The Sustainability Trends Report 2025

generation

16 September 2025

Contents

“And ’tis a kind of good deed to say well: And yet words are no deeds.”

Shakespeare, *Henry VIII*

Dear Reader,

We are living through a period of retrenchment.

Business people we thought were sincerely committed to the sustainability transition are backing out of promises they made only a few years ago. Politicians are waffling. Countries that have written emissions cuts into law are starting to wonder if their targets can be met.

Worst of all, of course: the new presidential administration in Washington has engineered a complete about-face in the climate commitments of the United States. The American government is going after renewable energy, slashing tax breaks and threatening to block the basic permits needed to build new projects. It is even attempting to shut down projects whose construction is nearly complete. It is bullying other countries to abandon their climate goals. This situation is especially tragic given that America is responsible for more historical emissions than any other country, by far. Since World War II, the United States — with the world’s largest economy and advanced scientific and technical capabilities — has been essential to solving humanity’s largest problems. Yet on the climate crisis, the country that ought to be doing the most is now doing the least.

We are disappointed by these developments, but not especially surprised. The climate and energy transition is the hardest collective task humanity has ever tried to pull off. It was never going to happen without backlash and entrenched political opposition. The fossil fuel industry has many politicians willing to serve its interests. Ordinary citizens are concerned, understandably, about the potential costs of the transition, and the oil companies are doing their best to exacerbate those fears.

Bleak as the situation may seem right now, we refuse to surrender to the politics of fear and cynicism. Make no mistake: we will come out of this period having sustained damage to the cause of a cleaner future. But come out of it we will. The opponents of the energy transition can slow it down, but we do not believe they can stop it.

In this report, you will learn why we think so. The progress of solar energy is astonishing. The improvements in batteries are so dizzying that sweeping technological change is becoming possible. Electric cars are only the most visible result. Entire American and Australian states are getting significant amounts of power from batteries that stored sunshine earlier in the day. Just a decade ago, batteries simply did not exist on this scale.

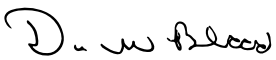
In short, we are on the road to a better future. It is a bumpy, winding road, and lately we have discovered potholes we did not know were there — big ones. But in so many ways, we are still going in the right direction.

As we offer readers the ninth edition of our firm's flagship publication, The Sustainability Trends Report, we want to point to an organisational change: we have combined the chapters on buildings and industry into a single chapter.

While we are firmly convinced that society is still moving in the right direction overall, we know that so much depends on how quickly we can get to that cleaner future. Please join us in hoping that this dark time will prove to be short-lived.

Al Gore, Chairman

David Blood, Senior Partner



Key Messages

01 Year in Focus

The new American president has already signed into law a bill that undoes much of the climate legacy of his predecessor, and he is pressuring other countries to abandon their own climate commitments. The American reversal raises a critical question for the rest of the world: does ambitious global climate action require the Americans, or can it survive without them? We may find out as soon as November, at the big global climate conference in Brazil.

02 Power

Solar power is fast becoming the breakout star of the energy transition, with power generation from solar panels growing 28 percent last year. Coupled with batteries, solar power is proving able to supply ever-growing slices of power demand, and is finally beginning to take off even in some of the poorest countries. However, electricity demand has suddenly started to rise at a brisk pace, so we are not yet driving fossil fuels out of the power grid at a global scale.

03 Transportation

Electric cars are now growing on a much larger base than in the past, and the rate of growth is slowing — but the transition continues. Cars with plugs are forecast to represent 25 percent of all cars sold in the world this year, with China in the lead at an electric market share closer to 60 percent. We are starting to see movement in heavy transportation, with sales of electric lorries doubling in a year from a small base.

04 Buildings

The promise that vast amounts of 'green hydrogen' would help clean up the world's industry is evaporating in failed projects. The costs of producing hydrogen through clean methods remain stubbornly high and it is not clear how much they can be brought down. But interest is rising in one of hydrogen's derivatives, ammonia, as a possible route to large-scale industrial cleanup. Progress in cleaning up the world's buildings, and getting fossil fuels out of them, remains halting, but heat pumps running on clean electricity remain an important way forward.

05 People, Land & Food

Despite some progress in rolling back world hunger, the food system continues to show worrying signs of instability and stress. Wild price gyrations in some commodities may be signalling the growing effects of climate change. The food system is a primary cause of the global extinction crisis, so putting more land under plough to solve shortages is not an option — instead, we must find ways to produce food more efficiently while returning millions of hectares to wild nature.

06 Financing the transition

Public finance is under severe strain as governments in the developed world cope with war, populist political revolts and other problems. Rich countries' climate finance pledges often fall short, deepening mistrust with developing nations. However, reform of development banks, smarter risk-sharing tools and falling clean energy costs are helping unlock greater flows of private finance. Clean energy investment already outpaces fossil fuels two-to-one, and the momentum is clear, even if not yet fast enough.

07 Looking Ahead

The chance to restore the world's momentum on climate change will come in November, when governments are due to make new national pledges under the Paris Agreement on Climate Change. Brazil is hosting the meetings, and its president is devoting himself to securing a meaningful outcome. This is the big test of whether the Paris Agreement can survive the decision by the United States to walk away.

01
Year in Focus

A race for the future, with or without the Americans

Can ambitious global climate action survive the decision by the United States government to walk away?

We are pained to ask that question, but political developments of the past year have made it inescapable. The election of Donald J. Trump to a second term as the American president has not only turned that country's climate policy on its head, but has endangered the strong international action that is so urgently needed. We had dared to hope that if Mr Trump were elected, he might largely ignore climate and energy, as he did in his first term from 2017 to 2021. But the opponents of the sustainability transition were better prepared this time, and Mr Trump has installed many of them into high office with a mission to roll back the clock. He also has a stronger grip over the Republican Party, which controls both houses of Congress and has rushed to do his bidding.

Mr Trump has already signed into law a bill that repeals or sharply limits climate investments that had been adopted under his predecessor. He has filed notice that he will withdraw the United States from the Paris Agreement on Climate Change, a decision that will take formal effect this coming January. He has moved to revoke the federal government's authority to regulate greenhouse gases at all, a move that — if allowed by the courts to take hold — would likely hobble climate action by future American presidents.

These developments mean that the climate goals the country has adopted in the past, including ambitious targets for emissions cuts by 2030 and 2035, will almost certainly not be met. The United States was not on track to meet them even under Joe Biden, but now the situation is much worse. Mr Trump's policies have thrown entire industries into turmoil and have already led to the cancellation of factories and other industrial projects within the United States that would have led to nearly $30 billion of investment.[1] An analysis by experts at Princeton University found that the lost investments over a decade could reach $500 billion.[2]

The American government's abandonment of climate action could not come at a worse time for the rest of the world. Countries are in the middle of a cycle in which they are supposed to be announcing ambitious new plans for emissions cuts by 2035. Even if Mr Trump had lost the election, this was going to be a difficult round of negotiations. Many poor countries are dismayed by the paltry financial help they are getting from the rich world to solve a problem largely not of their making, and have been reluctant to offer ambitious plans unless more aid is forthcoming. The rich countries are divided among themselves: even in Europe, the region most committed to climate action, internal fights have broken out about just how ambitious to be.

1. The figure of $30 billion in cancelled investments is likely conservative. Bloomberg New Energy Finance calculates a drop of $20.5 billion in renewable energy investments in the first half of the year as a result of Mr Trump's policies. See BloombergNEF, "Global renewable energy investment still reaches new record as investors reassess risks." BNEF Clean Energy, 26 August 2025. The Washington Post reported $8 billion in cancellations, in the first quarter alone, of factories meant to produce batteries for electric cars. See Osaka, Shannon, "A stunning number of electric vehicle, battery factories are being cancelled." The Washington Post, 4 April 2025.

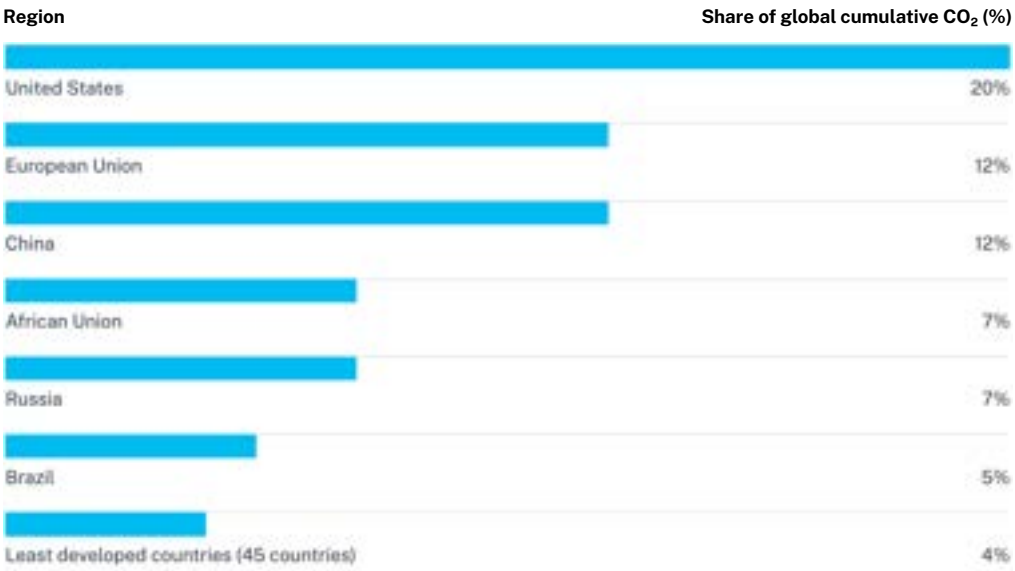
2. Jenkins, Jesse D. et al, "Impacts of the one big beautiful bill on the US energy transition — summary report." Princeton University Zero Lab, July 2025.

The new national climate pledges were nominally due in February, but only a handful were filed by then. Even as this report goes to press, relatively few plans have been filed, and they reveal a distinct lack of ambition in setting new emissions targets. If the Americans are giving up, many countries seem to be thinking, why should we keep trying?

Still time

We hope this analysis proves too pessimistic. The new climate plans are due to be adopted in November, and there is still time for countries to come forward with increased ambition. It is in their own interest to recognise how irresponsible the American position is, and to resolve to move forward, with or without the Americans. The new government in Britain, led by the Labour Party, has taken this view, and so have a handful of other countries. We hope all other countries that have yet to make new pledges will see the wisdom of following their lead.

Figure 1: Historical responsibility for the climate crisis

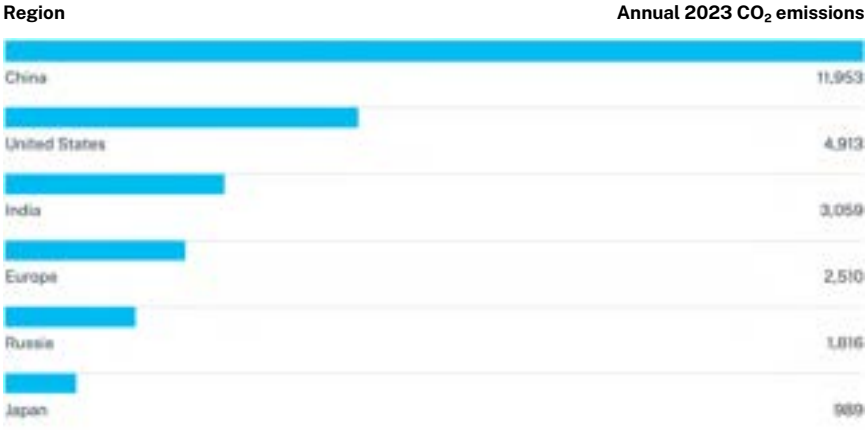


This graph shows each country's share of the cumulative industrial emissions of carbon dioxide that have occurred since the beginning of the industrial era in 1850.

Source: UNEP

As we mentioned earlier, the United States bears the largest responsibility for the emissions that are endangering the planet, with about 20 percent of industrial emissions since 1850. But in current emissions, China now leads the United States, even though its historical responsibility is still much smaller, at about 12 percent of emissions. The bulk of future emissions is projected to come from developing countries, including China. In fact, China's aggregate emissions have just surpassed those of the European Union.

Figure 2: Trading places



China's annual emissions caught up with those of the United States in 2006, and are now far higher. This chart shows annual carbon dioxide emissions from fossil fuel use and cement production in 2023, in millions of tonnes of CO_2 per year.

Source: Global Carbon Project

In effect, this means that action — or inaction — by the United States is no longer decisive in determining the long-term fate of the planet. Virtually all future emissions growth is expected to come from the developing world.

Therefore other countries, if they choose to do so, have the power to get the climate problem largely under control while the Americans sulk in the corner. It is a tragedy, of course, that one of the world's most dynamic economies will be missing in action as the low-emissions technologies of the future are invented and commercialised. But the Americans have chosen their course; we believe they will find themselves falling further and further behind as greener economies develop in the rest of the world.

Towards an 'electrostate'

Indeed, this is already happening. The report below outlines the dramatic embrace of solar power, wind power, electric cars and other advanced technologies in China. That country has played a central role in driving down the costs of these technologies, with the result that sales of Chinese-made energy technologies are accelerating all over the world.

While China also continues to build coal-fired power plants and to burn oil at a prodigious rate, that country's emissions may be on the verge of peaking, earlier than the 2030 target set by the Chinese government. In fact, the peak could well occur this year, though we will not be certain until several more years have passed.

The optimistic view is that China is setting itself up to become the world's first 'electrostate,' with the potential to run its economy largely on clean electricity. To cite one example, the idea that the Chinese car market, the world's largest, will go entirely electric is not some far-off fantasy: China is already more than halfway there, with electric cars representing nearly 60 percent of sales in that country by early August.[3] The rise of electric cars is limiting the growth of oil demand, which may peak globally by 2029.[4] As renewable electricity continues to grow, China will be in a position to start shutting down its dirtiest coal-fired power plants, and to run others less often than in the past, which will help to limit emissions.

This vision of a fully green China is by no means imminent, but it looks more achievable than it did only a few years ago. We await China's formal climate plan, which is one of those yet to be made public. In the past, Chinese leaders have been cajoled by the Americans into setting bold targets. That will not happen this time, but we hope the Chinese government will see that charting an ambitious course for 2035 is in the country's own economic interest.

In fact, most of the technological progress these days is happening in China, not the United States. Western democracies may have good reason to fear Chinese control of the industries of the future, but they have allowed it to happen. The partial reversal of the trend that Joe Biden tried to engineer in the United States now seems likely to fail, or at least to stall for years, giving the Chinese even more of a head start. China seems to see its lead in green technologies as one component of an overall strategy to become the dominant economic power of the 21st century.

Sobering as that prospect might be for the West, we also have to appreciate what China has achieved, to the benefit of the whole world. Countries shopping for clean-energy technologies have only to turn up in Shanghai or Shenzhen to find the world's largest bazaar for green gadgetry. We see a glimpse of the future in countries like Pakistan, where a mad rush to install Chinese-made solar panels is under way, as a strategy to cope with that country's unreliable power grid.[5] Likewise, imports of Chinese-made electric cars are soaring in countries as diverse as Brazil[6] and Indonesia.[7]

3. Electric cars accounted for 57.9 percent of the Chinese car market in August, and just over half the market for the year to date. These figures tend to display monthly volatility, but electric penetration is generally rising year over year in the Chinese market. For recent figures see Kang, Lei, "China NEV retail at 262,000 in Aug 1–10, up 6% year on year." *CNEV Post*, 14 August 2025.

4. The International Energy Agency's latest forecast shows world oil demand peaking in 2029 and declining slightly in 2030. See IEA, "Oil 2025." p. 12, June 2025.

5. Paddison, Laura, "How Pakistan pulled off one of the fastest solar revolutions in the world." CNN, 1 May 2025.

6. Sengupta, Somini, "Chinese car giants rush into Brazil with dreams of dominating a continent." The *New York Times*, 21 July 2025.

7. Xiaoyang, Yang and Yiran Xing, "Chinese electric vehicles soar in popularity in Indonesia." *EqualOcean News*, 21 July 2025.

Embracing the sun

In Karachi, Pakistan, even a petrol station finds solar power to be useful. In the last few years, Pakistanis have enthusiastically embraced rooftop solar as a substitute for spotty grid power.

Source: Muhammad Aqib, via Alamy

For the foreseeable future, the energy transition comes with a MADE IN CHINA stamp all over it. Perhaps the American voters who gave Donald J. Trump their mandate in November did not quite realise they were walking away from a race for the future, but as factories are cancelled and promised jobs evaporate, they are learning.

Strangely, one of the few national climate plans that has already been made public is a bold one — from the Americans. But that plan was offered late last year, while Joe Biden was still the American president. The Trump administration will almost certainly abandon it, and we would be surprised if the new American government ends up offering any plan at all.

The United States soon joins Iran, Libya and Yemen as the only countries in the world not party to the Paris Agreement. This does not mean the race to the future is lost, however — even within the United States. During Donald Trump's first term in office, emissions continued to fall despite his best efforts to revive coal and turn back the clock.[8] This time, we hope many state governments will continue to pursue clean-energy goals, in defiance of the federal government. Under the slogan "we're still in," many American cites, states and corporations have already declared their intention to do so.

8. The total greenhouse gas emissions decline in Mr Trump's first term was about 8.5 percentage points based on EPA data.

