Research Institute
Energy transition

September 10, 2025
Marketing material

The great energy race: challenge and transformation

(De)carbonization stocktake, and how the clean energy transition meets the great energy expansion


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IN A NUTSHELL

— The energy transition is progressing too slowly and unevenly across sectors and countries. This means a meaningful decline in greenhouse gas emissions before 2030 is unlikely.

— Investment in clean technologies is now double that of fossil fuels. However, the deployment of these technologies is sluggish and the sourcing of minerals critical to the energy transition presents long-term supply chain risks for consuming nations.

— The transport and real estate sectors have been laggards in terms of decarbonisation but over the past few years the pace of their clean energy transition has begun to accelerate. This raises the possibility that 2030 targets towards a 1.5°C pathway in certain parts of these sectors might be within reach.

— Government policies, including subsidies, tax credits, and carbon pricing, play a pivotal role in de-risking clean energy projects and attracting private capital. However, divergent climate policies have emerged this year particularly between the U.S. and the rest of the world.

— What seems certain is the increasing frequency and intensity of extreme weather events. Yet, adaptation finance, such as flood defenses, accounts for just 5% of total climate finance flows.[1] This will need to be scaled up rapidly to cope with increasing climate impacts.

Executive summary

The energy transition presents a broad set of investment opportunities, including across the clean energy supply chain. Investors should consider diversified exposure to key enablers such as critical minerals, which are essential for technologies such as solar, wind, and battery storage.

The energy transition is progressing at varying speeds across sectors and regions. To respond effectively, investors need to deepen their understanding of these differences, examining both the pace of transition and the underlying economic drivers and barriers. In addition, investors need to consider the regulatory environment and prioritize regions and countries with stable, long-term policy commitments such as clear tax incentives, carbon pricing mechanisms, and streamlined permitting processes, which de-risk investments and enhance capital deployment.

The still high level of global emissions also implies the need to assess physical climate risks and opportunities. This can include engaging with investee companies to assess and disclose physical climate risk in their operations and supply chains. In addition, investors may explore adaptation strategies and investment opportunities, for example in green infrastructure.

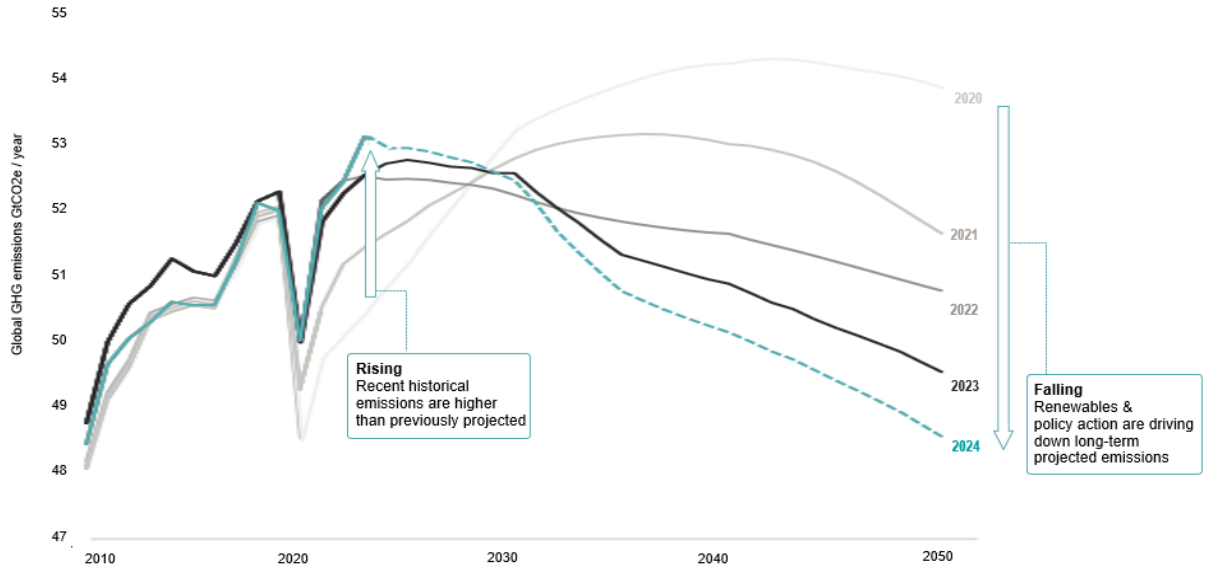
[1] Climate Policy Initiative (November 2024). State and trends in climate adaptation finance 2024

1 / The drivers of greenhouse gas emissions

1.1 Greenhouse gas emissions and temperature pathways

Over the past few years, projections for 2050 global greenhouse gas (GHG) emissions have been trending lower. However, this contrasts with GHG emissions remaining at all-time highs,[2] Figure 1. In 2020, forecasters predicted GHG emissions reaching over 54 $GtCO_2e$ by 2050. However, policy action and the growth of clean technologies since then has meant that emissions are now forecast to drop below 49 $GtCO_2e$ by 2050 even though most of this decline is not expected to occur until after 2030.[3]

Figure 1: Global greenhouse gas emissions: current and historical projections to 2050



Source: Climate Action Tracker (November 2024); DWS Research Institute (September 2025)

While there is optimism around the growth in renewables, fossil fuels remain an attractive energy source in both developed and emerging markets. This presents a significant challenge in terms of limiting GHG emissions growth. At a global level, coal consumption has increased 13% since the Paris Climate Agreement and has risen 86% since 2000. This hides coal demand declining by approximately 50% in the U.S. and the EU over the past decade, but hitting new all-time highs in China and India, which together represent just over 70% of global coal consumption. When it comes to oil and gas, consumption levels remain elevated in both developed and emerging markets. For example, oil and gas consumption has risen by 4% and 21% in the U.S. since 2015 while the equivalent figures in the EU-27 are -2% and 7% respectively.[4]

In 2015, climate forecasters projected that global temperatures could rise by 3.5°C above pre-industrial levels by 2100. More recent estimates suggest a lower increase of 2.6°C in 2100 assuming currently implemented policies. If all pledges and targets are successfully implemented, this rise could be limited to 2.1°C, still well above the Paris target of 1.5°C.[5] Maintaining a downward trajectory in long-term temperature forecasts will require, among other measures, the widespread adoption of low-carbon technologies across key sectors: power generation, buildings, industry, and transportation.

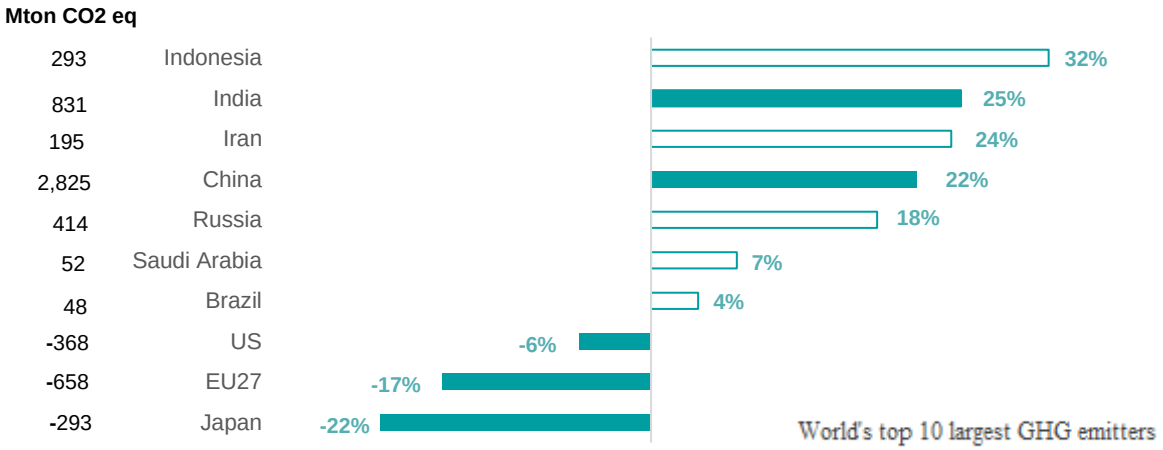
1.2 The sources of greenhouse gas emission by country and sector

