for green hydrogen (IRENA, 2024c).

Looking forward, renewable energy projects should be sustainable without external support, including through stable and diversified revenues – provided by productive energy uses, or market-based instruments like the trade of carbon or renewable energy credits.

Additional sources of funding must be tapped and innovative solutions mobilised.

Philanthropic funding towards climate change mitigation was estimated between USD 9.3 billion to USD 15.8 billion in 2023, a 20% increase from 2022, and more than ten times the 2015 amount (ClimateWorks, 2024). Philanthropic funding for the energy transition follows a similar pattern to other philanthropic funding, with most recipients concentrated in advanced economies. Between 2019 and 2023, the United States and Europe together received around 75% of global philanthropic funding for climate mitigation (ClimateWorks, 2024).

Philanthropic funds could significantly increase the available finance for renewable energy as part of efforts to ensure sustainable livelihoods. This type of funding could be scaled up to support energy access solutions that benefit communities and the environment; and to step in where it is not beneficial for local private sectors. Philanthropies have been very active in developing countries for many decades, and they have several options to channel their funds to final recipients. It is important to note that philanthropic funding complements rather than substitutes public and private finance.

One of the most common ways philanthropic foundations channel funding is directly or through non-governmental organisations (NGOs) and other foundations that then allocate it to local recipients. Many initiatives also involve philanthropic foundations collaborating under joint initiatives that channel money to NGOs and communities. Another option is the launch of collaborative initiatives between foundations, sometimes in conjunction with development banks. An example is the Global Energy Alliance for People and the Planet (GEAPP), which brings together philanthropic organisations such as the African Climate Foundation, Bezos Earth Fund, and many others with international organisations such as IRENA and development finance institutions such as the World Bank and the African Development Bank (GEAPP, 2025).

Philanthropic organisations can co-finance renewable energy projects alongside DFIs. Historically, philanthropists have supported trust funds at institutions such as the World Bank; however, there is growing potential for deeper collaboration on renewable energy projects that cannot attract sufficient private finance. The World Bank's Mission 300 is an example of such an initiative that brings together different partners, including philanthropic funds, to deliver affordable and sustainable electricity to Sub-Saharan Africa (World Bank, 2025c). A separate technical assistance facility (the M300 accelerator) is housed under Rockefeller foundation's RF Catalytic Capital facility. Pooling philanthropic capital with DFI resources could also help support local communities, for instance by supporting legal advice, and financing environmental mitigation.

Mitigation and adaptation measures also offer opportunities for debt relief. Many developing countries carry significant external debts, compounded by unfavourable trade terms, which limit their ability to finance essential public services such as renewable energy projects. Innovative financing tools such as debt-for-nature or debt-for-climate swaps could alleviate this burden. These instruments constitute a financial arrangement whereby a part of a country's external debt is forgiven, reduced, or restructured in exchange for commitments from the debtor to invest in climate projects such as renewable energy, or nature conservation projects. This approach not only frees up fiscal space for climate action but also enables sustainable development.

Ghana's debt-for-climate swaps demonstrates how external debt can be reduced while advancing environmental objectives (Sokona *et al.*, 2023). In 2012, the Philippines and Italy entered into an agreement to convert a debt obligation amounting to EUR 2.9 million (USD 3.7 million) into a grant for environment conservation and poverty reduction projects, with targeted support for local farmers and those in the fisheries sector. This grant funded nine projects on forest conservation and reforestation, sustainable and integrated agriculture, coastal resource management, and eco-tourism (DOF, n.d.).

Debt-for-climate swaps must be designed to ensure national ownership and align with countries' nationally determined climate strategies. Debtor countries would also need sufficient fiscal space to redirect available financing into meaningful climate projects. In heavily indebted contexts, creditor countries could form groups (much like the Paris Club does for conventional debt relief, but without the structural adjustment conditionality) to deliver tailored support at scale.

Broader debt restructuring reforms are also needed to improve negotiation speed, suspension of debt payments, and guarantee of debt sustainability, while dealing with solvent but illiquid countries through expanded support from MDBs and participation of private creditors (ICEFD, 2025). The FfD4 in 2025 saw the launch of several new debt mechanisms, including the Debt Swaps for Development Hub, Italy's Debt-for-Development Swap Programme, and the Debt "Pause Clause" Alliance. The Sevilla Forum on Debt was also created to facilitate learning and co-ordination in debt management.