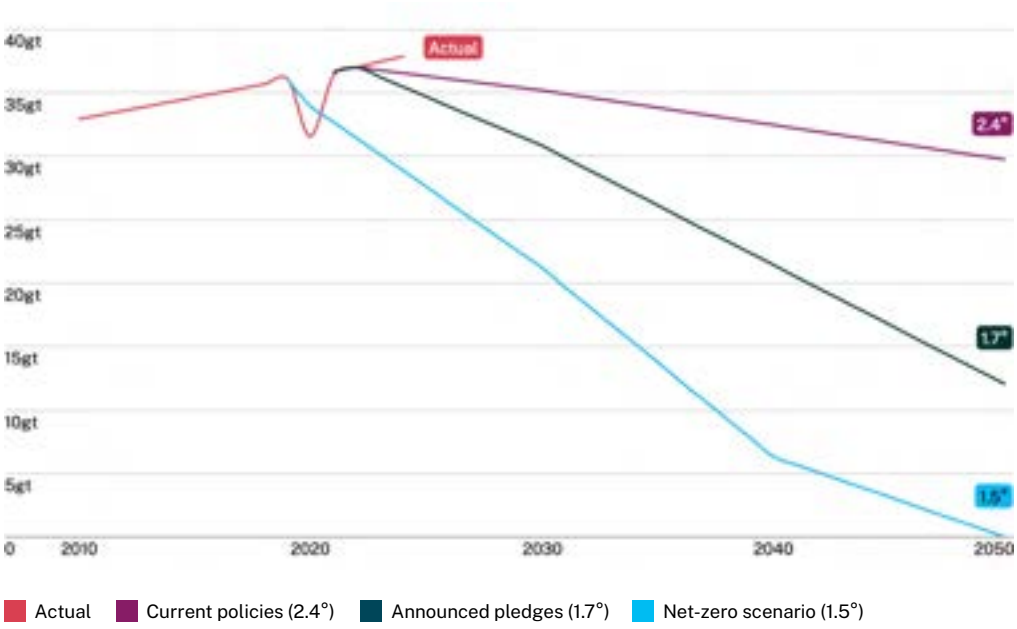
In some sense, nothing has really changed: the countries of the world have never pushed as hard on the climate crisis as they need to do. We have simply entered a period where the required changes will slow down a bit from a pace that was already inadequate to begin with.

As frustrating as this slow pace may be, the green economy is inevitable. We still think the world will get there, albeit with a great deal of damage from dragging our feet for so long. The question of the moment is how long this period of retrenchment will last before we come to our senses and adopt policies that get us back on track.

When the countries of the world convene in Brazil late this year to decide on new steps for global climate action, we hope they will send a powerful message to the United States: we embrace a cleaner, brighter future, even if your government does not. The Americans may have gone home early, but the race is still on.

Figure 3: Long way down

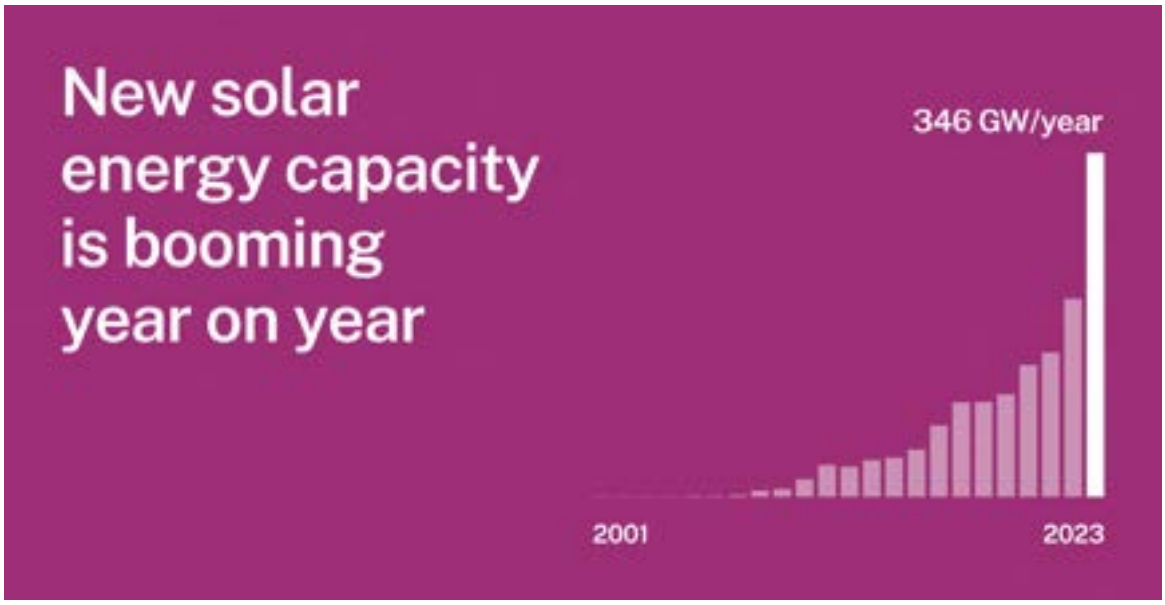
CO_2/year, in gigatonnes



The red line on this chart shows recent global emissions. The other lines represent the rapid declines required to meet various scenarios described by the International Energy Agency.

Source: IEA

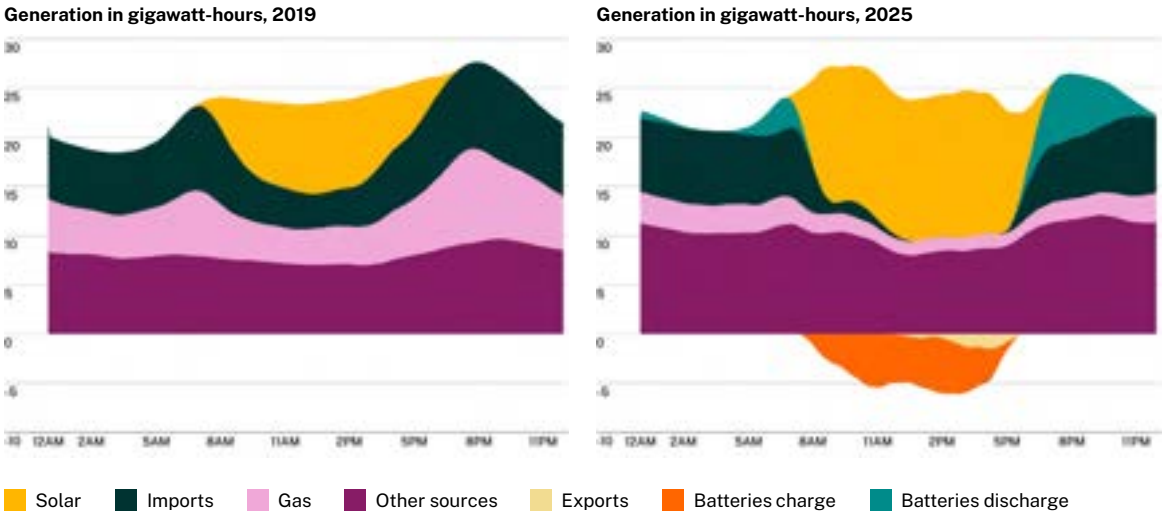
02
Power



Solar power takes centre stage

Solar power is becoming the breakout star of the energy transition, with costs continuing to fall and adoption accelerating the world over. Moreover, the idea that solar panels can supply electricity only in the middle of the day is being turned upside down.

Figure 4: Batteries improve California's grid

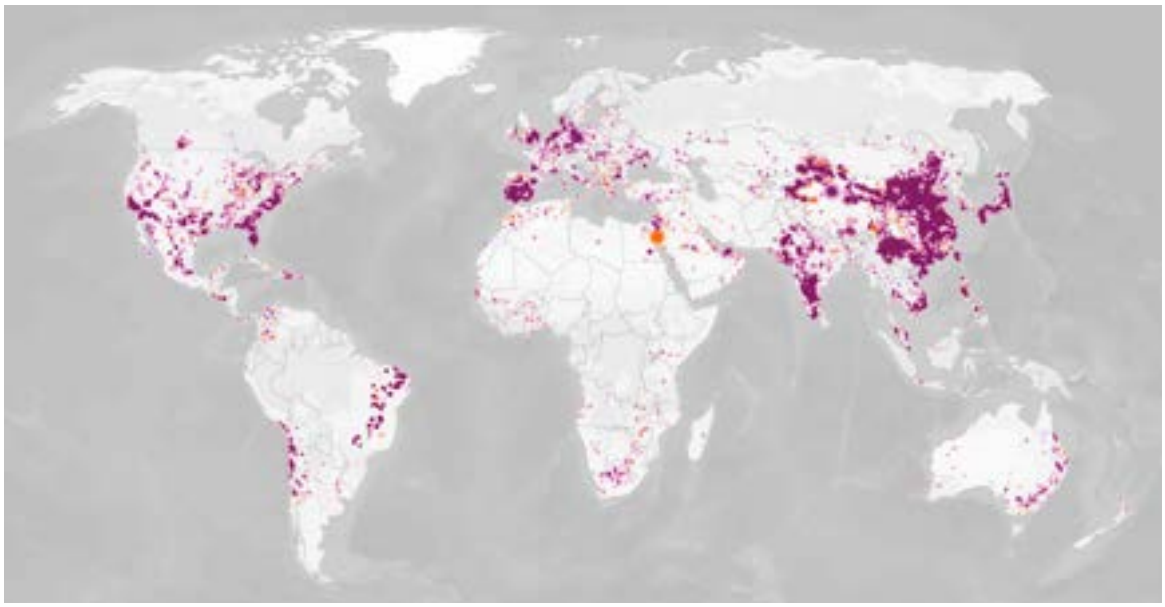


The chart at left shows California's electrical generation profile on 1 April 2019, while the chart at right shows the profile on 1 April 2025. Batteries now charge during the day and discharge in the early evening, displacing gas-fired power plants. Data granularity has been smoothed to enhance readability.

Source: GridStatus

Battery costs have fallen so far, so fast, that more and more large-scale solar projects are being coupled with huge banks of batteries, meaning the sun can now supply power to the electricity grid outside of daylight hours. In California during some peak evening hours, 20 percent of statewide electricity demand is now being met by batteries charged earlier in the day with solar panels, up from practically nothing a decade ago.[1] In parts of Australia, that figure is 30 percent.[2]

Figure 5: The spread of solar



This map shows how extensively solar power has spread around the world, with the size of the dots indicating existing or planned capacity. Projects smaller than 20 megawatts are excluded from the data. The map can be dragged and zoomed.

Source: Global Energy Monitor

Solar panels were invented in the United States, and critical technical breakthroughs came from Australia. Several other countries, including Germany and Japan, played seminal roles in getting this industry to scale. But it is largely to China that the world owes today's dramatic developments in solar technology. In a single month earlier this year, China added more solar capacity to its electricity grid than any other country has ever built in an entire year.[3] This breakneck pace was unusual, as Chinese power developers raced to beat a deadline for expiring government incentives. Still, the May record illustrates what China, with its immense factories and huge renewables-industry work force, is now capable of achieving. Year in and year out, it is harnessing more renewable energy than any other country.

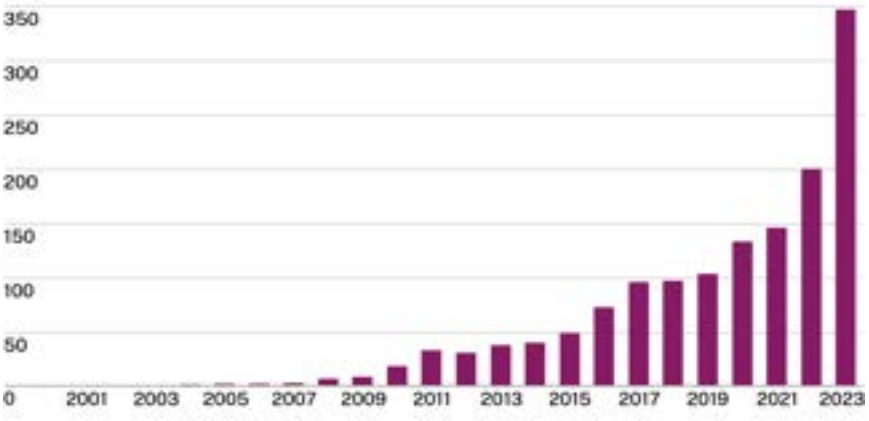
1. Batteries first supplied more than 20 percent of California's grid power in 2024, and that milestone has been surpassed repeatedly in 2025. Texas is following close behind California, with rapid installation of grid-scale batteries. It is important to note, however, that in certain circumstances grid-sized batteries can actually increase carbon dioxide emissions, if they charge from fossil-burning power plants rather than clean sources, as sometimes happens in Texas. Special rules are needed to ensure that batteries always supply clean power. See Plumer, Brad and Nadja Popovich, "Giant batteries are transforming the way the US uses electricity." *The New York Times*, 7 May 2024.

2. On the morning of April 5, 2025, battery discharge in South Australia peaked at 33.4 percent of electricity demand on the state's grid. See Parkinson, Giles, "Big batteries provide on third of state's power needs, smashing records and 'big banana' tropes." Renew Economy, 5 April 2025.

3. Howe, Colleen, "China's solar power capacity growth to slow in H2 after pricing reforms." Reuters, August 13 2025.

Figure 6: The solar boom

Capacity, in gigawatts



Installation of solar panels is soaring in many parts of the world as costs fall. This chart shows the capacity of photovoltaic panels, including those on homes, businesses and large solar farms; as well as concentrating solar power plants installed each year, in gigawatts.

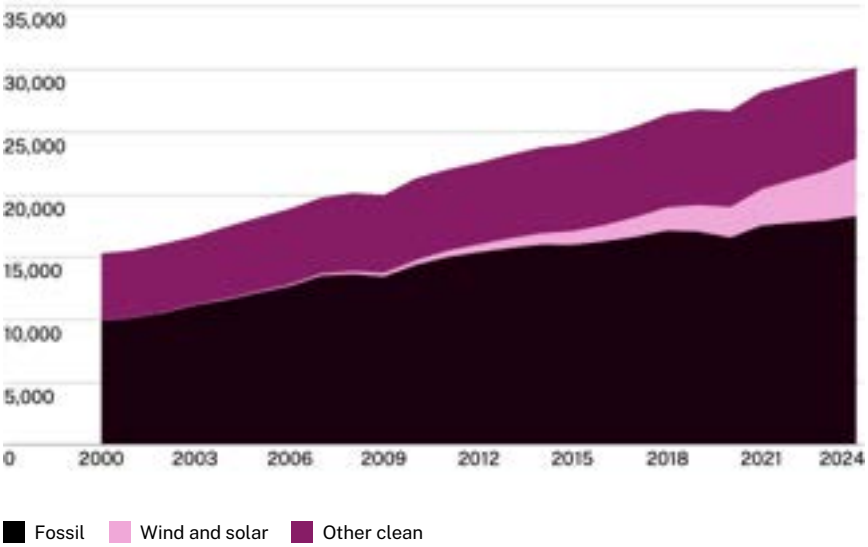
Source: Statistical Review of World Energy 2025

Worldwide, production of electricity from solar panels rose 28.3 percent last year. Wind power grew by 8.2 percent, and other sources of clean electricity, dams and nuclear plants, rose slightly. Total electricity demand is now growing rapidly, and overall, the large majority of that demand growth is being met by clean sources of power. But not all of it: electricity generated from fossil-fuelled power plants rose by nearly 2 percent last year, unfortunately, setting a new record for electricity-related greenhouse gas emissions.[4]

4. Ember, "Global electricity review 2024." 2024. See also Ember,"Yearly electricity generation — all electricity sources — world breakdown." Data Explorer, 2024. The dataset shows year-on-year increases of 28.25% for solar, 8.16% for wind, 4.20% for hydro, 2.90% for nuclear and 1.76% for fossil fuels. These figures differ slightly from those in the published review by the same organisation, which rounds or aggregates categories differently. Here we use the dataset figures for consistency with the charts.

Figure 7: Global electricity sources

Terawatt hours

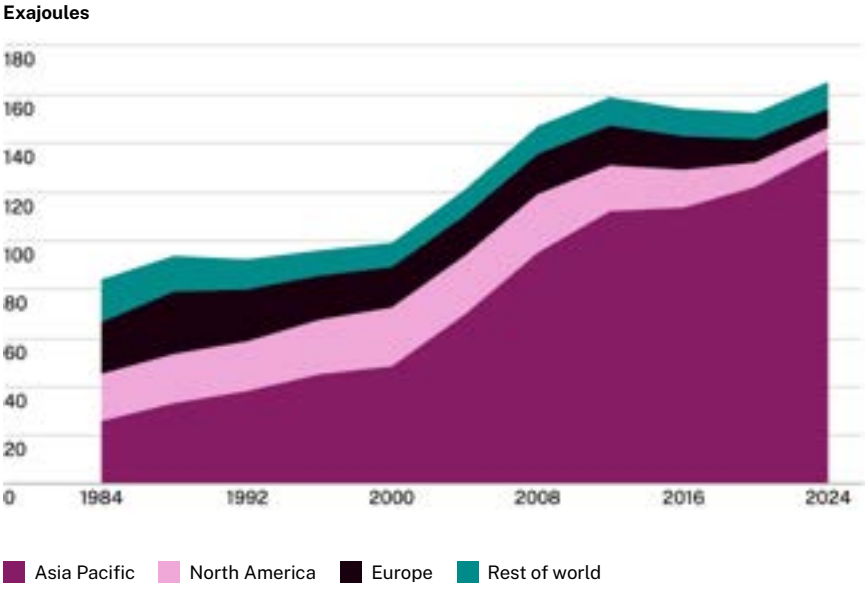


This chart shows the sources of global electricity production. 'Other clean' includes nuclear plants and hydroelectric generation.

Source: Ember

As a proportion of the power mix, coal is declining, but in absolute terms, the world is as dependent on coal as it ever has been. Coal combustion hit a new record in 2024. Squeezing coal-fired power plants off the grid is an urgent task, but it is happening only in some of the richer Western countries. China and India are still commissioning large amounts of new coal power, with many of these stations being sponsored or financed by coal-mining companies.