The world's top 10 largest GHG emitters account for approximately 70% of global GHG emissions, with China, the U.S., India and the EU27 representing the lion's share of these emissions. However, there is a significant divergence in GHG emissions trends between the major emitting countries. On the one hand, Japan and the EU have seen emissions decline by approximately one-fifth since 2015, while the emissions of major emerging market countries have increased significantly, Figure 2, with China, India

[2] EDGAR database. CO_2 emissions hit an all-time high in 2024. Final data for 2024 GHG emissions still to be published
[3] Climate Action Tracker (November 2024). As the climate crisis worsens, the warming outlook stagnates
[4] Energy Institute (June 2025). Statistical Review of World Energy (2025)
[5] World Meteorological Office (May 2025). World climate update

and Indonesia collectively responsible for 95% of the growth in global GHG emissions since 2015.[6] However, when GHG emissions per unit of GDP is considered, we find that since 2015 GHG intensity has declined by approximately 20% in China and India compared to roughly 25% in Japan, the EU and the U.S. Even so, it means that decarbonization efforts in developed markets are being offset by increasing fossil fuel use in emerging markets. However, meeting net zero emissions and climate neutrality is not just a question of replacing fossil fuels with renewables, it is a broader vision of building an entirely new and much larger clean energy system, the so-called Great Energy Expansion. This presents significant challenges, which we explore in the third section of this paper.

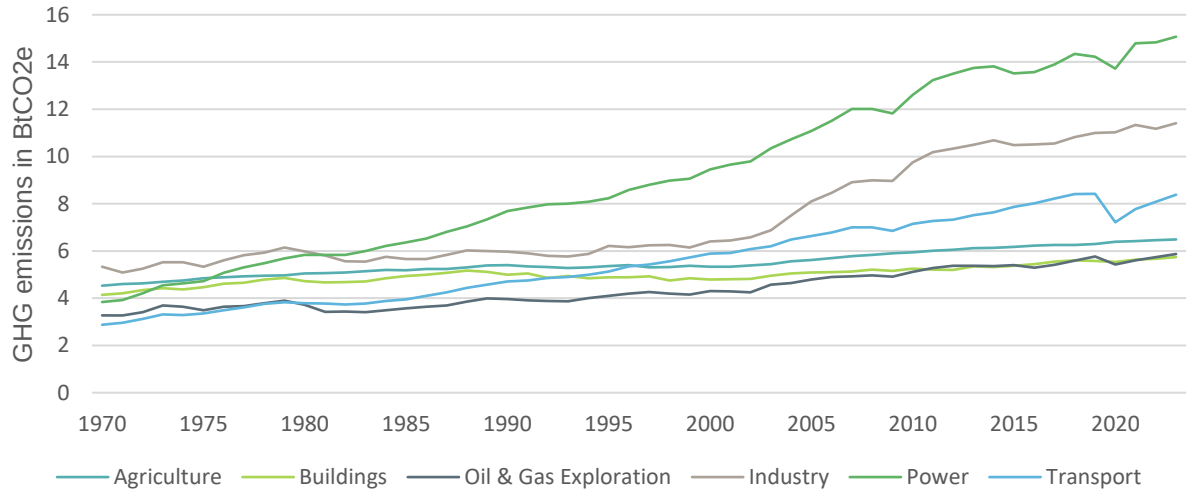
Figure 2: Absolute (Mton CO_2eq) and percentage change in GHG emissions by country or region (2023 vs 2015)



Japan's GHG decline in part reflects the switch from coal to nuclear restarts after 2015 following the 2011 Fukushima disaster
Source: DWS Research Institute (September 2025), EDGAR - Emissions Database for Global Atmospheric Research. SA stands for Saudi Arabia

On a global basis, greenhouse gas emissions are rising across all sectors of the economy, Figure 3. However, the power sector is responsible for the lion's share of these emissions and, alongside emissions in the industrial and transportation sectors, have accounted for approximately 85% of the rise in global GHG emissions since 2015.[7]

Figure 3: Global greenhouse gas emissions by sector*



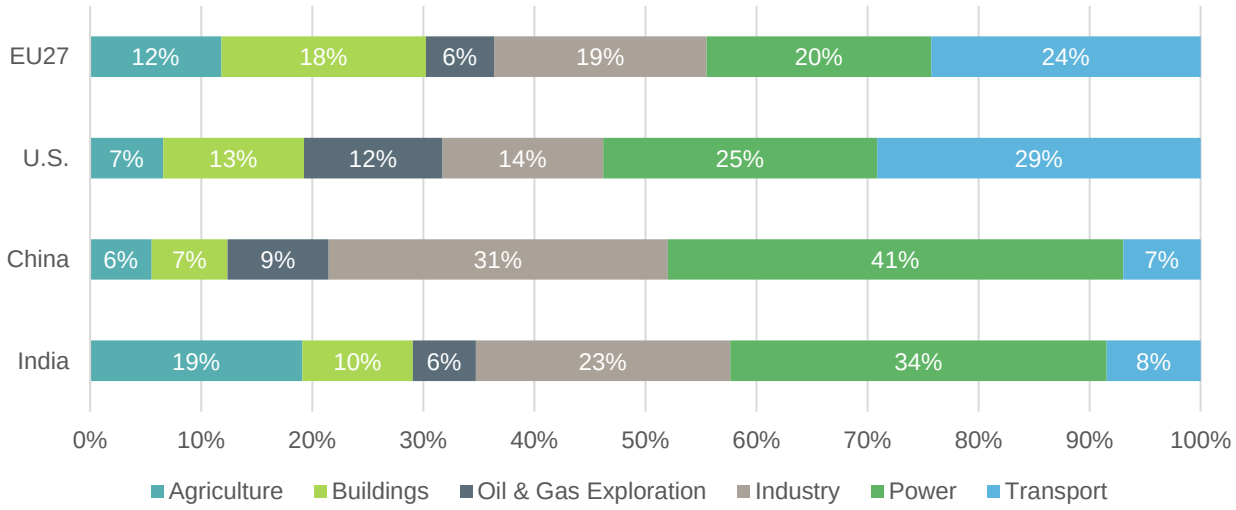
Source: DWS Research Institute (September 2025), EDGAR - Emissions Database for Global Atmospheric Research, data corresponds to 2023 GHG emissions. Buildings include solid waste disposed on land, solid waste composted and hazardous solid waste processing/storage, wastewater handling, waste incineration, Industrial combustion and processes includes combustion for industrial manufacturing and industrial process emissions (e.g. nonmetallic minerals, non-ferrous metals, solvents and other product use, chemicals, etc.). Oil & Gas Exploration is labelled "Fuel exploitation" by EDGAR and includes fuel extraction, transformation and refineries activities, including venting and flaring.

[6] EDGAR (September 2025). Emissions Database for Global Atmospheric Research
[7] EDGAR (September 2025). Emissions Database for Global Atmospheric Research

GHG emissions by sector vary significantly between developed and emerging markets. In the EU and the U.S., transportation and buildings combined account for over 40% of total emissions. In contrast, these sectors contribute less than 20% in China and India.[8] Conversely, the contribution of industry to total GHG emissions in China and India is roughly double that of the shares in the U.S. Similarly, the still high share of coal in the power generation sectors in emerging market means GHG emissions originating from this sector are, particularly in the case of China, substantially higher than in developed markets. Figure 4.