Financing the energy transition should be part of broader strategy for structural change and international co-operation, including South-South collaboration.

For the energy transition to be financed in a just and fair way and to unlock its potential for sustainable development in developing countries, structural change is needed. Funds need to be channelled to developing countries through international co-operation, including via climate finance.

Such funds should go beyond funding projects and be used to build local capacities for which South-South co-operation will be key. Funds also need to be mobilised domestically to strengthen local investments and ownership, breaking the cycle of dependency on international financiers and reducing the impacts of depreciating currencies.

Solving the financial enigma of climate and development should not be approached through isolated efforts but via integrated, global reforms grounded in equity and justice. This entails recognising the capacities of developing nations to leverage their domestic resources effectively, while establishing an international financial and economic architecture that can enable energy transitions embedded in energy systems, economies and societies.

Advanced economies can play a crucial role as global enablers, rather than mere financiers. Their contributions – through climate finance, debt restructuring, and technology transfer – are essential for fostering inclusive growth, resilient communities and sustainable development pathways that truly serve all regions. Only through such collective action can the scale of the climate crisis be met in a just and equitable way.

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ANNEX

Methodology, coverage and data limitations

For the renewable energy sector, data for 2013-2023 are taken from the Climate Policy Initiative (CPI) *Global Landscape of Climate Finance* dataset (CPI, 2025). CPI collects and standardises data on climate finance (including investments in renewable energy and other energy transition technologies) from a variety of sources. Data for 2024 investments are preliminary estimates, derived by applying BNEF's 2024 sector-level growth rates (relative to its 2023 figures) to CPI's 2023 Global Landscape of Climate Finance data.

Data for energy transition sectors come from a mix of different sources, including BNEF, CPI, IEA, IJGlobal and IRENA.

Overall, this report covers the following energy transition technologies:

- ***Renewable energy (power and end use):***
  - Biomass and biogas power
  - Biofuels, including biodiesel, bioethanol and biomethane
  - Geothermal
  - Hydropower, small and large scale
  - Marine, including wave, tidal, ocean currents and salt gradient technologies
  - Solar, including photovoltaic (both utility scale and rooftop), concentrated solar power, and solar heating systems (*e.g.* solar water heaters)
  - Wind, onshore and offshore
- ***Energy efficiency (no project-level data analysis)***
- ***Battery electric vehicles***
- ***Electric vehicle charging infrastructure***
  - Energy storage
  - Green hydrogen
  - Carbon capture and storage
  - Power grids

Additional details on renewable energy investments

For the renewable energy sector, this analysis includes only primary investments – that is, investments in new assets and/or projects reaching final investment decision. This means that investments are tracked at the time of financial close, rather than at project completion (*i.e.* when the resulting installed capacity comes online) or during the construction. A similar approach is undertaken for other transition technologies.

This approach differs from other (capacity-based) approaches that calculate investments in any given year as the total technology deployment in that year (in megawatts), multiplied by the unit cost of that technology (in US dollars per megawatt). Project lead times (*i.e.* the time between financial close and project completion) account for most of the discrepancies observed between investment reported in this Global Landscape of Energy Transition Finance report and these approaches. For instance, a solar photovoltaic project that is approved in 2020 with a lead time of two years would be tracked in 2020 in this report, but in reports that use a capacity-based approach it would typically be counted in 2022.

The figures for renewable energy investment may include grid-related components. In many cases, the cost of connecting generation facilities to the transmission and distribution network is embedded within the overall project financing. As a result, there are limitations to separately identify the portion specifically allocated to grid infrastructure at the project level.

The analysis also covers financial instruments such as project-level market rate debt and equity, balance sheet debt and equity, grants, and low-cost project debt across the technologies listed in this annex.

For more details on the data sources and underlying methodology, see (IRENA and CPI, 2022) and (CPI, 2025).