Figure 8: Still burning coal



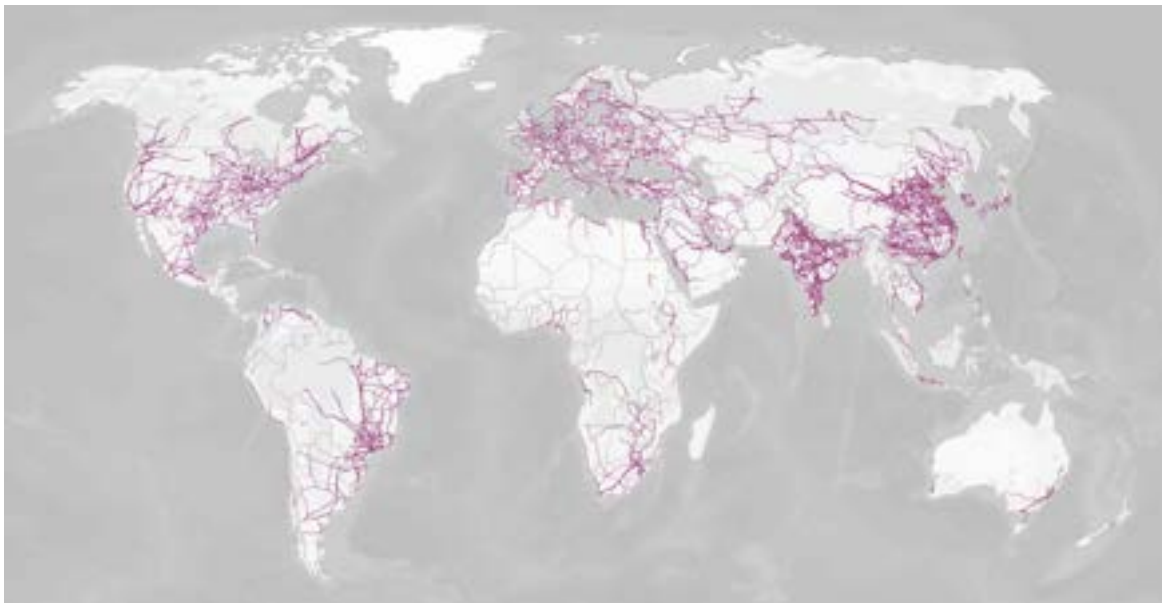
Global coal consumption remains high, driven by rising demand in Asia, especially in China and India. While advanced economies are reducing coal use, many emerging markets continue to rely on it for energy needs, keeping global demand near record levels.

Source: Statistical Review of World Energy 2025

Power demand is taking off as electric cars, heat pumps and new data centres connect to the grid, rising at close to 4 percent a year — nearly double the 2 percent growth that prevailed for many years.[5] Another reason for rising demand is less benign: as the climate crisis worsens, record heatwaves are driving up the use of air conditioning. The blistering heatwaves of the summer just past illustrate what we can expect to live through in the near future.

5. International Energy Agency, "Electricity 2025: Analysis and forecast to 2027." February 2025.

Figure 9: The power grid



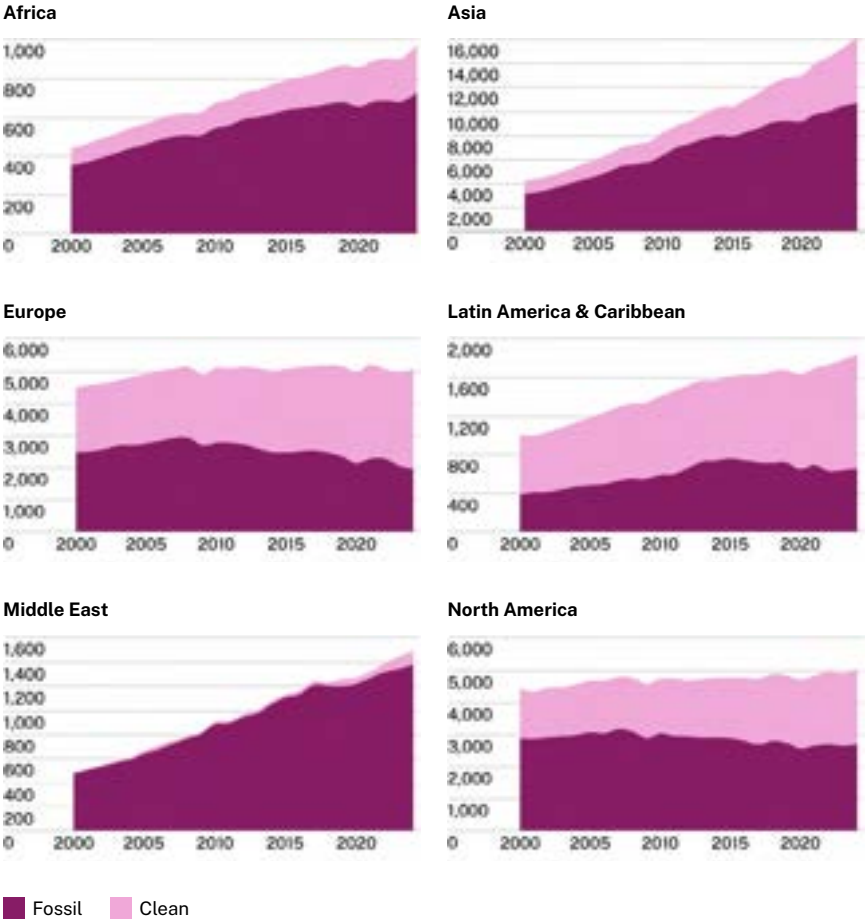
This map displays a visualisation of the world's main power lines. Note that the world's many millions of smaller power lines are omitted from the map.

Source: Infrageomatics, © Mapbox, © OpenStreetMap

In recent years, our reports have emphasised that the single most important issue in the transition is cleaning up the electricity grid. That is because the basic strategy for cutting greenhouse gas emissions is to electrify as many energy uses as possible and then run those cars, factories and heat pumps on clean power. We can report progress: with the growth of clean electricity outpacing the growth of dirty, the balance is tipping in the right direction. As of 2024 the world's electricity grid was about 41 percent clean, up from 39 percent in a year.[6] This pace of change is not adequate to meet the world's climate goals, but at least it is change in the right direction.

6. Ember, "World surpasses 40 percent clean power as renewables see record rise." 8 April 2025. Full figures on the global electricity mix are contained in a report from the same organisation, "Global electricity 2025."

Figure 10: Clean vs fossil by region



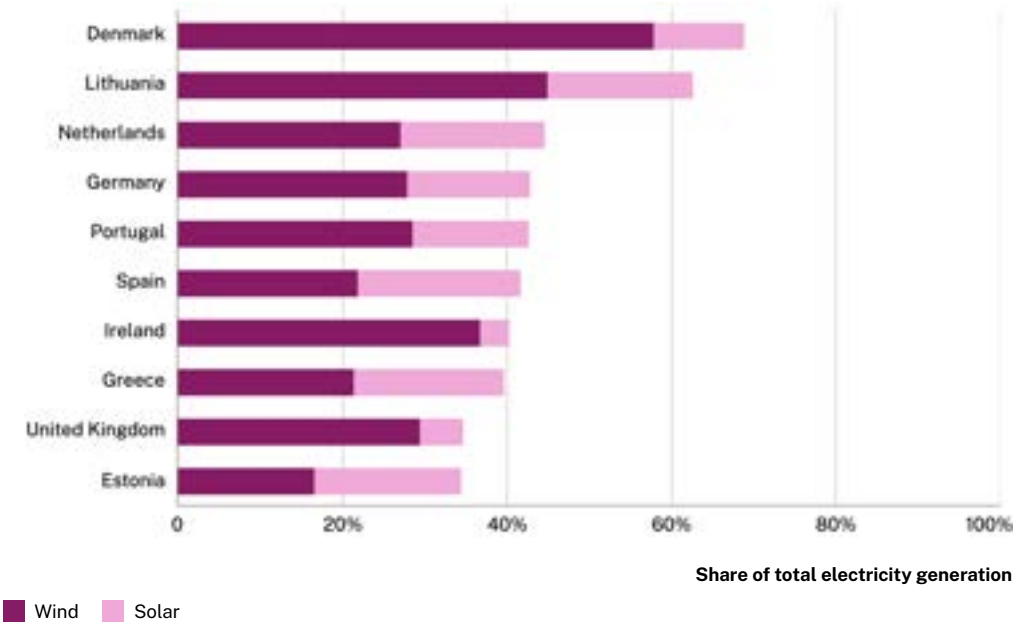
Clean power is growing in all regions of the world as a share of overall power generation, but at varying rates. This chart shows electricity generation in terawatt hours; note the differing scales. 'Clean' includes low-emissions sources, including wind, solar, bioenergy, hydropower, nuclear power and other renewables.

Source: Ember

At climate negotiations in Dubai in 2023, the world's governments set a goal of tripling the amount of renewable power connected to the grid by 2030. Meeting this target is essential if we are to get on track with the overall climate goals. As of now, only solar power is roughly on track to meet the target; wind power is not. It is still possible to get on track, however, if governments cut red tape and speed up approvals for new projects, as many of them have been pledging to do.

Figure 11: The leaderboard

Top 10 countries in wind and solar penetration, 2024



While China gets a lot of attention for its clean-energy boom, other countries are ahead of China in the proportion of their power being supplied by renewables. Here are the leaders in total proportion of wind and solar, excluding some small countries.

Source: Statistical Review of World Energy 2025

We are, however, deeply worried about the future of renewable power in the United States. That country remains the world's largest economy and second-largest emitter of greenhouse gases, and until recently renewables, especially solar power, had been growing there at a healthy pace.[7]

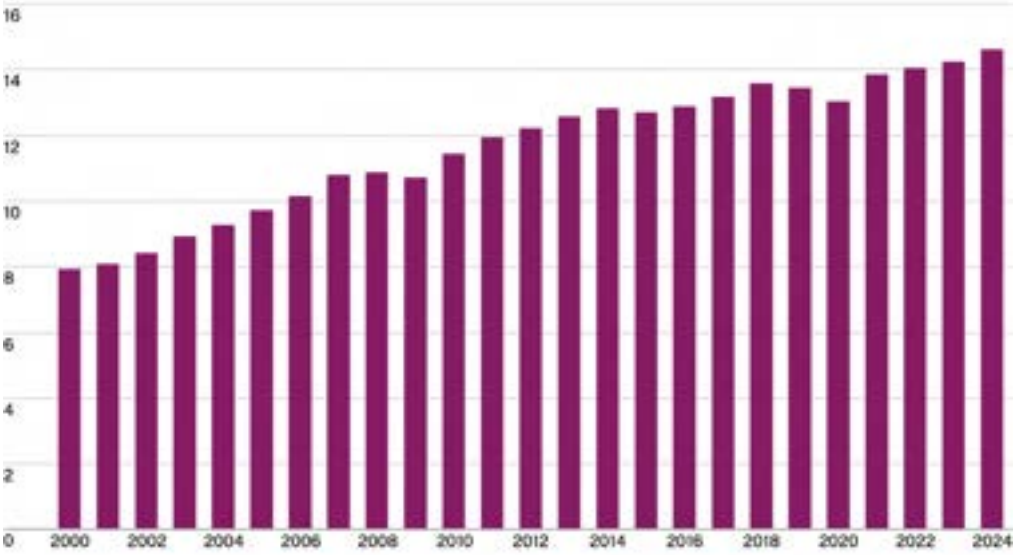
But the legislation the American Congress passed this summer at the behest of Donald Trump contained provisions explicitly designed to kill renewable energy. Only projects that are placed in service by the end of 2027 will qualify for tax breaks, and even those may be rendered uneconomic by Mr Trump's tariffs on metals, solar panels and other imported goods.

Moreover, the forecasts of rapid demand growth from data centres, which are needed to support the boom in artificial intelligence, are leading utilities in the United States to promise a wave of new power plants burning fossil gas. (Please see the box on page 27 for the pros and cons of artificial intelligence in the sustainability transition.) The country has already seen an increase in gas-fired power, but it is unclear that the utilities can build as rapidly as they might wish to do. Shortages of turbines and other critical parts are slowing these plans.

7. For representative figures regarding renewables growth in the United States through 2024, see Bird, Lori et al, "US clean power development sees record progress, as well as stronger headwinds." World Resources Institute, 21 February 2025.

Figure 12: Still too high

CO_2e emissions, in gigatonnes



This chart shows worldwide emissions for the power sector.

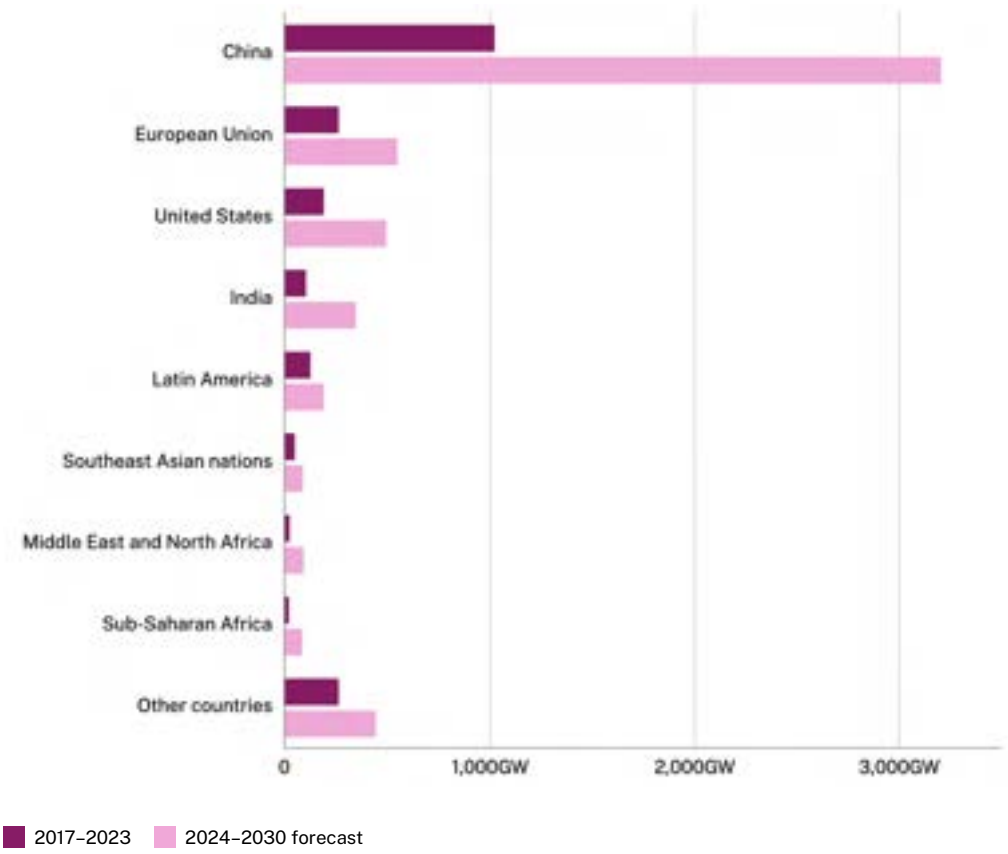
Source: Ember

The United States is not the only trouble spot: we are also concerned about whether the European Union will stick to its targets on renewable power, as well as its broader goals for cutting emissions. Commitment to the clean economy may be weakening in Europe as the bloc grapples with the Ukraine war, trade tensions with the United States and populist political movements that are hostile to renewables. Over the summer, French President Emmanuel Macron called for scaling back the EU goals.[8]

8. See *Brussels Reporter*, "Emmanuel Macron advocates for delaying the EU's next climate target," 28 June 2025, reporting that Macron confirmed support for postponing agreement on the EU's proposed 2040 emissions-reduction target of 90 percent compared to 1990 levels, and called for decoupling it from the 2035 goal while emphasising the need for democratic debate among the 27 member states.

Figure 13: The boom continues

Gigawatts



This chart shows recent and forecast growth in generating capacity for renewable electricity, by country or region. The forecast figures are from the International Energy Agency's most likely case.

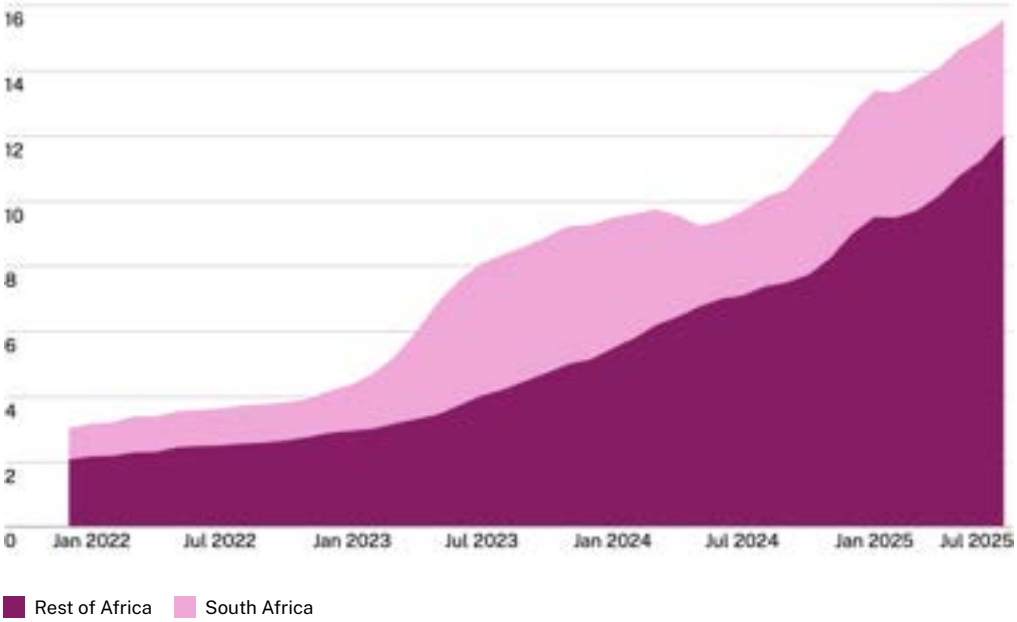
Source: IEA

Even as the rich countries waver, poorer countries are seeing greater adoption of renewable energy, especially cheap solar panels made in China. Aside from the boom in Pakistan that we mentioned earlier, imports of Chinese solar panels are rising in virtually every African country, a reflection in part of their growing affordability as prices continue to fall.[9] This is not entirely a happy story from the point of view of Chinese manufacturers: the country's capacity for panel manufacturing has expanded so rapidly that it now far exceeds global demand, and many solar manufacturers are losing money amid a cut-throat price war. A consolidation of the Chinese industry seems inevitable, possibly accompanied by a temporary rise in prices, but the long-term trend is that solar power keeps getting cheaper.