AI introduces another layer of complexity to decarbonizing the global economy. Over the medium-term, AI has the potential to support the climate agenda in areas such as grid optimization, energy efficiency and fostering innovation. However, currently the use of large machine learning models requires immense computational power, often running on energy-intensive data centers that rely largely on electricity girds still dominated by fossil fuels. This may likely be another factor keeping global GHG emissions at current elevated levels. The next section examines the remaining carbon budget - the amount of CO_2 that can still be emitted before breaching key temperature thresholds.

Figure 4: The sector share of greenhouse gas emissions by region or country



Source: DWS Research Institute (September 2025), EDGAR - Emissions Database for Global Atmospheric Research, data corresponds to 2023 GHG emissions. Buildings include solid waste disposed on land, solid waste composted and hazardous solid waste processing/storage, wastewater handling, waste incineration, Industrial combustion and processes includes combustion for industrial manufacturing and industrial process emissions (e.g. nonmetallic minerals, non-ferrous metals, solvents and other product use, chemicals, etc.). Oil & Gas Exploration is labelled "Fuel exploitation" by EDGAR and includes fuel extraction, transformation and refineries activities, including venting and flaring.

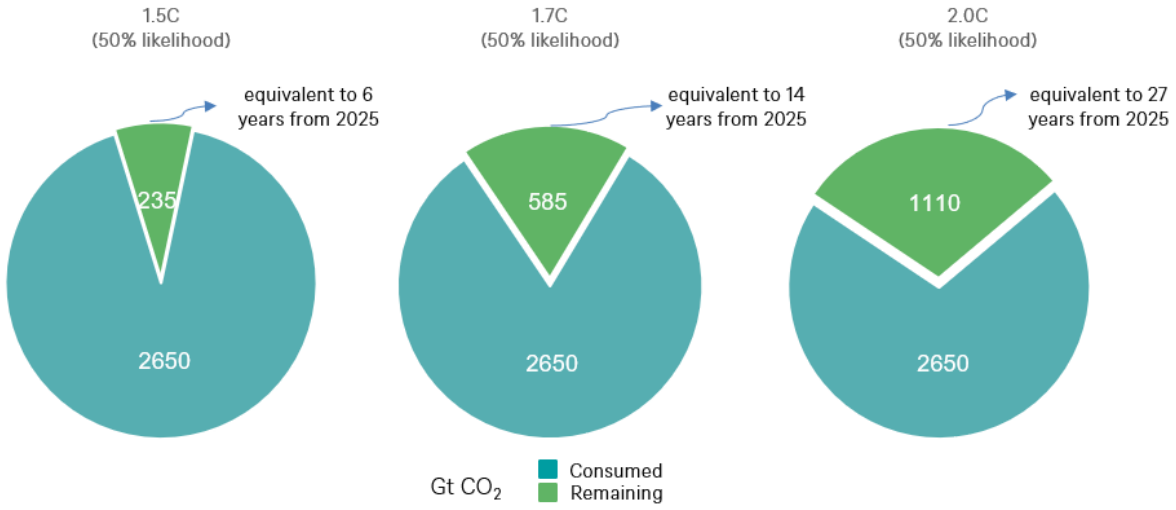
[8] EDGAR (September 2025). Emissions Database for Global Atmospheric Research

2 / Where are we on the carbon clock?

2.1 The carbon budget and climate scenarios

The carbon budget refers to how much CO_2 emissions can be emitted into the atmosphere to avoid, reach or pass a mean global temperature target. At the beginning of this year, around 235 billion tons of CO_2 remained in the carbon budget for the 1.5°C target. At the current pace of global CO_2 emissions of approximately 40 billion tons of CO_2 per year,[9] the climate system will reach 1.5°C above pre-industrial levels with a 50% likelihood in six years, or 2031. If we relax the 1.5°C temperature goal, this will provide for a more generous carbon budget such that a 50% likelihood of 1.7˚C delivers a carbon budget of 585 billion tones which at the current emission levels would be exhausted in 14 years,[10] Figure 5.

Figure 5: The remaining carbon budget across different temperature scenarios (GtCO2e billion tonnes)



Source: Earth System Science data (March 2025). Global carbon budget 2024

However, the lack of sufficient action in reducing emissions to date means that it may be almost impossible to limit global warming to 1.5˚C above pre-industrial levels. In fact, according to latest estimates current climate policies imply a 97% probability of global mean surface temperatures exceeding 2˚C.[11] However, if all net zero pledges were honored this would reduce the probability of surface temperatures exceeding 2˚C above pre-industrial levels from 97% to just 20%, Figure 6. In the next section, we examine whether the clean energy transition can meet the great energy expansion and ultimately drive temperature projections lower.

Figure 6: Current likelihood of global heating exceeding a specific temperature limit by climate scenario (%)

Climate scenario	1.5°C	2°C	3°C
Current policies continuing	100%	97%	37%
Unconditional pledges (NDCs) continue	100%	94%	22%
Conditional pledges (NDCs) continue	100%	79%	10%
All net zero pledges	77%	20%	0%

Source: UNEP (2024i. NDCs: Nationally Determined Contributions. No assurance can be given that any forecast, target, or opinion will materialize.

[9] Annual emission of CO2 amounted to 41.6 billion tonnes in 2024. This compares to global greenhouse gas emissions of approximately 53 billion tonnes of CO2eq.
[10] Earth System Science data (March 2025). Global carbon budget 2024
[11] UNEP Emissions Gap Report (October 2024).: No more hot air … please!

3 / The energy transition & the great energy expansion

3.1 The clean energy transition tracker

The clean energy transition refers to the transformation of the energy system from fossil fuel-based energy such as oil, gas and coal towards low- or zero-carbon sources such as wind and solar. This will be largely enabled through the electrification of the power, buildings, industrial and transportation sectors alongside the channeling of climate finance to scale up clean technologies.

To assess progress in the clean energy transition, we identified a range of key performance indicators (KPI) across the power, buildings, industrial and transportation sectors and relating to climate investment flows. These KPIs include metrics such as the carbon intensity in the buildings, cement and steel sectors as well as the share of coal and zero-carbon sources in global electricity production, Figure 7. We then calculated the average annual rate of change in the previous five-year period in each of the KPIs. To assess whether the KPI was on target or efforts needed to be stepped up, we then calculated the average annual rate of change which would be required to meet the 2030 target consistent with a 1.5°C pathway.[12] From here, we compared it to the previous five-year change to derive the acceleration factor.

The results make for dismal reading. For example, the share of zero-carbon sources in the generation of global power electricity reached 41% last year but on our estimates the pace of renewables adoption needs to increase fivefold if there is any chance of achieving a 70% share of zero-carbon sources in global electricity production by 2030.[13] Moreover, the pace with which coal needs to be retired from the power generation sector needs to be ramped up eight times faster than the current rate of decommissioning. The clean energy transition tracker also reveals that in the areas of green hydrogen production and the share of sustainable fuels in the aviation and shipping sectors, adoption needs to be scaled up even faster. In the case of the carbon intensity of global steel production, the energy transition is moving in the wrong direction as carbon intensity has risen over the past five years. However, there are some glimmers of hope: private climate finance flows are on track to meet their 2030 target and, compared to two years ago, the clean energy transition is slowly picking up speed in the building and transport sectors.