Countries and territories by region	
Asia (excluding China)	Afghanistan; Bangladesh; Bhutan; Cambodia; China; Democratic People's Republic of Korea; Hong Kong SAR (PRC); India; Indonesia; Japan; Kazakhstan; Kyrgyzstan; Lao People's Democratic Republic; Macau SAR (PRC); Malaysia; Maldives; Mongolia; Myanmar; Nepal; Pakistan; Philippines; Republic of Korea; Singapore; Sri Lanka; Chinese Taipei; Tajikistan; Thailand; Timor-Leste; Turkmenistan; Uzbekistan; Viet Nam.
Eurasia	Armenia; Azerbaijan; Georgia; Russian Federation; Türkiye.
Europe	Albania; Andorra; Austria; Belarus; Belgium; Bosnia and Herzegovina; Bulgaria; Croatia; Cyprus; Czechia; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Italy; Kosovo; Latvia; Lithuania; Luxembourg; Malta; Montenegro; Netherlands (Kingdom of the); North Macedonia; Norway; Poland; Portugal; Republic of Moldova; Romania; Serbia; Slovakia; Slovenia; Spain; Sweden; Switzerland; Ukraine; United Kingdom.
Latin America and the Caribbean	Antigua and Barbuda; Aruba; Argentina; Bahamas (The); Barbados; Belize; Bolivia (Plurinational State of); Brazil; Cayman Islands; Chile; Colombia; Costa Rica; Cuba; Curacao; Dominica; Dominican Republic; Ecuador; El Salvador; French Guiana; Grenada; Guadeloupe; Guatemala; Guyana; Haiti; Honduras; Jamaica; Martinique; Montserrat; Netherlands Antilles; Nicaragua; Panama; Paraguay; Peru; Puerto Rico; Saint Kitts and Nevis; Saint Lucia; Saint Vincent and the Grenadines; Suriname; Trinidad and Tobago; Uruguay; US Virgin Islands; Venezuela (Bolivarian Republic of).
Middle East and North Africa	Algeria; Bahrain; Egypt; Iran (Islamic Republic of); Iraq; Israel; Jordan; Kuwait; Lebanon; Libya; Morocco; Oman; Palestine; Qatar; Saudi Arabia; Sudan; Syrian Arab Republic; Tunisia; United Arab Emirates; Yemen.
North America and Oceania	Australia; Bermuda; Canada; Cook Islands; Fiji; French Polynesia; Guam; Kiribati; Marshall Islands; Mexico; Micronesia (Federated States of); Nauru; New Caledonia; New Zealand; Niue; Palau; Papua New Guinea; Samoa; Solomon Islands; Tokelau; Tonga; Tuvalu; United States of America; Vanuatu; Wallis and Futuna.
Sub-Saharan Africa	Angola; Benin; Botswana; Burkina Faso; Burundi; Cabo Verde; Cameroon; Central African Republic; Chad; Comoros; Congo; 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; Rwanda; São Tomé and Príncipe; Senegal; Seychelles; Sierra Leone; Somalia; South Africa; South Sudan; Togo; Uganda; United Republic of Tanzania; Zambia; Zimbabwe.
China	Analysed separately to Asia.

Countries and territories by region	
Advanced economies	Albania; Andorra; Australia; Austria; Belarus; Belgium; Bermuda; Bosnia and Herzegovina; Bulgaria; Canada; Croatia; Cyprus; Czechia; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Iceland; Ireland; Israel; Italy; Japan; Kosovo; Latvia; Lithuania; Luxembourg; Malta; Monaco; Montenegro; Netherlands;New Zealand; North Macedonia; Norway; Poland; Portugal; Republic of Korea; Republic of Moldova; Romania; Russian Federation; Serbia; Singapore; Slovakia; Slovenia; Spain; Sweden; Switzerland; Ukraine; United Kingdom; United States of America.
G20 EMDEs excluding China	Argentina; Brazil; India; Indonesia; Mexico; Saudi Arabia; South Africa; Türkiye.
Non-G20 EMDEs	All other economies excluding China and those listed in advanced economies and G20 EMDEs; includes least-developed countries unless mentioned otherwise.
Least-developed countries	Afghanistan; Angola; Bangladesh; Benin; Burkina Faso; Burundi; Cambodia; Central African Republic; Chad; Comoros; Democratic Republic of the Congo; Djibouti; Eritrea; Ethiopia; Gambia (Republic of The); Guinea; Guinea Bissau; Haiti; Kiribati; Lao People's Democratic Republic; Lesotho; Liberia; Madagascar; Malawi; Mali; Mauritania; Mozambique; Myanmar; Nepal; Niger; Rwanda; Senegal; Sierra Leone; Solomon Islands; Somalia; South Sudan; Sudan; Timor-Leste; Togo; Tuvalu; Uganda; United Republic of Tanzania; Yemen; Zambia

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