9. Ember, "The first evidence of a take-off in solar in Africa." 26 August 2025. This analysis shows that exports of solar panels from China to Africa rose 60 percent in the previous 12 months to June 2025 (15,032 megawatts, up from 9,379 MW), with 20 countries setting new records and 25 countries importing at least 100 MW, compared to 15 the prior year.

Figure 14: Solar boom in Africa

Gigawatts of capacity



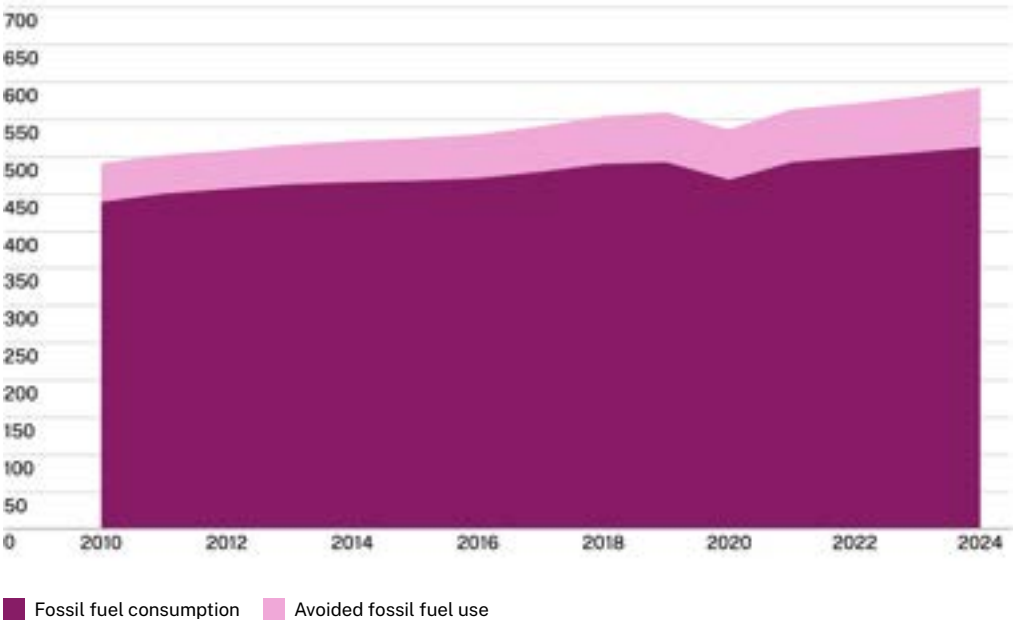
Imports of solar panels across the vast continent of Africa have risen 60 percent in the past year. This chart shows the rolling 12-month sum of solar panel imports from China.

Source: Ember

Even as the Americans attempt to kill wind and solar power in their country, a couple of bright spots have emerged there. The government and some corporations are making renewed commitments to nuclear power, including attempts to jump-start the construction of smaller, more modular nuclear plants. Big technology companies have signed deals to buy power directly from nuclear plants to run their data centres. Microsoft has negotiated a deal that could even lead to the restart of the undamaged reactor at Three Mile Island in Pennsylvania, site of America's worst nuclear disaster.

Figure 15: Avoided fossil fuel use

Exajoules



This chart shows the amount of coal, oil and gas avoided by using renewables and nuclear power to supply energy instead.

Source: Statistical Review of World Energy 2025

We remain uncertain what role nuclear power will ultimately play in the energy transition; at a global scale, it has been losing ground to other technologies. But the question needs to be tested, and it is good that considerable sums of American money are going to the purpose. With that said, it is far from clear that nuclear power is going to be able to compete economically with the combination of solar panels and batteries. The one new nuclear plant now under construction in the United Kingdom, for instance, has seen staggering cost overruns. The initial estimate was that it would cost £18 billion, but the latest calculations put the likely cost not far below £50 billion,[10] and we will be unsurprised to see it escalate further. China and South Korea are both able to build nuclear plants on time and on budget, but Western nuclear developers have not managed to emulate their success.[11]

American energy developers are also making headway in expanding geothermal power, which uses heat from deep inside the Earth to turn water into steam and generate electricity. In the past this technology has been limited to select geological hotspots and supplies less than 1 percent of the world's energy,[12] but new drilling techniques perfected by the Americans could lead to much wider adoption. Recent research suggests that geothermal wells could ultimately supply as much as 20 percent of American electricity.[13] If the industry does take off, we would hope to see it spread worldwide; geothermal power can be generated at any time, which would make it a highly useful complement to more intermittent wind and solar power.

10. Duckett, Adam, "Hinkley Point C could go £28 billion over budget as EDF predicts further delays." *The Chemical Engineer*, 26 January 2024.

11. Rodriguez, Sebastian, "Emerging economies turn to Asian reactors for new wave of nuclear power." *Climate Home News*, 21 August 2025

12. International Energy Agency, "The future of geothermal energy." 2024.

13. Ricks, Wilson and Jesse D. Jenkins, "Pathways to national-scale adoption of enhanced geothermal power through experience-driven cost reductions." *Joule* 9, 16 July 2025.

Drilling for heat

An American company called Fervo Energy is leading efforts to expand the use of geothermal power. Here, a Fervo drilling rig operates near Milford, Utah.

Source: Ellen Schmidt, via Alamy

AI & POWER

Is artificial intelligence compatible with a sustainable world?

Only a few years ago, artificial intelligence felt like a technology of the future, to be debated at conferences. Today, it is shaping people's daily lives: composing emails, optimising energy grids, forecasting floods and, occasionally, hallucinating confidently on our screens. The shift has been rapid, and for many, disorientating. Yet for all the visible progress, we are still in the early stages of what may prove to be the most foundational technology platform of our time.

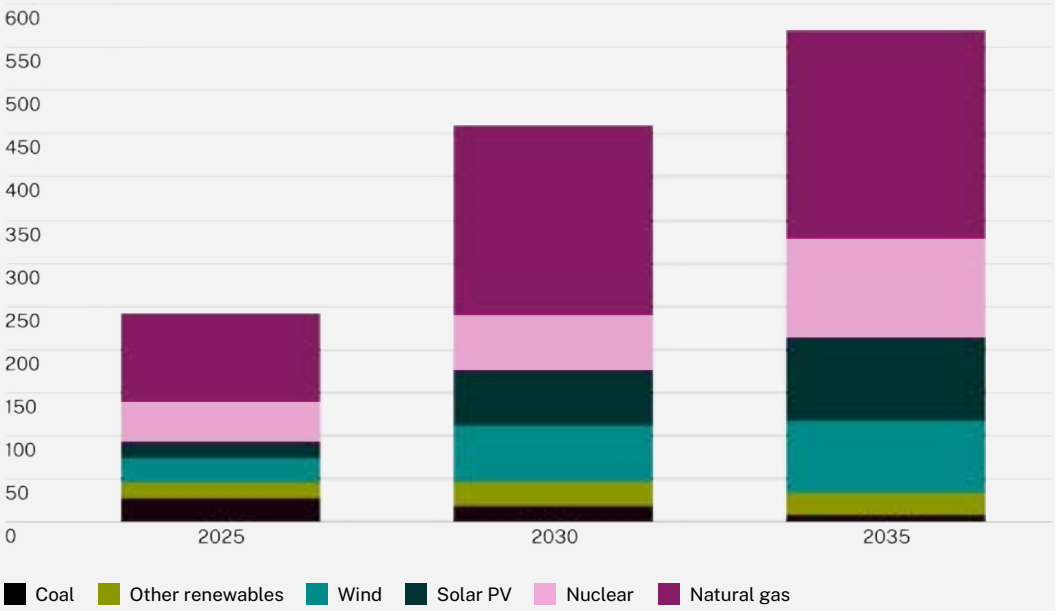
As with other major technology transitions of the past, this one is likely to have profound consequences. Past experience suggests the benefits to humanity will ultimately outweigh the harms, but predicting exactly how that balance will shake out is impossible. It is critical that safeguards be built in now, while the technology is still in its early stages.

At Generation, our Global Equity and Growth Equity teams have been studying the potential implications of this technology since 2011. In this special report, we will outline some of our thinking about those implications, the potential use cases, the possible harms — and the improvements in governance needed to protect society, and the planet we all live on, from those harms.

Perhaps the most critical immediate issue is the exploding power demand associated with running the latest AI models, and how to meet it without driving up harmful emissions. The largest AI models can demand immense amounts of electricity. Training OpenAI's GPT-4 alone consumed an estimated 50 gigawatt-hours of electricity,[a] roughly equivalent to the annual usage of a small city. Today, AI-related data centres already account for 1 to 2 percent of global electricity-related emissions, and their power demand is projected to more than double between 2024 and 2030, according to the International Energy Agency. Left unchecked, this growth could strain energy grids and conflict with climate targets — particularly in geographies already facing energy insecurity.

Figure A: Power hungry

Terawatts



This is the International Energy Agency's forecast of power demand for data centres, and the agency's estimation of how that demand is likely to be met.

Source: IEA

The United States is a focus of particular concern, given that 65 percent of the world's data centre capacity is forecast to be built there.[b] Power demand had flatlined in that country for two decades as better technologies, like improved lighting, contributed to greater efficiency. But the trend could now reverse in part because of power demand from AI. In 2024, fossil fuel generation in the United States rose, primarily due to the use of fossil gas. Attempts are being made across the country to fast-track new gas power plants to keep up with rising demand. The inventory of planned gas generation projects has nearly tripled, from six gigawatts in late 2023 to 17.5 gigawatts in 2025.[c] Even before the huge demand spike associated with AI, the American grid was antiquated and under strain from decades of inadequate investment, unable to move electricity around the country to the degree required. The AI demand spike is rapidly worsening that problem. Efforts are beginning to supply cleaner power to newly built data centres, so that extra computing loads do not drive up emissions, but it is as yet unclear if these new sources of clean power will be able to keep up with fast-rising demand.

In addition to the energy challenge, AI is projected to consume 1.1 to 1.7 trillion gallons of freshwater annually by 2027.[d] Unlike fossil fuels, water can be re-used, but there are still meaningful concerns around diversion from local communities.

Computing horsepower needed

This $1 billion Google data centre, under construction north of London, gives a sense of the scale of the computing facilities now going up all over the world.

Maurice Savage, via Alamy

Can AI cut emissions?

While the potential for increased emissions from AI has gained a great deal of attention, the opposite prospect has barely been discussed — and could ultimately be more important. AI could be an enormous help in cutting emissions, if it is used to make systems like power, transportation and food more efficient. A recent study found that AI applications across those systems could reduce global emissions by 6 to 10 percent annually by 2035[e] — more than offsetting the projected emissions from AI's energy use. Earlier research from Microsoft and the consultancy PwC estimated that applying AI across the energy, agriculture, water and transport sectors could cut emissions by something like 4 percent by 2030 while adding $5 trillion to global economic output. These efficiency gains could also support large-scale job creation — with Microsoft and PwC's model projecting 38 million net new roles across these four sectors globally by the end of the decade.[f]

Whether forecasts like those will actually come to fruition is one of the most significant questions. Yet we are already beginning to see early examples of AI's positive impact on the planet. For example, a company called WEKA, in which Generation has invested, helped its customers avoid more than 358,000 tonnes of emissions in 2024, through a platform that helps advanced computing workloads reduce their hardware requirements by up to 90 percent.[g] Similarly, a 2023 study of Google's AI-based aviation prediction models found that using them could reduce jet contrails, which are responsible for over a third of aviation-related global warming, by 54 percent.[h] In the non-profit space, Climate TRACE's AI-powered emissions tracking platform has created the first comprehensive, near-real-time inventory of global greenhouse gas emissions at the facility level. Combined with Altana's supply chain intelligence tools, it enables companies to quantify emissions in their supply chains — something they could not do very well until these new tools became available.[i]

While AI's net impact on the planet is still up for debate, so too is its impact on society. Evidence of social harm is stacking up: AI tools are making it easier to create 'deepfake' videos and photos of politicians, and they are being used for darker purposes like creating child pornography. In some teenagers, interacting with AI chatbots has worsened mental health problems and in one case possibly even led to death by suicide.[j] Spammers and fraud artists are eagerly exploring what AI might be able to do for them. Governments are already using AI as a tool of mass surveillance. These early problems with the technology have demonstrated the fundamental inadequacy of the guardrails built into some models. While their creators are rushing to patch over particular problems as they crop up, we have no guarantee that AI will not result in large-scale social harm.

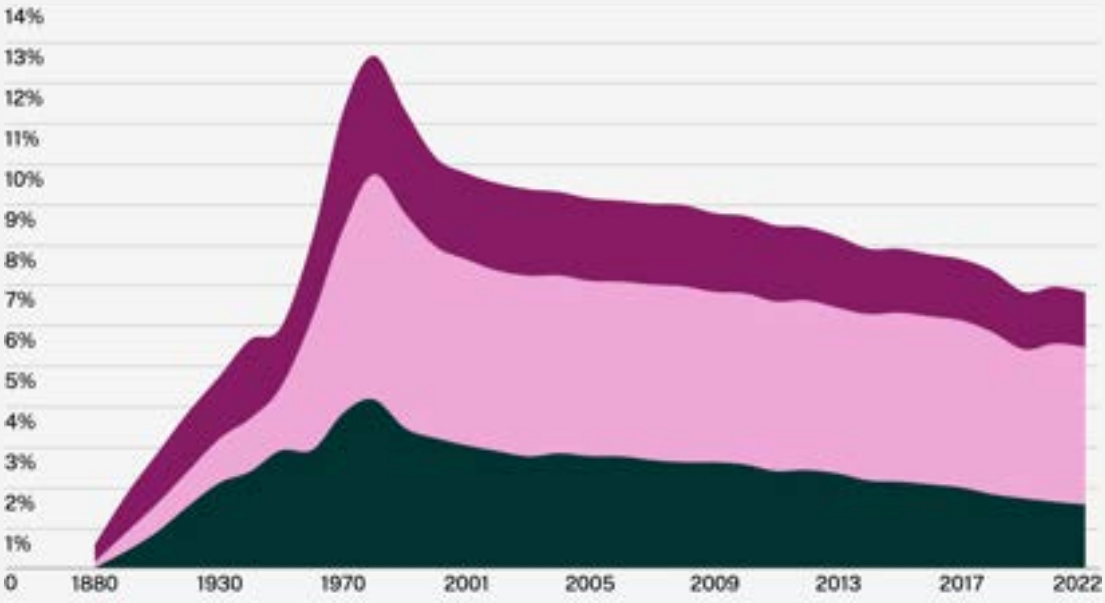
Privacy and disinformation concerns are mounting too. As AI systems become increasingly embedded in our

lives, users often engage with them in deeply human-like ways, unlike any previous technology. One study found that 70 percent of queries across one million ChatGPT conversations included personal identifiable information, while another found that 76 percent of AI chatbot users did not understand basic privacy risks.[k] Many of us are already confiding in AI systems more freely than we might confide in other people. This creates new risks, especially when there's little transparency into how data is exploited or fed back into model training.

The inequality problem

Without deliberate intervention, AI could also deepen structural inequalities. Access to high-quality models, computing resources and relevant datasets remains heavily concentrated in the global north. In 2024, just 1.4 percent of global AI investment went to companies based in Africa, Latin America and Southeast Asia.[l] And as AI begins to reshape job roles, the divide between workers who can make use of it and those who cannot will only grow, with potentially significant implications for inequalities in both wealth and well-being
New technologies always trigger shifts in the type of work humans are required to do. While we expect AI to augment and displace various tasks and roles performed by knowledge workers, new fields will also be created in areas such as data science, AI development and the energy sector. As AI is embedded in the physical world over the coming decades, robotics systems will lead to further displacement in the skilled and frontline workforces — though this is happening more slowly. A 2025 paper by Larry Summers and David Deming of Harvard University suggests AI is already transforming labour markets: they noticed a barbell-shaped pattern in wage growth, as highest earning and lowest earning jobs are growing faster while middle-paid jobs are not, leading to growing wage inequality.[m]

Figure B: The rise and fall of office work



At its peak in 1980, office and administrative support roles accounted for 12.7% of employment in the United States — about one in eight workers. By 2022, this share had fallen to 6.8%, returning to levels last seen in 1920.

Source: David Deming

The idea that AI will make work easier or more tolerable is a long way from proven. A recent study from the Massachusetts Institute of Technology found that using AI for knowledge work reduces human memory recall.[n] The early indicators suggest, however, that the potential for improvements in both productivity and work quality are real. A recent study at Procter & Gamble, the multinational consumer goods company, found that teams with access to AI assistance delivered noticeably higher quality work than those without, even when both sets of workers started with the same data.[o]

AI also holds potential to combat social and economic inequality, especially in personalising education. For instance, platforms like Speak and Masterschool are developing AI tutors that adapt in real time to individual learning styles — including for neurodivergent students like those with autism or other conditions, who are often poorly served by standardised instruction.

The 'how' of AI is just as important as the 'what' when it comes to accessibility. This includes promoting conversational AI through voice, translating for non-dominant languages and designing with equity at the core. For example, ElevenLabs AI voice-cloning technology has made computer-aided speech for disabled people sound exactly like their real voices.[p] The 'how' also means broadening the circle of those who participate in AI design, testing and feedback; reviewing data used to train AI for bias; and ensuring the right data privacy and cybersecurity practices.

AI is becoming embedded in the infrastructure of essential systems like healthcare, finance and education. It is driving innovation in the physical, climate and medical sciences. The critical question is not whether AI will shape our systems, but how we choose to shape AI. That choice will determine whether these technologies reinforce fragility and inequality, or help build resilience, equity and human flourishing.