Figure 7: Assessing the speed of the clean energy transition across the global economy

	Latest	2030 target	Average annual rate of historical change (last five years)	Average annual rate of change required to meet 2030 target (from latest date)	Acceleration factor required to meet 2030 target	Status
Power						
Share of zero-carbon sources in electricity generation (%)	40.9 (2024)	70	0.90	4.85	5x	Off track
Share of coal in electricity generation (%)	34.3 (2024)	12	-0.45	-3.72	8x	Off track
Carbon intensity of electricity generation (gCO2 /kWh)	473 (2024)	100	-6.49	-62.17	10x	Way off track
Buildings						
Energy intensity of building operations (kWh/m2)	130 (2024)	85	-4.47	-7.50	2x	Acceleration needed
Carbon intensity of building operations (kgCO2 /m2)	38 (2022)	13-16	-0.87	-2.94	3x	Acceleration needed
Industry						
Share of electricity in the industry sector's final energy demand (%)	23 (2023)	35-43	0.40	2.29	6x	Off track
Carbon intensity of global cement production (kgCO2 /t cement)	580 (2023)	450	-1.00	-18.57	>10x	Way off track
Carbon intensity of global steel production (kgCO2 /t crude steel)	1900 (2024)	1340-50	10.00	-92.50	U-turn	Reversal needed
Green hydrogen production (Mt)	0.09 (2023)	58	0.01	8.27	>1000x	Way off track
Transport						
Share of electric vehicles in light-duty vehicle sales (%)	20% (2024)	65	3.50	7.50	2x	Acceleration needed
Share of electric vehicles in the light-duty vehicle fleet (%)	4% (2024)	20	0.70	2.67	4x	Acceleration needed
Share of battery electric vehicles and fuel cell electric vehicles in bus sales (%)	5% (2024)	60	0.60	9.17	>10x	Way off track
Share of sustainable aviation fuels in global aviation fuel supply (%)	<1% (2024)	6	0.09	0.91	>10x	Way off track
Share of zero-emissions fuels in maritime shipping fuel supply (%)	<1% (2024)	10	0.15	1.53	>10x	Way off track
Finance						
Global public climate finance (trillion $/yr)	0.646 (2023)	1.31-2.61	0.07	0.19	3x	Acceleration needed
Global private climate finance (trillion $/yr)	1.256 (2023)	2.61-3.92	0.25	0.29	1x	On track
Ratio of investment in low-carbon to fossil fuel energy supply	2:1 (2025e)	5:1	0.12	0.45	4x	Acceleration needed

Source: DWS Research Institute (September 2025), Climate Action Tracker (November 2023) State of climate action 2023

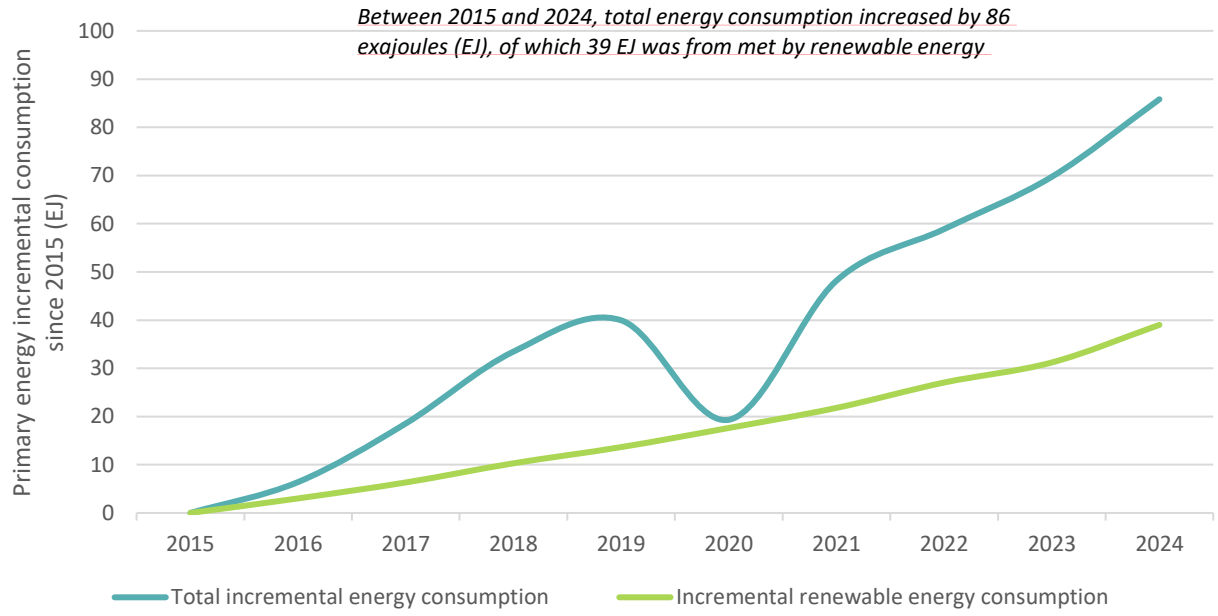
[12] Targets from Climate Action Tracker. For the share of zero-caron sources in electricity generation, we relax the 2030 target, from 88-91% to 70%
[13] We use a 70% zero-carbon source in power generation target in line with EU-27 ambition

3.2 The future of global energy

But the challenge is not just the electrification of the global economy, it is also meeting rising energy requirements. The so-called Great Energy Expansion refers to the projected increase in total global energy demand, particularly in emerging markets, due to population growth, industrialization and rising living standards.

From a net zero perspective, the Great Energy Expansion needs to be powered by the clean energy transition. However, in reality this is not happening. Since the Paris Climate Agreement in 2015, primary energy consumption has increased by 86 exajoules (EJ) but less than 50% of this increase was met by renewables,[14] Figure 8.

Figure 8: Incremental primary energy consumption and renewable energy consumption



Source: DWS Research Institute (September 2025), Energy Institute (June 2025). Statistical Review of World Energy 2025; Renewables include solar, wind, biofuels, hydropower and other renewables.

3.3 Meeting the Great Energy Expansion

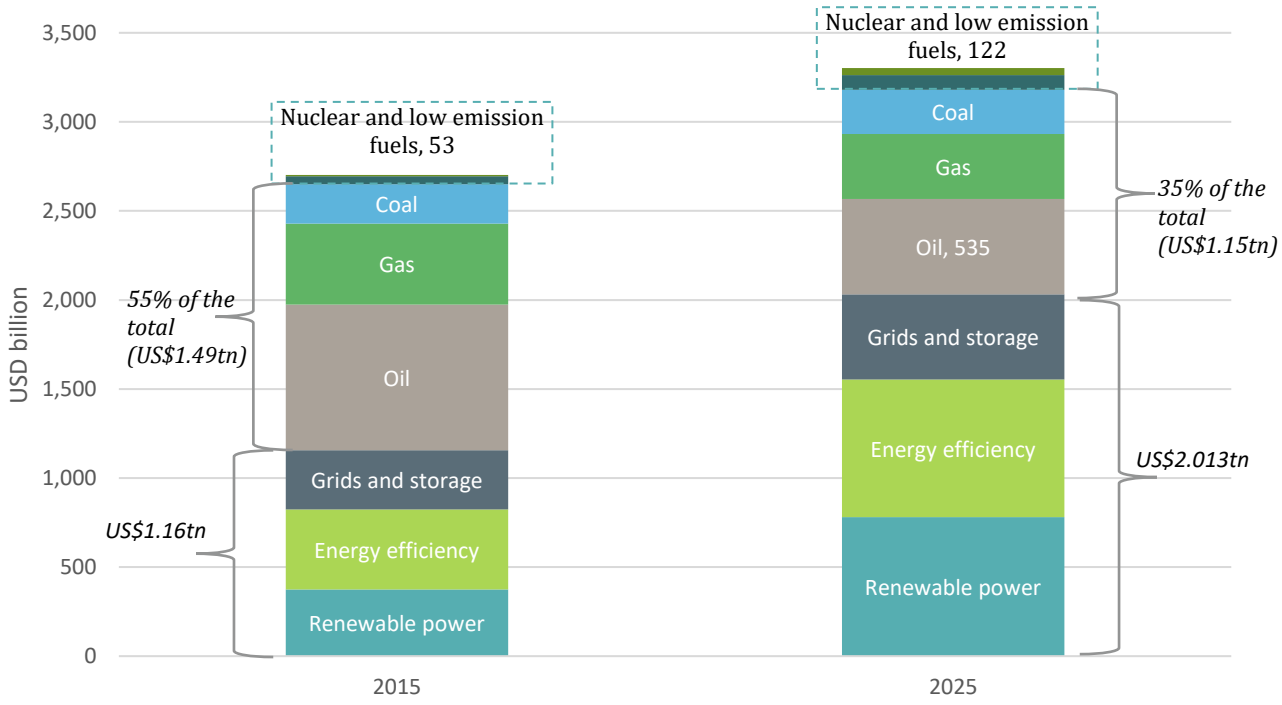
Depending on the scenario, global energy demand is expected to increase between 20% to 50% by 2050.[15] Renewables alone will struggle to meet this increased demand, particularly in the near term, meaning more aggressive energy efficiency measures and carbon pricing schemes will have to be deployed in if there is to be a peak in global GHG gas emissions before the end of this decade.