Momentum is building as the positive effects of AI are felt across industries. In healthcare, companies are accelerating drug discovery and equipping millions of doctors with AI note-taking devices, known as scribes. In finance, digital platforms are lowering barriers to adoption. In climate resilience, tools like real-time flood forecasting are saving lives. These examples are early signals of what is possible when AI is deployed with purpose. But they also remind us that the window for shaping norms, standards and safeguards is narrow. Governments are beginning to regulate, companies are beginning to adapt and investors are beginning to allocate significant amounts of capital. Yet the frameworks for sustainability remain incomplete.

So what do we mean by sustainable AI? At its core, it is AI that advances human and planetary well-being while safeguarding environmental and social systems. It is AI that reduces carbon intensity rather than inflating it, that expands access rather than excluding people, and that strengthens resilience rather than creating new vulnerabilities. This is not a distant aspiration: it is a design choice available today. The genie may already be out of the bottle, but we still get to decide what kind of future it creates.

In 10 years, in a world where AI may very well design, direct and influence large parts of our economy, what will we wish we had done differently today?

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a. OpenAI GPT-4 training costs and energy usage are referenced in RISE Research Institutes of Sweden, "Generative AI does not run on thin air." 2024.

b. Boston Consulting Group, "Breaking barriers to data center growth." 2025.

c. Rystad Energy, "Data centers reshape US power sector." 2025.

d. World Economic Forum, "Why circular water solutions are key to sustainable data centres." 2024.

e. Stern, Nicholas et al, "Green and intelligent: the role of AI in the climate transition." *NPJ Climate Action*, 23 June 2025.

f. PricewaterhouseCoopers and Microsoft, "How AI can enable a sustainable future." PwC UK, 2024.

g. Generation's Growth Equity team invested in WEKA through its Sustainable Solutions IV fund. WEKA provides a parallel, distributed file system. That means it lets many computers access and process huge amounts of data simultaneously, without getting bottlenecked by storage speed. Its customers include many leading AI businesses. More information on WEKA's impact can be found in Sustainable Solutions IV's 2024 Impact Report, available on the Generation website.

h. DeepMind, "Contrails research." Google Research, 2023.

i. Generation's Growth Equity team invested in Altana through its Sustainable Solutions IV fund. Altana is an AI-powered supply chain network enabling global shippers and logistics providers to have full visibility through multiple tiers of suppliers. This allows customers to comply with cross-border trade regulations and shape procurement approaches. Climate TRACE is a non-profit organisation that is supported by the partners of Generation.

j. There have been several reports of mental health crisis in part caused by interaction with AI chatbots. One such example was referenced in Jargon, Julie and Sam Kessler, "A troubled man, his chatbot and a murder-suicide in old Greenwich." *Wall Street Journal*, 28 August 2025.

k. Mireshghallah, Niloofar et al, "Trust no bot: Discovering personal disclosures in human-LLM conversations in the wild." *arXiv* 2407.11438, 2024. See also Ive, Julia et al, "Privacy-preserving behaviour of chatbot users: steering through trust dynamics." *arXiv* 2411.17589, 2025.

k. Per data from PitchBook as at August 2025 when searching for 2024 transactions where the company's description included 'artificial Intelligence.'

l. Per data from PitchBook as at August 2025 when searching for 2024 transactions where the company's description included 'artificial intelligence.'

m. Deming, David J. et al, "Technical disruption in the labour market." NBER Working Paper No. 33323. National Bureau of Economic Research, 2025

n. Kosmyna, Nataliya et al, "Your brain on ChatGPT: Accumulation of cognitive debt when using an AI assistant for essay writing test." '*arXiv* 2506.08872, 2025.

o. Dell'Acqua, Fabrizio et al, "The cybernetic teammate: A field experiment on generative AI reshaping teamwork and expertise." Harvard Business School Working Paper No. 25–043, 2025..

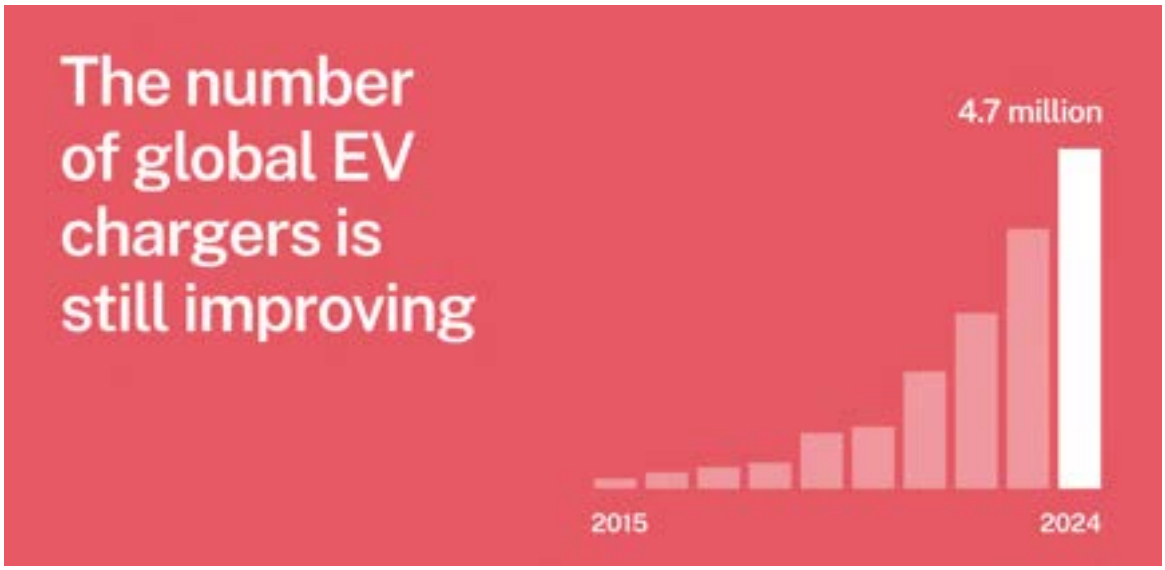
p. ElevenLabs provided the voice cloning technology that allowed a motor neurone disease patient to speak with her own voice, referenced in BBC News, "How eight seconds of scratchy audio from a VHS tape gave a mum back her voice." BBC News, 29 August 2025.

In many countries, this is the first time in two decades that power demand has started to rise significantly. The old way of meeting that demand would have been to build a slew of additional power plants. But in this digital era, other possibilities are coming to the fore. For instance, plenty of power may be available for data centres if they will agree to ramp down their operations during brief periods of the year when power grids are under extreme stress. Google has already signed two deals along these lines, and many other data companies are thinking about whether they might wish to do the same. Grid operators in the United States are starting to offer faster connection times to new facilities that can commit to this sort of flexibility.

The approach has found some use in other countries, too. In the United Kingdom, some consumers earn points they can redeem for prizes if they cut down their power use during times the grid is stressed.[14] In principle this sort of thing can be automated, with devices like air conditioners or water heaters turned up or down in response to price signals. We believe the grid of the future will make much greater use of this sort of digital intelligence, instead of solving shortages with the brute force of new transmission lines and new power plants.

14. For a description of how this kind of programme works in the UK, see Latief, Yusuf, "Octopus Energy gamifies load reduction with Octoplus rewards scheme." Smart Energy International, 30 October 2023. Readers should note that Generation is an investor in Octopus Energy.

03 Transportation

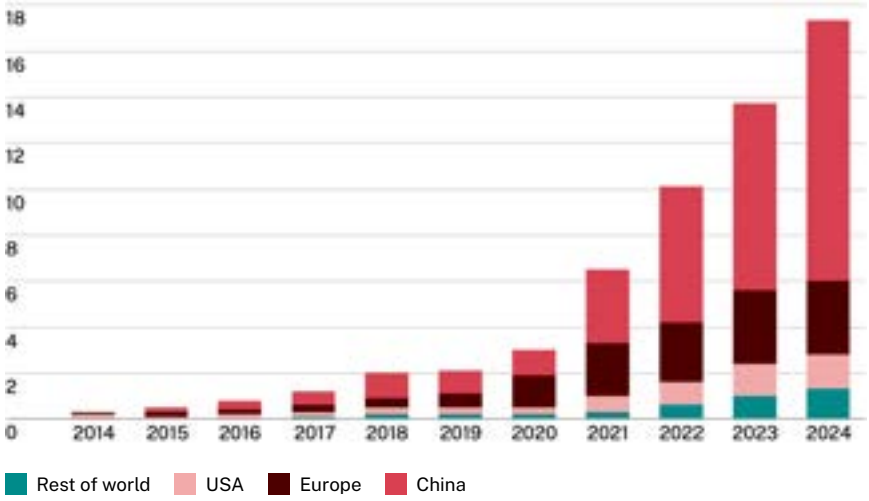


Yes, cars really are going electric

The worldwide boom in electric cars continues apace. Sales rose sharply last year and the growth continued into the first months of 2025, with a 35 percent increase globally in the first quarter and sales jumps across most major markets.[1] It is true that year-on-year sales growth for 2024 was not as strong, in percentage terms, as in some recent years, but that should be expected: electric cars are now growing on a much larger base than in the past.

Figure 16: Electric cars are still booming

Global EV sales in millions



Sales of cars with plugs continue to grow, though at a slower rate of increase than in the past. This should be expected, as the recent sales growth is coming on a much larger base.

Source: IEA

1. International Energy Agency, "More than 1 in 4 cars sold worldwide this year is set to be electric as EV sales continue to grow." 14 May 2025.

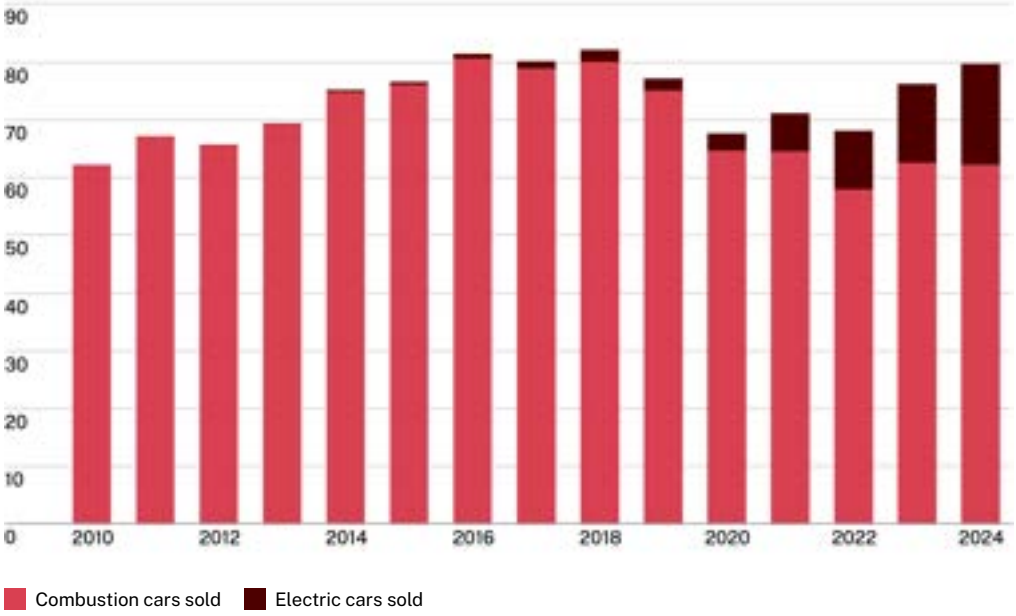
The International Energy Agency forecasts that electric cars will make up 25 percent of all cars sold in the world this year.[2] The market share will be roughly the same across Europe, albeit much higher in a few markets, like Norway. Cars with plugs now constitute well over half of new-car sales in China and they continue to gain market share in that automotive market, the world's largest.[3] Chinese automakers are now producing some of the world's best and most affordable electric cars, and they are gaining share in many export markets, including the United Kingdom. Markets in Latin America, Southeast Asia and Africa are starting to see rapid growth in sales of Chinese cars, off a very low base in some countries.

2. Ibid.

3. International Energy Agency, "Global EV outlook 2025: outlook for electric mobility." 2025.

Figure 17: Changing consumer preferences

Number of vehicles sold, in millions



This chart compares the global annual sales of cars with plugs, including hybrids and fully electric cars, vs fuel-burning cars.

Source: IEA

Manufacturing the future

Robotic arms hard at work on a production line in China's Zhejiang Province for the Leapmotor brand of electric vehicles.

Source: Hu Xiaofei, via Getty

As it has been throughout this transition, the United States is the most important laggard, with only about 10 percent of its car sales being electric in 2024. The IEA forecasts that this number will jump slightly in 2025 as consumers race to buy cars ahead of the expiration of federal subsidies for their purchase.[4] Then, the hammer could fall: the Trump administration is so determined to kill the market for electric cars that it is stripping away every federal support programme, risking thousands of jobs that were expected in new battery factories. California and several other states are likely to continue supporting the automotive transition, however, so it is somewhat unclear how far the American market will drop. California car sales were about 25 percent electric in 2024, matching the average across Europe, but sales so far in 2025 suggest their penetration may already be slipping.[5]

Compounding the confusion in America is Donald Trump's on-again, off-again tariff policies, which could make all cars — not just electric ones — more costly. If Mr Trump's machinations drive the American economy into recession, the entire automotive market would be expected to suffer. Whether the tariffs are even legal is an open question, with one court having already ruled that they are not.

Tesla, the company headed by Elon Musk, was for years responsible for the bulk of electric-car sales in the United States. But that dominance is eroding as other companies improve their offerings. Tesla's worldwide importance is also declining, especially in countries where Mr Musk's foray into politics as a supporter of Mr Trump has become a liability for his company. Tesla sales fell 27 percent in France, 62 percent in the Netherlands, 58 percent in Belgium, 52 percent in Denmark and 86 percent in Sweden as the backlash took

4. Ibid.

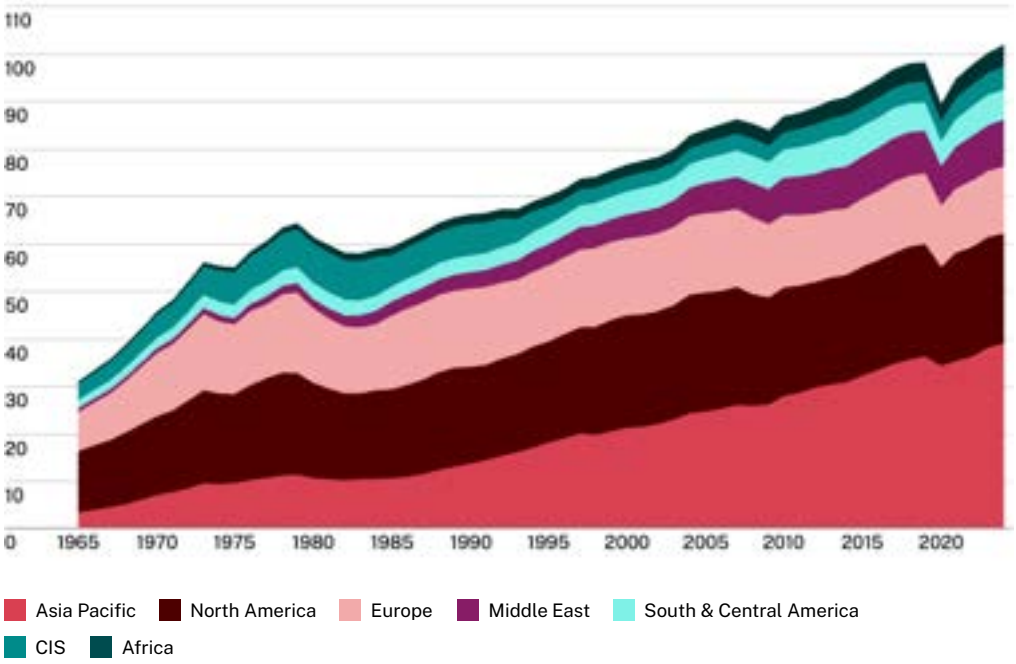
5. Ibid.

hold. Only a few markets bucked the trend, including Spain, up 27 percent, and Norway, up 83 percent.[6] The company has pinned its hopes on offering driverless ride-hailing services. But in that nascent market, Tesla is far behind competitor Waymo, a Google offshoot that has been offering driverless rides in a handful of cities for as long as five years, and is now expanding rapidly.

If Mr Trump manages to precipitate a stagnation or decline of the American electric-car market, that will be a development of global importance. The country is so car-dependent that its autos are the largest single source of greenhouse gas emissions in the United States,[7] and one of the most important sources worldwide. Mr Trump's actions threaten to undo decades of effort to get the United States into a better place regarding emissions, and to cut its dependence on oil.

Figure 18: Thirst for crude

Million barrels per day



This chart shows global oil consumption from 1965 to 2024. The CIS category includes the former Soviet Union and its successor states.

Source: Energy Institute

As batteries continue to improve and their costs continue to fall, the electrification trend is starting to show results in heavy transport, not just in passenger cars. Sales of electric versions of heavy lorries jumped 80 percent in 2024, off a tiny base; they are now almost 2 percent of global truck sales,[8] with growth expected as new regulatory standards take hold in Europe and California. It is already clear that electrification will be possible for some segments of the heavy transport market: the city of Shenzhen in China has managed to put 16,000 electric buses on the road.[9] How quickly electricity can

6. Reuters, "Tesla sales drop again around Europe despite Model Y revamp." 1 August 2025.

7. US Environmental Protection Agency, Office of Transportation and Air Quality, "Fast facts on transportation greenhouse gas emissions, 2024." in "Climate change indicators: U.S. greenhouse gas emissions." 2025.

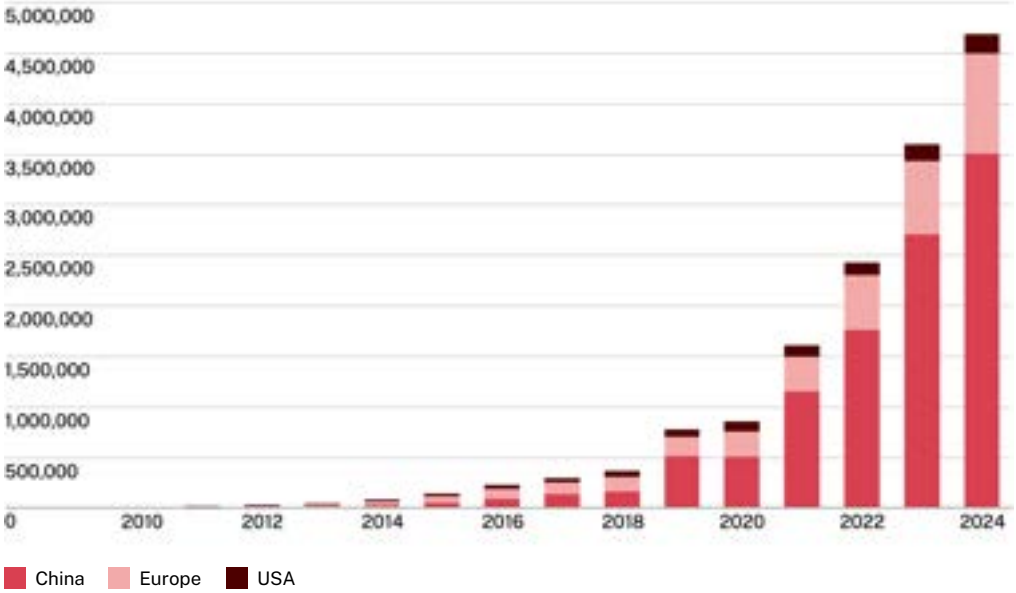
8. International Energy Agency, "More than 1 in 4 Cars sold worldwide this year is set to be electric as EV sales continue to grow." 14 May 2025.

9. Keegan, Matthew, "Shenzhen's silent revolution: world's first fully electric bus fleet quietens Chinese megacity." *The Guardian*, 12 December 2018.

displace diesel in all heavy-duty road transport is still unclear, however. One of the biggest bottlenecks will be the availability of heavy-duty, high-powered chargers, which in most countries are only just starting to be installed.

Figure 19: Getting there

Number of EV chargers



This chart shows the worldwide number of public chargers for electric vehicles.

Source: IEA

So far, the small electrification trend is far from adequate to tackle the growing problem of freight emissions. Of all the emissions from transportation, more than 40 percent can be attributed to moving goods rather than people,[10] and as passenger cars get cleaner, this proportion will grow. The most emissions-intensive form of goods hauling, air transport, is also the fastest growing,[11] and countries have yet to come up with policies adequate to tackle this issue.

One possible way to cut emissions from aeroplanes would be the creation of sustainable aviation fuels. Many of these are under development, but not all are equally sustainable. Electrofuel, known as e-fuel, offers the greatest environmental potential: it can be made with renewable electricity and waste carbon dioxide, potentially eliminating most of the emissions. This fuel would also avoid the land-use conflicts associated with biofuels, another potential way of fuelling planes.

The problem with these fuels is that they are prohibitively expensive today. In 2023, the European Union adopted the world's most ambitious mandate for such fuels. This has helped to spur a wave of development, with 41 large-scale projects across Europe, giving the region the highest project count globally.

10. Ritchie, Hannah, "Cars, planes, trains: Where do CO^2 emissions from transport come from?" Our World in Data, 6 October 2020.

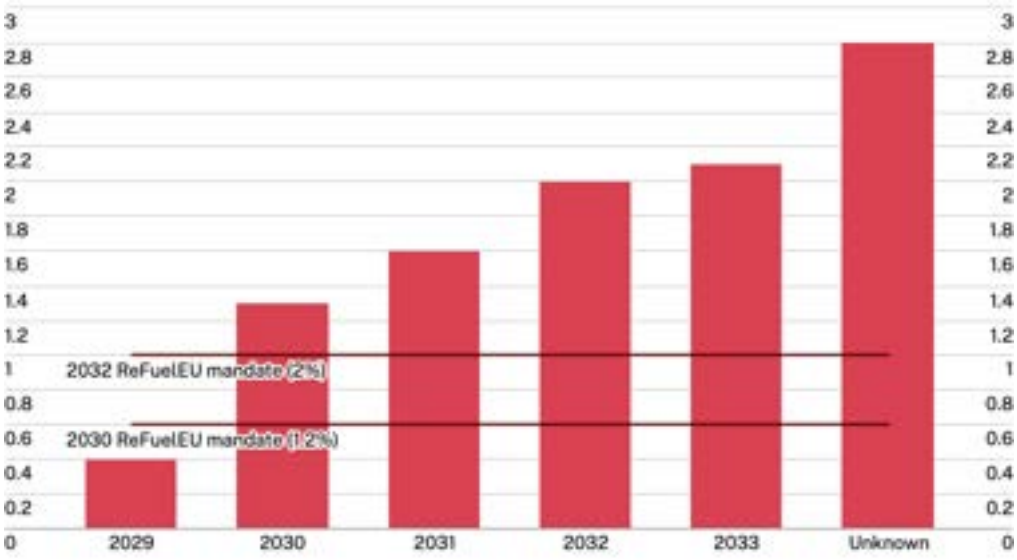
11. International Transport Forum, "Key transport statistics 2024 data, statistics brief." 15 May 2025.

However, challenges with financing and regulatory uncertainty mean these projects are hitting roadblocks. For the sector to develop, more airlines need to agree to binding deals to buy the resulting fuels, like the deal recently signed by International Airlines Group, which controls several carriers.

Even if the fuel mandates are fully met, e-fuels would cover just a sliver of aviation fuel demand by 2032. Barring technical breakthroughs and rapid declines in the cost of e-fuels, policymakers face hard choices. They could, for example, attempt to reduce the demand for flights with stiff 'frequent flier' taxes or the like, though intense political resistance to any such measures can be expected.

Figure 20: Sustainable aviation fuel

Annual e-kerosene capacity from large-scale projects, in millions of tonnes

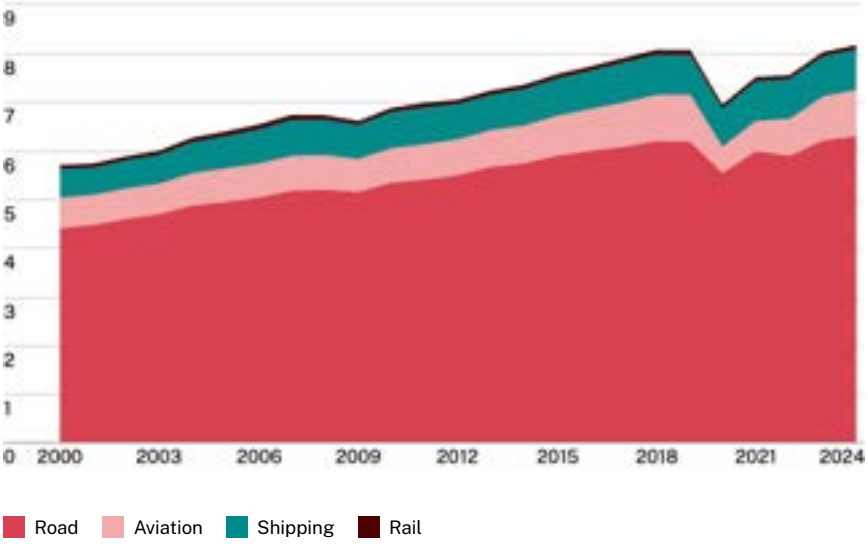


If all projects on the drawing board come to fruition, airlines will be able to buy enough sustainable aviation fuel to meet the European blending mandates for e-fuels shown as black lines on the chart. Final investment decisions have yet to be made on most of these fuel projects, however.

Source: T&E

Figure 21: Out of the exhaust pipe

Annual CO_2 emissions, in gigatonnes

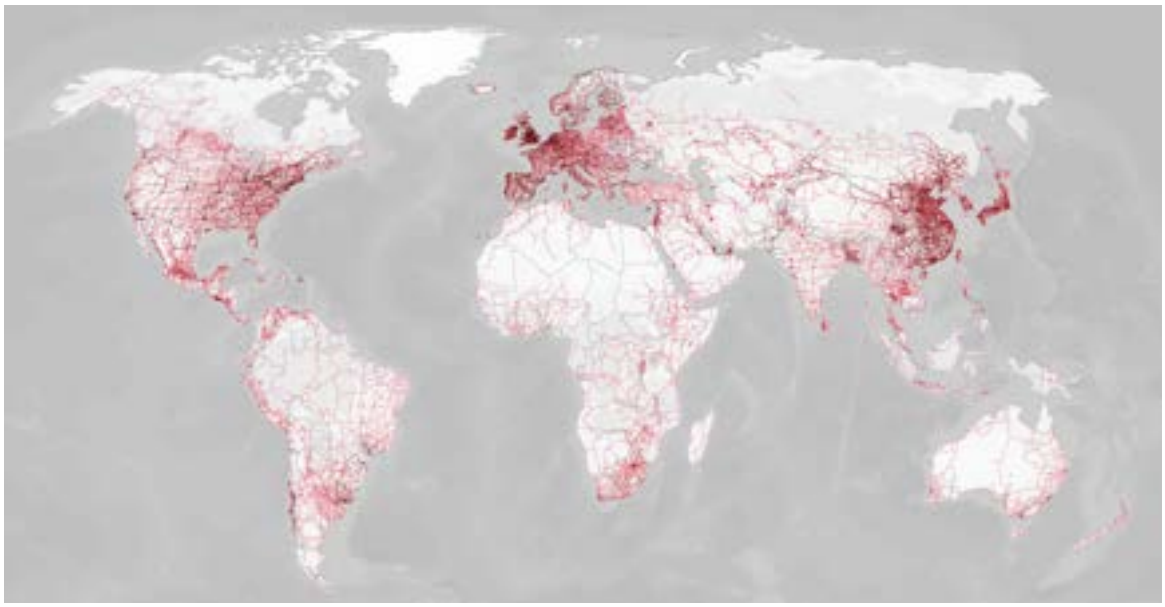


This chart shows historical to present-day emissions from transportation.

Source: BloombergNEF

We have argued for years that public policy is too skewed towards private transportation, and not enough effort is being made to move people out of cars and into more efficient trains, trams and buses. We saw progress over the past year in a few countries, though. After delaying plans for a congestion charge to suppress car traffic in New York City, the governor of that state finally let it go through, albeit at a lower fee than planned; the money will be invested in transit improvements that are badly needed in New York.

Figure 22: Roads to everywhere



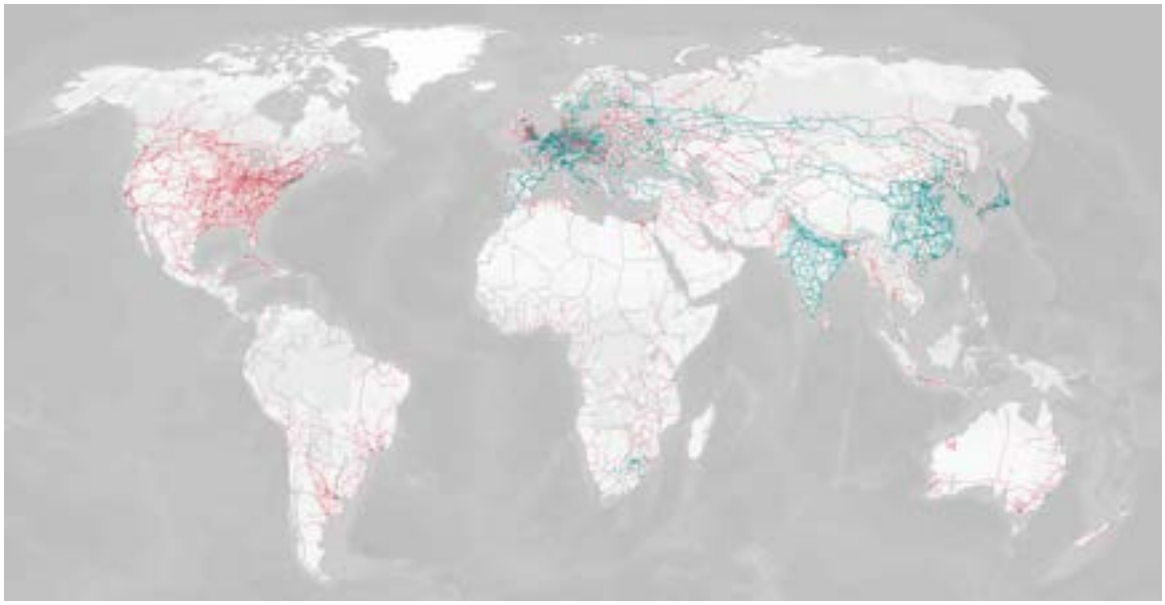
The construction of 64 million kilometres of roads across the face of the Earth has been one of humanity's most dramatic impacts. Roads have cut the immense landscapes of old into patches, disconnecting plants and animals from one another and eradicating wild vistas.

Source: GLOBIO, © Mapbox, © OpenStreetMap

In Germany, the new, conservative-led government is responding to years of public complaints about the deterioration of that country's once-vaunted rail network. The government is setting up a $500 billion fund to invest in infrastructure, with more than $100 billion of that specifically earmarked for the railways.[12] Similarly, the new Labour government in the United Kingdom intends to spend billions improving the country's rail infrastructure.

12. The German cabinet approved a €500 billion Special Fund for Infrastructure and Climate Neutrality, of which approximately €100 billion is earmarked for railways as part of the long-term investment strategy through 2029. See Federal Ministry of Finance, "Fiscal foundations for the coming years: German government adopts 2025 federal budget, benchmark figures to 2029 and implementation of the €500 billion investment package." Federal Ministry of Finance, Berlin, 24 June 2025.

Figure 23: Back to the future?



The great transportation breakthrough of the 19th century, railroads, might be what we need for the 21st. Railways running on clean electricity could play a major role in meeting the demand for both passenger travel and freight haulage, but many countries have yet to electrify their tracks. India and China are ahead of much of the world.

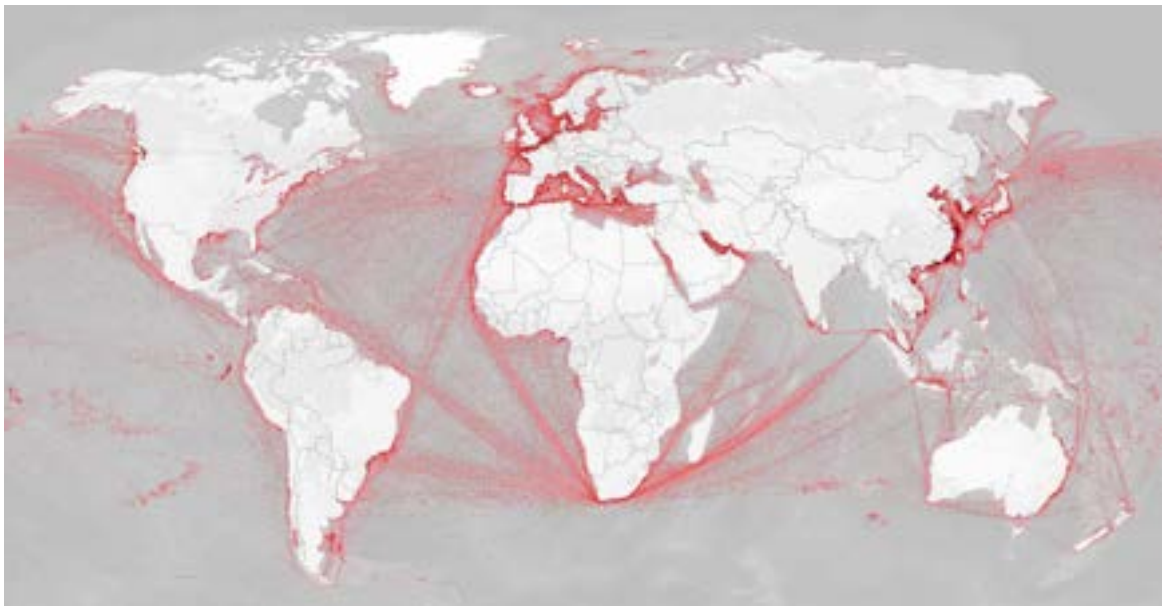
Source: OpenRailwayMap, © Mapbox, © OpenStreetMap

In principle, electrified railways running on a cleaned-up grid could satisfy a great deal of passenger and freight demand. High-speed rail lines, which have been built across China, Japan and large parts of Europe, can even compete with planes for intercity travel. But these projects are costly and sometimes controversial: a high-speed rail line under construction in Britain has bedevilled governments with cost overruns and political opposition. The few high-speed rail projects under way in the United States, such as one intended to connect Los Angeles to San Francisco, have had similar problems. Even in America, however, high-speed rail may work in specific corridors: a private company is pursuing a fast rail connection between the Los Angeles basin and Las Vegas, the gambling mecca. More than 40 million trips on that route are made every year by car,[13] and the rail line could cut the journey time from four hours to two.

Ocean shipping is another large source of emissions that need to be cleaned up. In principle, large ships could run on fuels like ammonia without producing significant greenhouse gas emissions, although ammonia-burning does produce localised air pollution. Before Donald Trump took office, countries were on the verge of agreeing to bold new targets for the cleanup of global shipping, but the Trump administration is now trying to sabotage the deal. Despite the populist backlash against globalisation, shipping emissions are expected to continue growing in the future, so a cleanup plan is urgently needed.

13. Brightline West, "Our Story." 2025. The company behind the Las Vegas rail plan notes: "Nearly 50 million trips occur between Las Vegas and Southern California each year, with over 85 percent of them by automobile."