There are some encouraging signs in that the composition of energy investment has changed dramatically over the past five years such that clean energy investment is estimated to have hit US$2.2 trillion this year, almost double that of fossil fuel investments,[16] Figure 9. Within total clean energy investment, renewable energy and energy efficiency capture more than 70% of the total.

But for the time being, a large part of the increase in global energy demand is going to be met by fossil fuels. In fact, since 2015 the level of fossil fuel investment has, in real terms, remained steady at around US$1.1 trillion. Moreover, the bulk (47%) of fossil fuel investment is in the coal sector, which produces more CO_2 per unit of energy that any other fossil fuel.[17]

[14] Energy Institute (June 2025). Statistical Review of World Energy (2025)
[15] IEA; US EIA projections
[16] IEA World Energy Investment (June 2025) (2025 values are estimated)
[17] IEA World Energy Investment (June 2025) (2025 values are estimated)

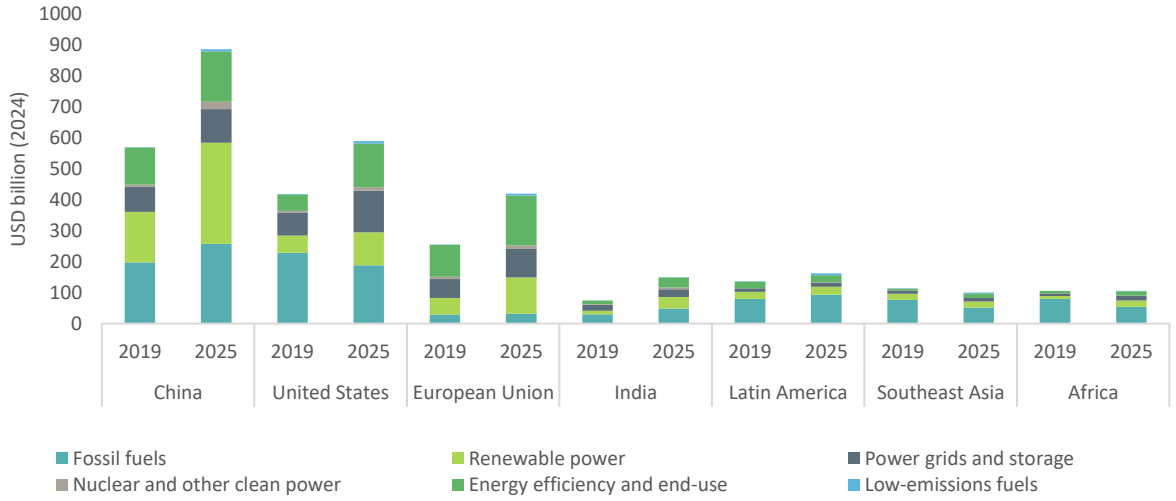
Figure 9: The world now invests almost twice in clean energy as in fossil fuels



Source: DWS Research Institute (September 2025), IEA World Energy Investment (June 2025) (2025 values are estimated).

China will remain one of the most important contributors to the increase in global energy demand. Since 2000, China has accounted for 52% and 95% of the growth in global oil and coal consumption respectively.[18] To meet this and future energy requirements, China is investing heavily in both clean and dirty fuels. Figure 10.

Figure 10: Energy investment by type and country



Source: DWS Research Institute (September 2025), IEA World Energy Investment (June 2025) (2025 values are estimated).

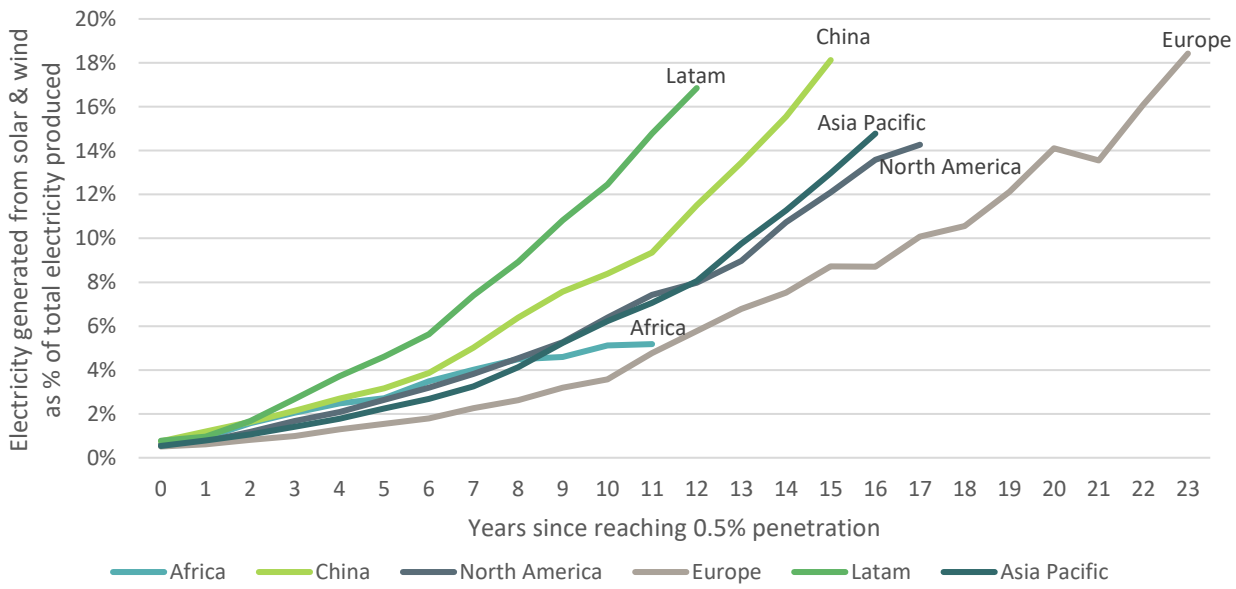
[18] Energy Institute (June 2025). Statistical Review of World Energy (2025)

China's status as the world's largest clean energy investor has met with significant success. Last year, the country reached its 2030 wind and solar capacity targets six years ahead of schedule.[19] However, this is occurring alongside significant fossil fuel investments. These are projected to exceed US$257 billion in 2025, including more than US$54 billion in coal.[20] According to Global Energy Monitor[21], more than 450 coal producing sites are in development across China, with nearly 40% under construction or in test operation. If completed, their combined capacity of 1.35 billion tons a year would surpass that of Indonesia and Australia, the world's largest coal exporters. Coal continues to play a dominant role in China's energy landscape, accounting for just over 60% of primary energy consumption and a similar share of electricity generation. Given current trends, coal is therefore expected to remain a significant part of China's energy portfolio for the foreseeable future.

3.4 Electrifying the global economy

Despite 85% of renewables power investment occurring in China, the U.S. and the EU, the deployment of renewables across the power generating sector has become a global phenomenon, albeit at different speeds. We find that it took North America and Europe 18 years for solar and wind to surpass 12% as a share of total power generation whereas for China and Latin America they reached the same milestone 5-8 years earlier,[22] Figure 11.

Figure 11: Share of solar and wind power in electricity generation by region



Source: DWS Research Institute (September 2025). Data for 2015 to 2023 sourced from IEA. Data for 2024 sourced from BNEF.

3.5 Critical minerals and the energy transition

The ability to move away from fossil fuels towards clean energy is to a large degree dependent on the ability to scale up key technologies such as renewable energy, energy storage, electric vehicles (EV), charging point infrastructure, green hydrogen and carbon capture. Many of the strategic technologies in the clean energy transition are highly dependent on the supply of critical minerals, such as cobalt, lithium and rare earth metals.[23]

The IEA projects that across a range of commodities, such as cobalt and rare earths. expected supplies can meet projected demand through the 2030s, if all announced projects are delivered on time. However, there are two major exceptions. First copper, where the IEA is estimating that the existing development pipeline, combined with declining ore grades, could lead to as much as a 30% shortfall by 2035, unless new extraction projects are announced. The second is lithium, where ample near-term

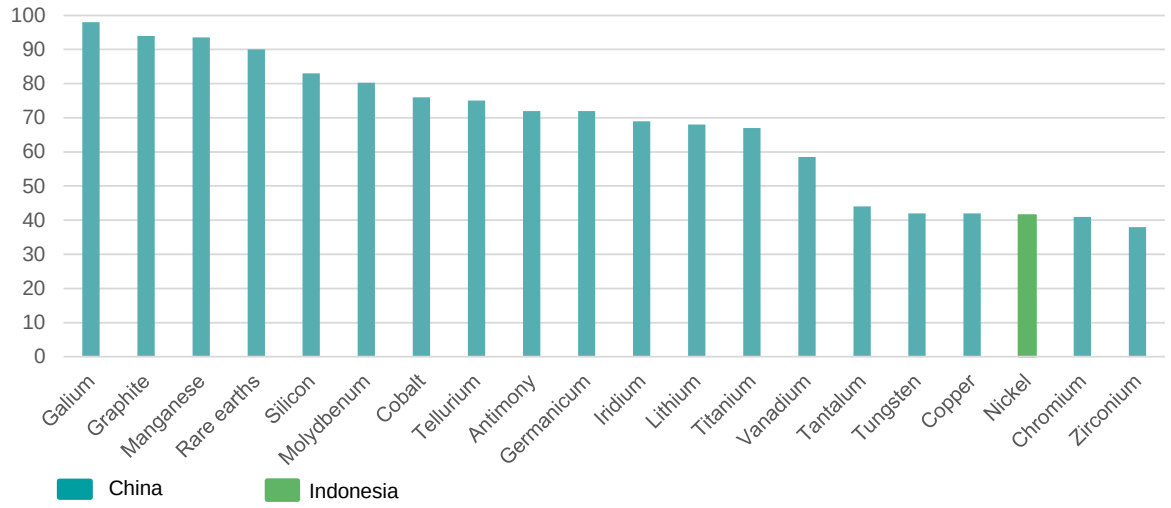
[19] Bloomberg Finance LP (August 2024). China's Xi Jinping renewables power target six years early
[20] IEA World Energy Investment (June 2025) (2025 values are estimated)
[21] Global Energy Monitor (July 2025). Still digging 2025. Tracking global coal mine proposals
[22] Data for 2015 to 2023 sourced from IEA. Data for 2024 sourced from BNEF.
[23] For more details refer to the DWS report "Critical minerals at the center of geopolitical tensions" DWS Investment GmbH (June 2025)

supplies begin to tighten rapidly during the 2030s as EVs and storage demand increases. Long development cycles add to these risks since the time from discovery to production can average around 16 years. This would suggest likely pressure points may relate to copper for grids and electrification, and lithium, graphite and rare earths for batteries and machinery.

Another risk is that the production of critical minerals is concentrated in just a few countries, which creates supply chain risks for consuming regions such as the U.S., Japan and Europe. For example, 70% of global cobalt production originates in the Democratic Republic of Congo, 90% of the processing of lithium is from Australia, Chile and China, and for rare earths' China accounts for 70% of global supply. When refined production is considered, China accounts for between 70-90% of global capacity for all three metals,[24] Figure 12.

Data from the IEA[25] reinforces the refining concentration and supply chain risks. For example, the share of the top three refining countries across the range of critical minerals essential to the energy transition increased four percentage points to 86% in 2024, compared to 2020. When it comes to supply chains in October of 2023 China introduced export-permit requirements on several graphite products used in EVs, resulting in elevated concerns across battery supply chains.

Figure 12: China dominates refining in 19 of the 20 energy-related minerals (% share of top refining country)



Source: IEA, DWS Investment GmbH (May 2025)

3.6 Climate policy around the world

Governments play an important role in driving or derailing decarbonization for example in supporting or opposing mechanisms such as carbon pricing, renewable energy mandates, building efficiency standards, subsidies and tax incentives.

The most dramatic policy reversal this year has occurred in the U.S., which has included halting climate funding, exempting coal power plants from emissions' rules, scrapping methane control for oil and gas companies, and fast-tracking fossil fuel projects and expediting permits. In addition, the termination of tax credits for the build-out of solar and wind as well as ending financial sweeteners for the purchase of electric vehicles have all been part of a revamped industrial policy. The U.S. government's decision last month to place a stop-work order on a Danish offshore wind project off Rhode Island reveals how the federal government is also wielding administrative authority to halt highly advanced clean energy infrastructure projects.[26]

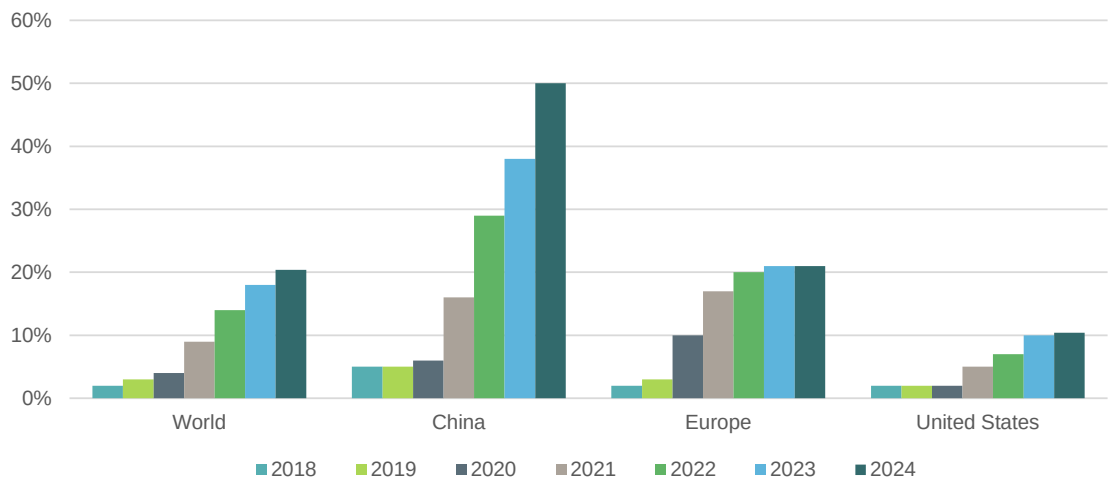
[24] IEA (2025). Critical minerals: A new frontier for global energy security
[25] IEA (2025) Market outlook
[26] Reuters (August 26, 2025). Orsted shares sink to record lows after U.S. halts wind farm off Rhode Island