Figure 24: Global shipping



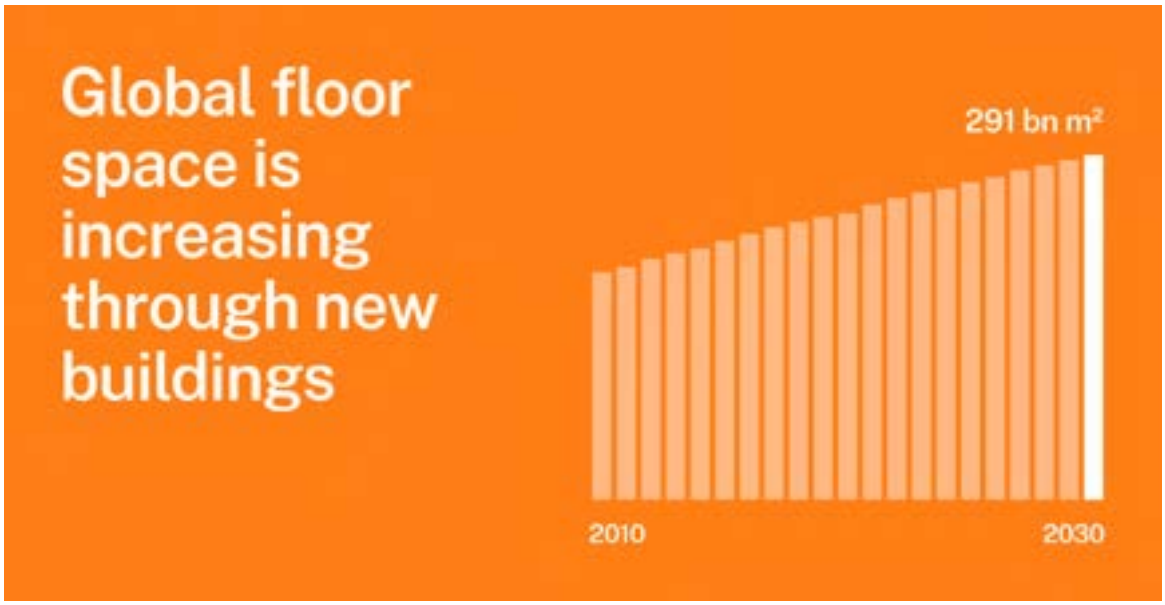
This map allows you to visualise the world's major transcontinental shipping routes.

Source: Global Maritime Traffic, © Mapbox, © OpenStreetMap

One of the most hotly contested issues around the electrification of transport is when global oil demand will peak and begin to fall. The International Energy Agency says that it may happen before the end of this decade, as the rising share of electric cars eats into petrol demand in China and other countries. The Organisation of the Petroleum Exporting Countries has attacked this idea and projected growth in oil demand all the way through 2050, the end of its forecast period. The Western oil industry is also offended by the IEA's forecast, for a simple reason: industry executives know that Wall Street detests shrinking businesses. If oil does peak and begin to fall, the stock prices and the political power of the oil companies will erode more rapidly than their revenues do. The industry has thus put its most faithful servants, Republican politicians in the United States, to work attacking the IEA.

The IEA is not perfect, but it is the best analytical shop the world has in trying to understand the energy system and its future. With the United States government captured by the oil lobby, we hope other governments will defend the agency's independence and its right to make forecasts based on its best reading of the evidence.

04 Buildings & Industry



Moving much too slowly

As heartening as the progress has been on electric power and transportation, we are more or less stuck in place with some other sectors of the economy. We turn now to two where relatively little headway is being made: the decarbonisation of the world's buildings and its industry.

For more than a decade, many people have pinned their hopes for cleaning up industry on the development of a huge new enterprise to produce clean, 'green' hydrogen. In principle, hydrogen made without releasing emissions could substitute for fossil gas and other dirty energy in many factories. But over the past couple of years, the great bubble of hydrogen hope has finally burst.

We are now seeing cancelled projects, wasted public funds and recriminations around the world. At least 20 percent of the hydrogen projects on the drawing board in Europe have died recently,[1] and most of the others are on life support. The story is much the same in other industrial countries. The exception may be the United States, where some federal tax breaks for hydrogen projects were retained in the bill that slashed most other clean-energy subsidies, and China, where the government is pushing several large-scale projects. But even in those countries it is unclear how many hydrogen projects will really get off the ground. [2]

The basic problem is that green hydrogen, made without emissions, is still several times more expensive than dirty hydrogen made from fossil gas.[3] At the prices that green hydrogen producers would need to charge, buyers are just not showing up, nor is it clear that costs can fall enough in the long term to make green hydrogen competitive. In retrospect, the bubble of enthusiasm

1. Westwood Global Energy Group, "Over a fifth of all European hydrogen projects stalled or cancelled." Westwood Insight, 17 December 2024.

2. For a more optimistic take than ours, see Moore, Malcolm, "Clean hydrogen investments top $110 billion to defy industry pessimism." *Financial Times*, 9 September 2025.

3. Winterbourne, Richard, "Hydrogen production costs: a comparison of green, blue and grey hydrogen." Haush Ltd., 12 November 2024.

for hydrogen may have cost us years in which industrial decarbonisation could have been pursued by more practical means. It may be no accident that much of the enthusiasm for a cleaned up supply of hydrogen came originally from oil companies. If society could be sold on hydrogen as the essential pathway for cleaning up industry, that would have played to their expertise and given the oil majors a key role in the energy transition. Now, the hydrogen hype cycle is ending just as many of those same oil companies walk away from their own weak climate commitments.

Initially, the oil companies wanted to capture the emissions from dirty hydrogen production and bury them underground, although they invested little money and made little progress on the idea. The longer-term goal, in theory, was to use renewable electricity to make hydrogen by splitting water molecules into their constituent elements, oxygen and hydrogen. Hydrogen can burn cleanly and it can reach exceedingly high temperatures, so in theory, it would work in many industrial uses. Hydrogen is used in some plants today, but it is made from fossil gas in a way that throws carbon dioxide emissions into the air. Green hydrogen would not do that.

Some potential uses of green hydrogen still make sense, at least in locations where plentiful renewable energy is available — the steel industry, for instance, may have no choice but green hydrogen to clean up certain kinds of production.[4] But green hydrogen was also being bandied about for many other uses that never made much sense. Some companies, for instance, fantasised about sending it through pipelines to heat homes, but heat pumps powered with electricity are far more efficient and, therefore, less costly.

With so many hydrogen plans in ruins, where does that leave us?

Practically no progress has been made in decarbonising heavy industry, even though everyone knows it has to be done. Governments, initially convinced by the hydrogen talk, have been slow to adopt other strategies that could help to get industry moving. Among the most useful tools would be ‘buy clean’ provisions, which are essentially performance standards requiring that a rising percentage of goods sold to the government itself be produced by clean methods. To cite one example, governments buy as much as a third of all the cement in the world, for roads, bridges and similar projects.[5] If these large buyers declared that a percentage of the cement they buy must be made with climate-friendly methods, this would shake the cement industry from its lethargy. Such policies have indeed been adopted in a few places, and we are beginning to see a bit of movement, but there is a very long way to go. Clean production methods are available in many industries, but still in their earliest stages.

One potentially important development is that the chemical industry’s attention may be turning from hydrogen to one of its compounds: ammonia. This is a vital industrial chemical, used for many purposes — including a critical role in the world food supply as the basis for the most important

4. Generation is an investor in one project that involves the use of green hydrogen to make steel, a company called Stegra. Its first plant, in the northern Swedish town of Boden, is under construction and on track to produce steel at commercial quantities in 2027.

5. See Global Efficiency Intelligence, 2024: “Public procurement of cement in selected countries.” UNIDO news release. See also Industrial Deep Decarbonization Initiative, 2025: “Public procurement and cement demand.” Clean Energy Ministerial/UNIDO explainer PDF. And see United Nations Industrial Development Organization, 2023: “Public procurement and construction spending.” UNIDO COP28 release.

type of fertiliser. The world's ammonia production is now dirty, producing as much as 2 percent[6] of global greenhouse gas emissions, but could be cleaned up using renewable electricity. Ammonia is a compound of nitrogen and hydrogen, but because it is a liquid instead of a gas, it is easier and cheaper to handle than hydrogen alone. Worldwide, more than 300 clean ammonia projects are on the drawing board,[7] and a few have already gone into production. This may turn out to be a more promising pathway than green hydrogen.

Hydrogen is not the only example where the cleanup of the world's industry is stuck in neutral. Hopes for a global treaty to control plastics pollution, and the emissions associated with production of virgin plastic, ran aground late last year in Busan, South Korea, when negotiators failed to bridge deep divides over the issue. Efforts this year to get the negotiations back on track failed again, in Geneva. The United Nations has not given up trying to bring a plastics treaty into existence, but fossil-fuel interests oppose it, and with Donald Trump in the White House, it is extremely unlikely the Americans will agree to adopt any treaty. China is the world's largest plastic producer, using coal as its main feedstock — the dirtiest possible way to make plastic. Without a global treaty that limits production and requires improved recycling systems, global plastics production could increase 70 percent by 2040, compared to the level in 2020.[8] Plastic is already an environmental catastrophe, polluting land and ocean and, in microscopic form, the human supply of food and water. Microplastics have been detected all over the world, in rainwater, agricultural soils and even Antarctic snow. The health consequences of ingesting microplastic, if any, are still largely unknown. Efforts to recycle plastic continue to falter. Despite decades of investment, only about 9 percent of global plastic waste is recycled.[9] Much of it is incinerated, landfilled or exported — often to countries without adequate waste infrastructure. The plastics industry may account for more than 3 percent[10] of global greenhouse gas emissions, large enough that getting this under control is a critical issue.

6. Production of ammonia is directly responsible for 1.3 percent of global greenhouse gas emissions. However, indirect emissions from the use of ammonia — such as its tendency to volatilise into a greenhouse gas after being spread on farm fields — pushes its total contribution to the greenhouse gas inventory to 2 percentage points or higher. See Mingolla, Stefano and Lorenzo Rosa, "Low-carbon ammonia production is essential for resilient and sustainable agriculture." *Nature Food* 6, pp. 610–621, 17 February 2025.

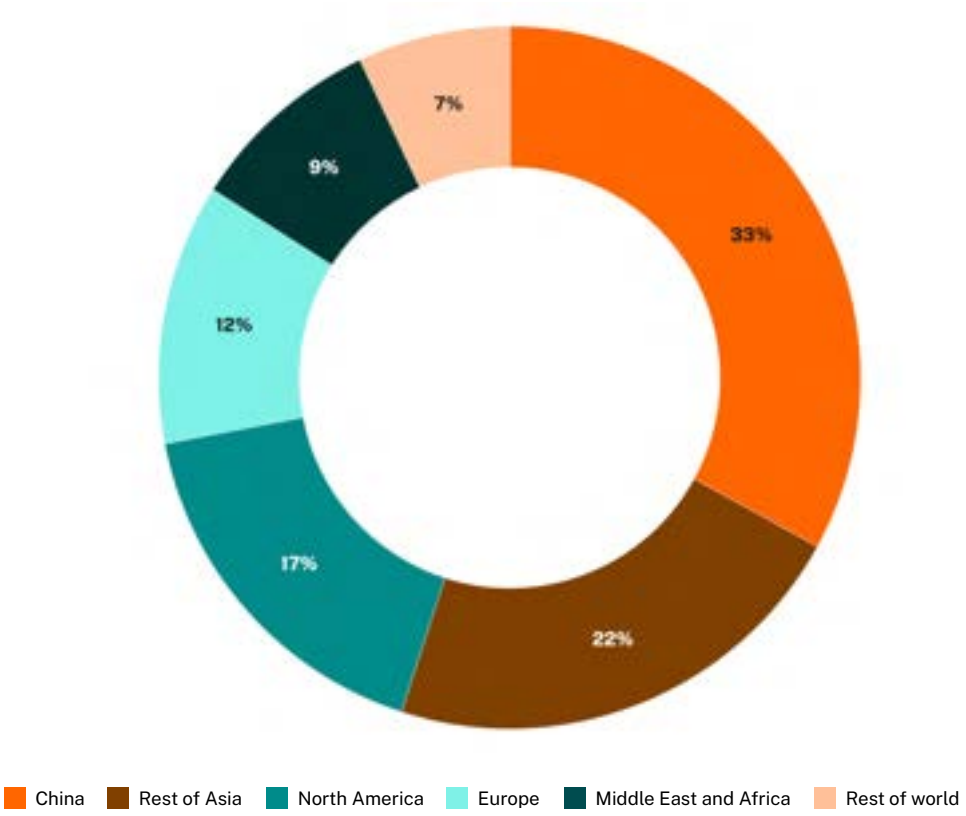
7. The estimate of 300 clean-hydrogen projects is likely conservative. Sightline Climate earlier this year published a database of 364 low-carbon ammonia projects; this database is not publicly accessible but is available to the company's subscribers, of which Generation is one. Using broader criteria than Sightline Climate, the Ammonia Energy Association in late 2024 put out a public document stating that it was tracking more than 400 projects.

8. Organisation for Economic Cooperation and Development, "Policy scenarios for eliminating plastic pollution by 2040." OECD Publishing, 2024.

9. Organisation for Economic Cooperation and Development, "Global plastics outlook: economic drivers, environmental impacts and policy options." OECD Publishing, 2022.

10. Some estimates of the greenhouse gases from plastics production run as high as 5 percent, but the United Nations Environment Programme puts the figure at 3.4 percent. See United Nations, "Plastics – fueling oil demand, climate change and pollution."

Figure 25: Buried in plastic



The chart shows the share of plastic production by country. China is now the world's largest plastics producer by far, with some of its production exported to other countries as packaging material.

Source: PlasticsEurope

The fashion and clothing industry is yet another example of halting, inadequate progress. This is another industry that may represent 2 percent[11] or more of global emissions. With the advent of cheap 'fast fashion,' clothing consumption per person has been rising worldwide, yet much of this cheap clothing is disposed of after being worn for limited periods. An estimated 73 percent[12] of discarded clothing is landfilled or incinerated — a tragic waste of the water, cotton, land and fuels required to produce these goods. Despite token take-back schemes from some manufacturers, we have yet to figure out how to recycle most garment types back into garments. Of the small share of clothing waste that does make it into a recycling stream, most is 'downcycled' into insulation fibres, carpet backing, industrial rags or other low-value uses. Of the 3. 3 billion tonnes of materials the clothing industry consumes each year, more than 99 percent comes from virgin sources.[13]

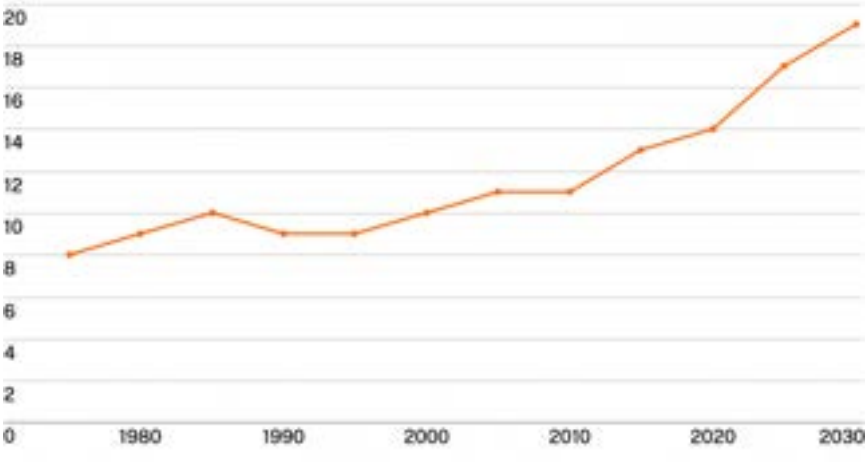
11. World Bank, "How much do our wardrobes cost to the environment?" World Bank News & Events, 23 September 2019.

12. Ellen MacArthur Foundation, "#WearNext." 22 June 2021.

13. Circle Economy, "Circularity gap report: Textiles – closing the circularity gap in the textile industry." November 2024.

Figure 26: Global fibre production

Kilograms per person



Global fibre production per person has nearly doubled over the past half-century, and is expected to keep rising without stronger public policies to limit the growth. Polyester made from plastic has displaced cotton as the world's most widely used clothing fibre.

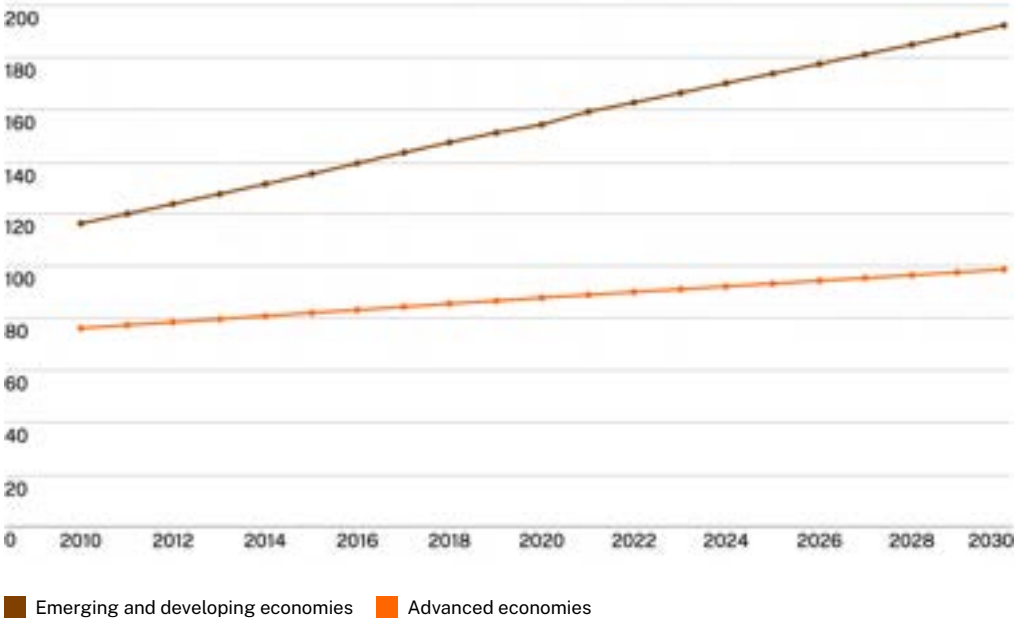
Source: Textile Exchange

France, long associated with high fashion, is at the forefront of policy innovation to tackle the textile-waste problem. Key initiatives there include anti-waste legislation that prohibits the destruction of unsold textiles and promotes re-use, stricter environmental labelling requirements and a proposed advertising ban and surcharge on ultra-cheap garments. It is too early to know how successful these efforts will be at curbing the wasteful fast-fashion trend, but one country is trying, at least.