Conversely, in Europe, recent fiscal stimulus programs have been aimed at infrastructure, green transformation and defense. These are reinforcing policy actions such as the Green Deal Industrial Plan and the Net-Zero Industry Act to the Competitiveness Compass and Clean Industrial Deal, which are laying the foundations for a high-tech, low-carbon industrial revolution. Through streamlined permitting, targeted subsidies, and other regulatory steps, Europe is de-risking investment in clean technologies, from battery gigafactories and hydrogen hubs to carbon capture and heat pump manufacturing. Europe's climate ambition includes cutting greenhouse gas emissions by 55% by 2030, increasing the share of energy from renewable sources to at least 42.5% by 2030 and raising the share of battery electric vehicles to 80% of total car sales by 2030.[27]

China has also adopted an aggressive clean energy policy agenda which includes targeting a peak in carbon emissions before 2030, reducing carbon intensity by 65% by 2030 and increasing non-fossil fuel energy share to 25%.[28] These ambitions are being supported by government incentives to drive investments in the country's energy and transportation infrastructure.

For example, China's expansion of solar has been supported by subsides to cover investment costs and generous feed-in tariffs for solar power projects. The surge in solar power has meant CO_2 emissions in the power sector have declined by 1 percent in the first half of 2025, marking the first sustained emission reduction driven primarily by clean energy expansion rather than economic slowdown.[29] In terms of the electrification of the transportation sector, the rise in EV car sales from 5% to 50% of total sales in less than five years has been driven in part by tax breaks and charging infrastructure build-out, such that the country is home to 65% of the world's public charging points,[30] Figure 13. This is also reflected in crude oil demand growth in China surprising to the downside for the last two years compared to EIA and IEA projections.

Figure 13: Share of electric cars in total sales by region (%)



Source: IEA analysis based on country submissions, ACEA, EAFO, EV Volumes and Marklines

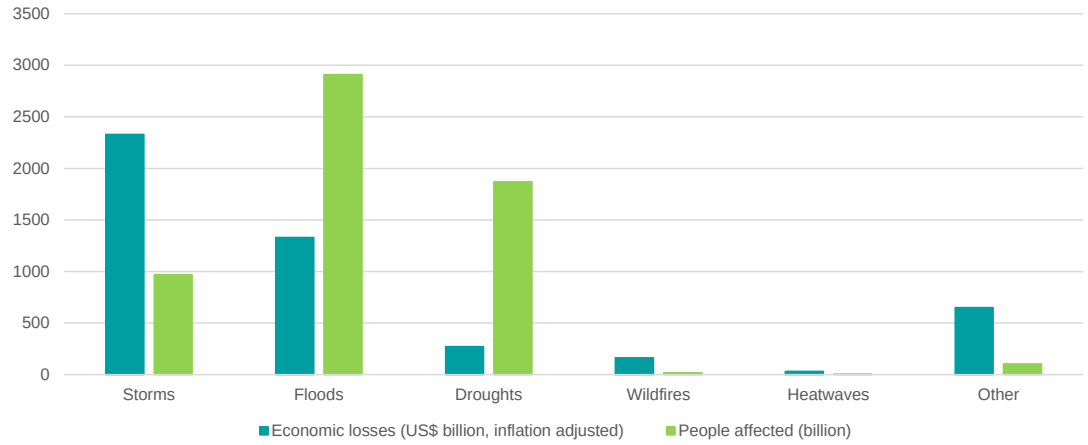
[27] For more details of Europe's transformational agenda see DWS Research Institute (April 2025). Igniting European Transformation
[28] UNFCC (October 2021). China's achievements, new goals and new measures for nationally determined contributions
[29] Carbon Brief (August 2025). Record solar growth keeps China's CO_2 falling in first half of 2025
[30] IEA (2025). Global EV Outlook 2025 - Electric vehicle charging

4 / The inevitable rise in physical climate risk

4.1 Extreme weather events and financial losses

A delayed shift toward clean energy is likely to intensify physical climate risks and amplify financial-related losses. Between 1993 and 2022, over 9,400 extreme weather events caused an estimated US$4.2 trillion in damages,[31] with storms and floods accounting for 75% of these losses, Figure 14. Extreme weather events also present significant risk to the insurance market.

Figure 14: Economic losses and affected people by extreme weather events between 1993 and 2022



Source: German Watch (May 2025). Climate Risk Index 2025

According to the IPCC Assessment Report,[32] heatwaves that had a 10% probability of occurring annually in the pre-industrial era are now 2.8 times more frequent and 1.2˚C hotter. If 2˚C of global warming is surpassed, the frequency will rise to 5.6 times, with 2.6˚C temperature increases. Similar upgrades to crop failure and flooding were also reported by the IPCC. For example, floods which were considered once in a decade event in the pre-industrial era will be 1.8 times more likely under the 2˚C scenario and 14% wetter.

4.2 Extreme weather events and market impacts

Of all the regions globally, Asia is expected to be hit hardest by the increasing frequency and intensity of extreme weather events. According to one industry estimate,[33] the impact of weather events on South Asian GDP during the current decade will be as much as 4% of GDP, twice the global average and rising to four times the global average by the 2050s. Bangkok, along with 12 other Asian cities, is in the top 20 cities globally forecasted to experience the largest growth of annual flood losses from 2005-2050.[34] One of the most impactful weather events in recent memory were the Thai floods in 2011, which was examined in a DWS research paper.[35]

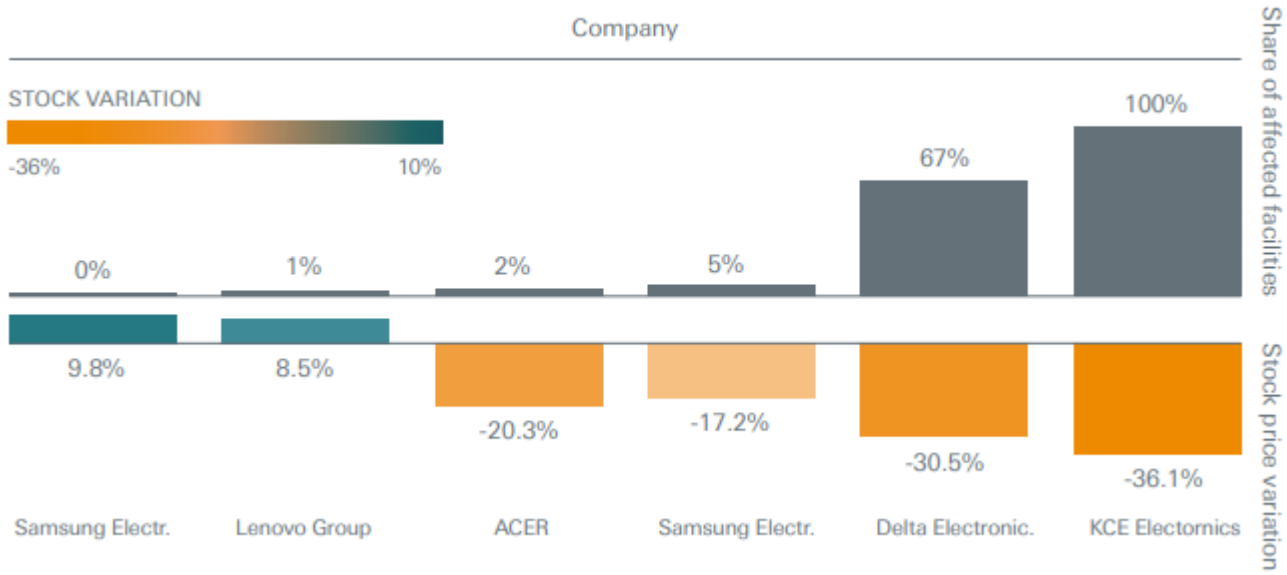
The floods hit the technology hardware sector particularly badly, as Thailand was at the time home to about a quarter of the world's manufacturing capacity for hard disk drives. Using asset facility maps, it was possible to identify precisely which Asian hardware manufacturing companies were most affected by the floods. For example, Acer, Lenovo, and Samsung Electro-Mechanics all had facilities in the Bangkok region, as did two smaller Thai firms, KCE and Delta Electronics.

Acer, Samsung Electro-mechanics, Delta, and KCE all reported drops in share prices over this period; the largest being that of KCE, a Thai manufacturer of printed circuit boards, whose shares fell by 35% between July and October 2011.[36] In contrast, Samsung Electronics and the Lenovo Group both saw their stock prices go up over the same period, by 10% and 9% respectively, Figure 15.

[31] German Watch (May 2025). Climate Risk Index 2025
[32] IPCC Seventh Assessment Report (May 2024).
[33] S&P Global (November 2023). Lost GDP: Potential impacts of physical climate risks
[34] WEF (November 2021). Around the world, these are just some of the cities at risk of rising sea levels
[35] Four Twenty Seven, DWS Research Institute (September 2017). Measuring physical climate risk in equity portfolios
[36] Bloomberg Finance LP

A closer look at corporate facilities reveals that geographic concentration of facilities may have been a key driver of stock price performance. Lenovo and Samsung Electronics both had over 100 company sites worldwide, of which only one was located within the area affected by the floods. In contrast, KCE Electronics had at the time only three manufacturing facilities, all of which were in Thailand, and all located within the areas affected by the floods.

Figure 15: Thai floods: Financial impact is correlated to asset geographic concentration



Companies within the MSCI AC Far East ex-Jap Index, and the Technology hardware & Equipment Global Industry Classification Standard (GICS). Percentage of affected facilities computed per number of sites identified by Four Twenty Seven, Inc. Stock variation from 7/29/2011 to 11/30/2011.
Source: Four Twenty Seven; DWS Research Institute (September 2017). Measuring physical climate risk in equity portfolios

Figure 16 provides examples of more recent extreme weather events and their impact on financial markets.

Figure 16: Extreme weather events by region and impact

Date	Region	Weather event	Impact
Feb 2021	Texas, United States	Winter storm Uri	4.5 million outages due to widespread grid failures. Spike in wholesale electricity prices and disruption to refineries and petrochemical plants
Mar 2021	Eastern Australia	Floods	Closure of Hunter Valley coal rail to Port Newcastle, the world's largest coal exporting port
Jul 2021	Germany-Belgium	Floods	Roal and rail damage and suspension in Rhine shipping with impact on chemical, fuels and bulk commodity transportation networks
Jun-Aug 2022	Sichuan, China	Heatwave	Lower hydropower generation. Power rationing with impacts on roughly half the country's lithium production. Disruption to global supply chains, especially for electric vehicles and batteries
2023-2024	Panama Canal	Drought	Low water levels forced re-routes around the Cape, higher freight costs with impact on shipping costs, for example on grain and LNG
Sep 2022	Florida & South Carolina, U.S.	Hurricane Ian	Up to US$1.2 billion in hurricane Ian-related losses at major listed insurers
May 2023	Emilia-Romagna, Italy	Floods	Italy's costliest weather catastrophe on record with large infrastructure damage. Economic losses estimated at EUR9 bn
Jul-Aug 2023	Fujian-Hebei, China	Typhoon Doksuri & floods	Higher claims for insurers. Construction and cement companies gain on rebuilding expectations
Jun-Jul 2025	Western Europe	Heatwave	Pressure on hydro-and nuclear-reliant utilities and potential support for gas-fired utilities

Source: DWS Research Institute (September 2025).

5 / Investor implications

Summary of key findings

1. **Life beyond 1.5°C:** The energy transition is progressing too slowly and unevenly across sectors and countries. As a result, a meaningful decline in global GHG emissions before 2030 is unlikely.
2. **Surge in clean energy investment:** Investment in clean technologies, such as solar and wind, is now double that of fossil fuels. This growth is driven by falling technology costs and supportive government policies. However, the pace of clean technology adoption is disappointing and supply chain risks exist in the sourcing of minerals critical to the energy transition.
3. **Momentum in buildings and transportation:** These sectors have been laggards in terms of decarbonization but have begun to show signs of acceleration over the past few years. In transport, this is being led by China. This raises the possibility that 2030 targets towards a 1.5°C pathway in certain parts of these sectors might be within reach.
4. **Policy and regulation as catalysts:** The pace and direction of the energy transition are heavily influenced by the regulatory landscape. Government policies, including subsidies, tax credits, and carbon pricing, play a pivotal role in de-risking clean energy projects and attracting private capital. However, this year climate policies divergence has increased, especially following the U.S. withdrawal from the Paris Agreement.
5. **Rise of physical climate risk:** More frequent extreme weather events are disrupting supply chains, damaging infrastructure such as energy grids, transportation networks and wastewater systems and unprecedented insurance claims.[37] Adaptation finance, such as flood defenses, makes up just 5% of total climate finance flows[38] and these need to be scaled up rapidly to cope with increasing climate impacts.

Investor actions

1. **Understand sector and regional transition dynamics:** The energy transition is unfolding at different speeds across sectors and regions. To respond effectively, investors need to deepen their understanding of these differences, examining both the pace of transition and the underlying economic drivers and barriers.
2. **Unlock opportunities and diversity across the clean energy supply chain:** The energy transition presents a broad set of investment opportunities across the clean energy supply chain. Investors should consider diversified exposure to key enablers such as critical minerals, which are essential for technologies like solar, wind, and battery storage. Proactive risk management is needed to address supply constraints and geopolitical dependencies, while positioning portfolios to benefit from long-term structural growth
3. **Capturing inflection points in real estate and infrastructure:** Parts of the alternatives asset class are being buoyed by policy-driven tailwinds, particularly in Europe. We view investment opportunities in the buildings and transportation sectors as potentially gaining increasing investor interest as the clean energy transition in parts of these sectors gathers momentum.
4. **Integrate policy and regulatory analysis into investment decisions:** Investors should consider conducting in-depth analysis of the regulatory environment. Prioritize regions and countries with stable, long-term policy commitments such as clear tax incentives, carbon pricing mechanisms, and streamlined permitting processes, to de-risk investments and enhance capital deployment.
5. **Assess physical climate risks and adaptation opportunities:** This can include engaging with investee companies to assess and disclose physical climate risk in their operations and supply chains. In addition, investors may explore adaptation strategies and investment opportunities in green infrastructure, such as flood defenses and resilient energy systems.

[37] SwissRe Institute (June 2025). Extreme heat: the insurance fallouts
[38] Climate Policy Initiative (November 2024). State and trends in climate adaptation finance 2024

Important information – EMEA, APAC & LATAM

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