Buildings are another example where government policy is stuck in neutral, so that far too little progress is being made in cleaning them up. In the Dubai declaration that we mentioned earlier, governments committed themselves to doubling the rate at which the energy efficiency of buildings is improving, but they have not come anywhere close to achieving this. With just a few more years of delay, that pledge will look like another bit of unserious hypocrisy. Meanwhile, the number of buildings constructed in the world continues to grow at a steady pace, with two-thirds of them built in developing countries where construction standards are often weak. Investments in making buildings more energy-efficient need to rise sharply, but the International Energy Agency actually forecasts a decline in 2025.

Figure 27: Building the future

Cumulative floor space, in billions of square metres



In the advanced economies, new buildings are being added to the existing stock only slowly. The pace of growth is much faster in the developing world, so minimising energy use in those new buildings is a critical issue. Note that Generation has interpolated values for 2023 until 2029 by assuming a linear progression toward the 2030 IEA projection.

Source: IEA

The best policy tools are strong building codes, to ensure that newly constructed buildings use as little energy as possible, as well as performance standards for existing buildings, to require retrofits that drive down their emissions. The construction and real estate industries have fought these vociferously, unwilling to trade modest cost increases for themselves in the short run with large savings for consumers in the long run. Time after time, even in Europe, tough rules have been proposed and then watered down. Moreover, the effort to improve the world's buildings is starting to run into a major headwind: the housing affordability crisis that seems to be spreading worldwide. California, long one of the world's leaders in building efficiency, just passed a law freezing any new requirements on residential buildings for three years, out of concern that the energy standards were driving up costs.[14]

A fundamental tenet of the energy transition is that the burning of fossil gas in buildings needs to stop. A primary way to achieve this is to replace gas-powered boilers with heat pumps, which are essentially two-way air conditioners that can both heat and cool a building. Sales of heat pumps got a worldwide boost as the Ukraine war drove up the relative cost of fossil gas, but that factor has abated. With gas being more economically competitive, and with a slowdown in new construction, heat pump sales dropped 21 percent in Europe in 2024. However, the United States was still making headway last year, with heat pump sales up 15 percent.[15] This is, however,

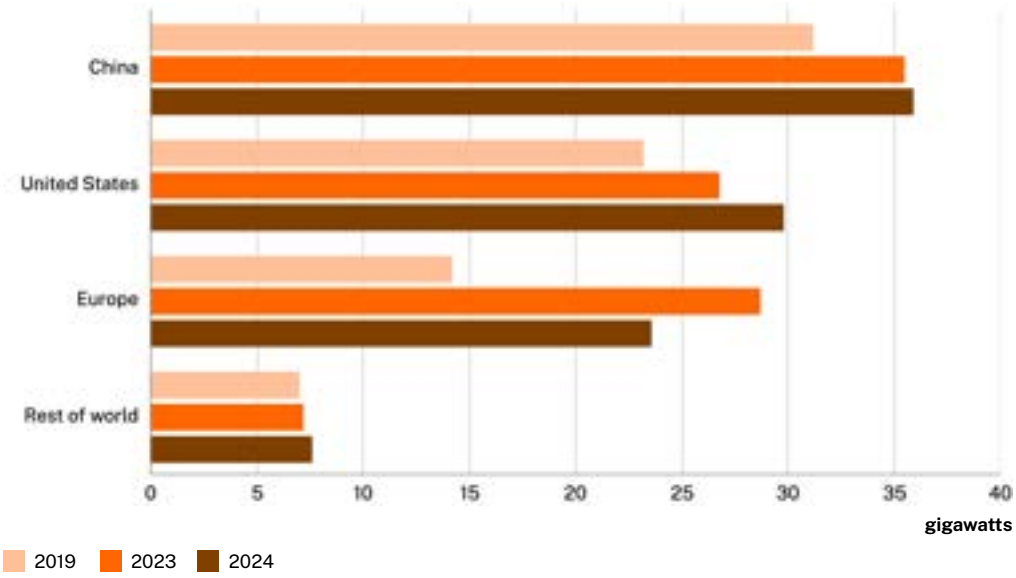
14. Takemura, Alison F., "California halts building code updates in a blow to electrification." Canary Media, 4 August 2025.

15. International Energy Agency, "Global energy review 2025." March 2025. Some readers may note an apparent discrepancy between our chart of heat pump sales and the figures cited in the text, but they are reporting slightly different metrics. The text is reporting percentage changes in unit sales, while the graph is reporting changes in installed capacity.

another market where we could see erosion as a result of Donald Trump's policies. He is cutting federal tax credits that had encouraged Americans to adopt heat pumps.

Figure 28: Heat pump sales

Heat pump sales in gigawatts of capacity



Sales of electric heat pumps got a huge boost from the high gas prices that accompanied the war in Ukraine, but have since fallen a bit. Shifting from gas to electric heat is one of the fundamental strategies of the energy transition.

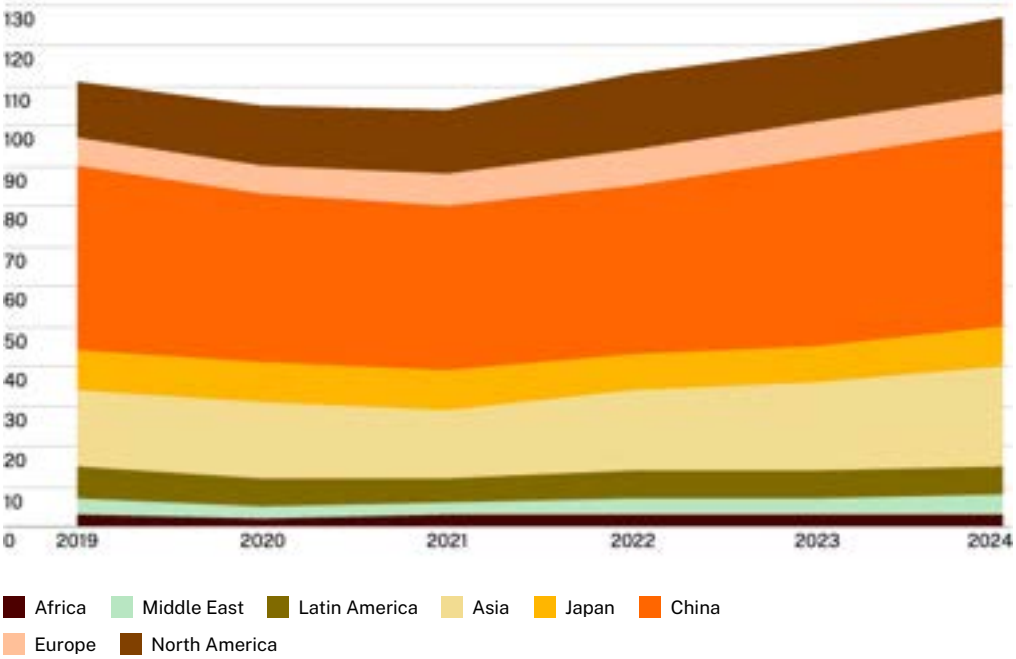
Source: IEA

Another important policy tool is strict efficiency standards for the devices that go into buildings, such as appliances. Huge gains have been made in improving the efficiency of refrigerators, for example. And the improvement in lights, with the transition from energy-wasting incandescent bulbs to modern fixtures based on light-emitting diodes, or LEDs, has cut the power use for lighting by as much as 80 percent.[16] It is one of the greatest success stories of the energy transition. Yet again, Donald Trump is undoing some of the American policies that had led to progress on this front, but other countries are moving forward. We hope to see worldwide market pressure to continue making appliances more efficient.

16. The comparison is to traditional incandescent bulbs. For example, a standard 60-watt incandescent bulb can usually be replaced by an LED bulb drawing 12 watts, for an energy saving of 80 percent. Because light-emitting diodes convert more of the electricity into light and less into heat, the light output will be approximately the same, while the production of waste heat will be far lower.

Figure 29: Life in the greenhouse

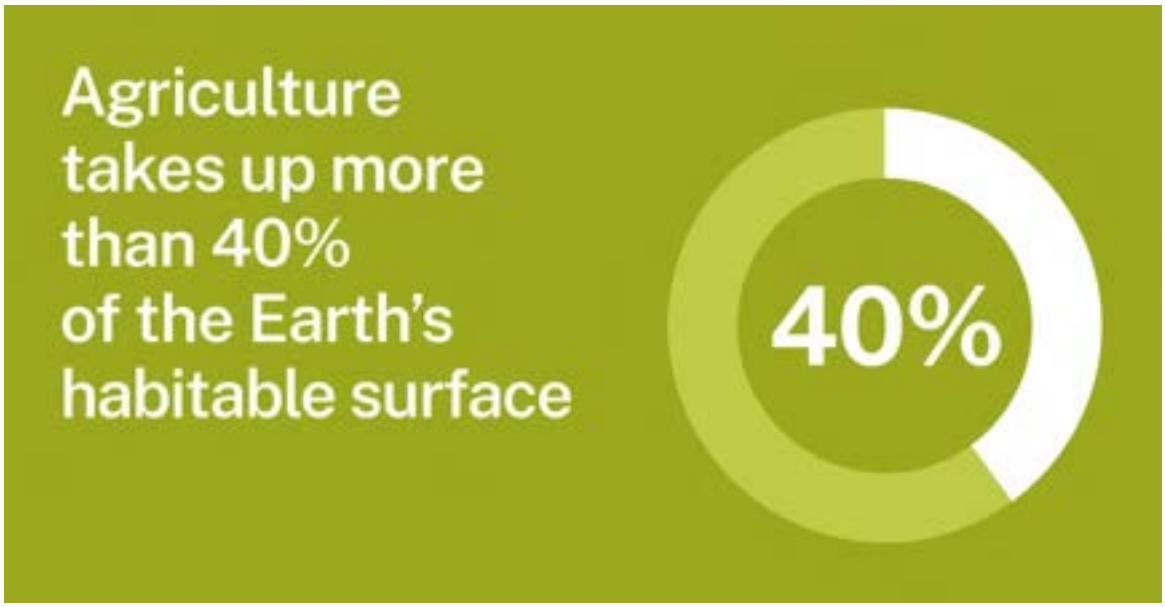
Million units sold



Sales of air conditioners are rising worldwide as the climate gets hotter — leading to higher electricity consumption, which makes the planet hotter still.

Source: JRAIA

05
People, Land & Food



The double imperative of feeding ourselves and saving nature

The single most damaging thing humanity has done to planet Earth is to commit the simple act of feeding ourselves.

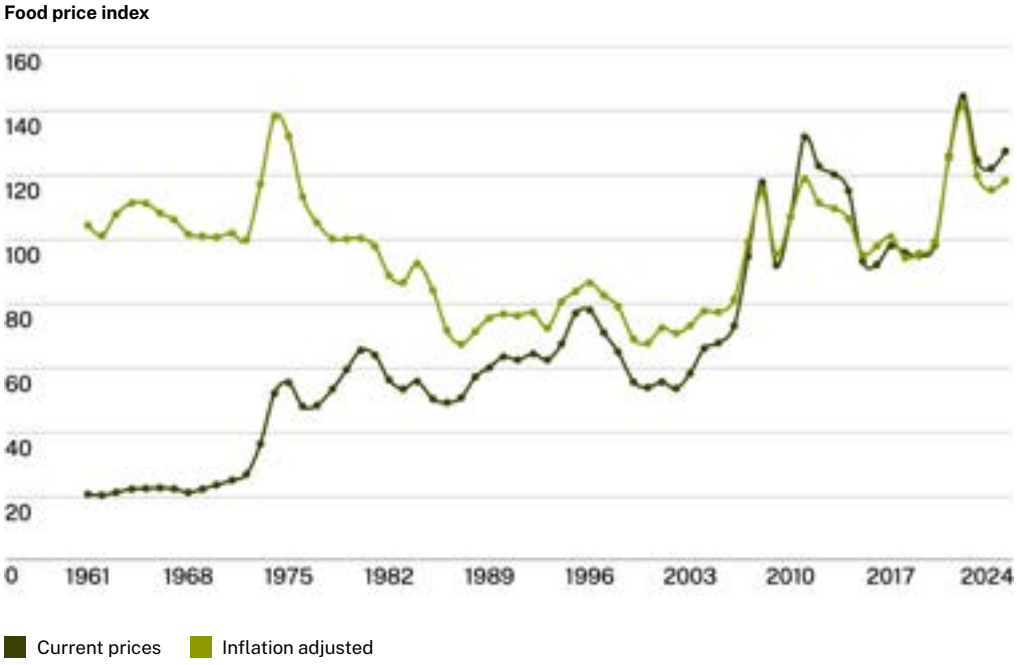
Humans have essentially evicted nature from more than 40 percent of the habitable land on the planet, and taken it over for growing food.[1] We have chopped down or burned forests to convert them to farmland, throwing immense amounts of carbon dioxide, the primary greenhouse gas, into the air. At least a third of the excess CO_2 now in the atmosphere came, historically, from human changes to the land.[2]

And after all that damage, we are not really doing a very good job of feeding everyone. Global hunger declined slowly for several decades, but then jumped as a result of the pandemic, the Ukraine war and the resulting run-up in global grain prices. Crop failures, driven by the increase in heatwaves and other weather catastrophes, contributed to the price increases. We have lately turned the corner and are again making headway against hunger, but slowly.

1. This is an intentionally conservative estimate; Our World in Data puts the figure at 44 percent of the world's habitable land devoted to agriculture. Although it was published under an inaccurate headline, see Ritchie, Hannah and Max Roser, "Half of the world's habitable land is used for agriculture." 2019.

2. Schwingshackl, Clemens et al, "How land use drives CO_2 emissions around the world." Carbon Brief, 25 April 2023.

Figure 30: Food prices are high



The UN Food and Agriculture Organisation's global food price index is near record highs. The dark green line shows then-current prices, while the light green line shows prices as adjusted for inflation. Index = 100 in 2014-2016.

Source: FAO

Humanity confronts an urgent double imperative: to increase the supply of food for a global population expected to peak above 10 billion,[3] and to save what is left of wild nature even as we do so. These are not two problems: they are a single, interlocking problem. In the same way that people now speak of an energy transition to guide the global push for cleaner energy, we believe the world also needs a *land transition*.

The principles of this land transition are straightforward in theory, but difficult in practice. Instead of destroying more forests, we need to go in the other direction: we need to improve our food system so much that we can begin withdrawing from agricultural land, letting some of it revert to wilderness. That implies using the rest of our farmland far more intelligently. The excesses, the waste, the pervasive inefficiencies, the overuse of chemicals in today's food system — all need to be squeezed out.

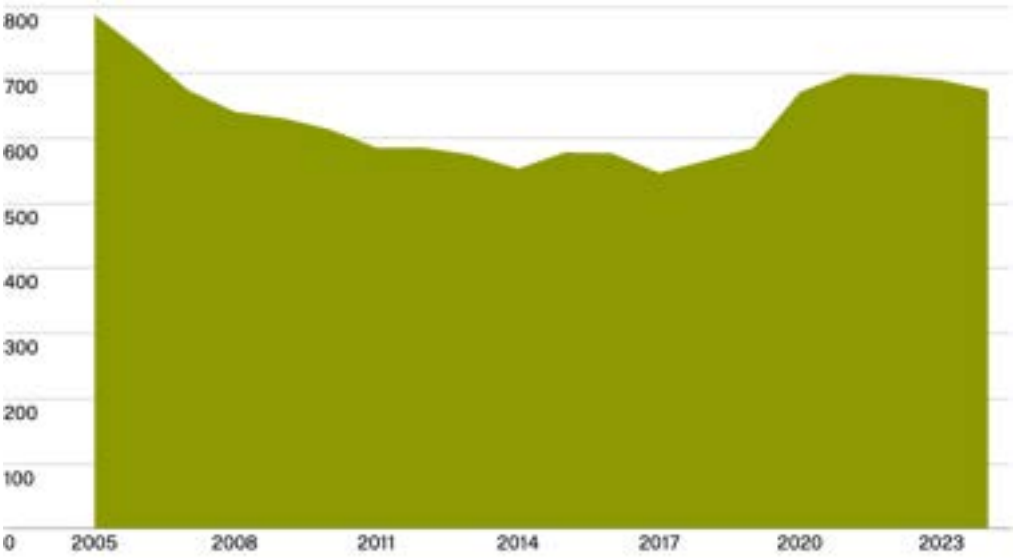
Some 2.3 billion people faced moderate to severe food insecurity in 2024 — a small decline from the previous two years, but still up by more than 600 million people from a decade earlier. A more serious measure, chronic undernourishment, stands at 673 million people, more than 8 percent of the world's population.[4]

3. The latest United Nations projection is for global population to peak at 10.3 billion in the mid-2080s, up by about two billion people from today's population, and then to begin a gradual decline. The peak has already been reached in some countries, including China, and they are declining in population, but rapid population growth continues in parts of Asia and Africa. See United Nations Department of Economic and Social Affairs, "World population prospects 2024: Ten key messages." July 2024.

4. The figures reported in this paragraph come from the flagship global publication on world hunger: Food and Agriculture Organisation of the United Nations, "The state of food security and nutrition in the world: 2025." 2025.

Figure 31: Going hungry

Total number of undernourished people, in millions



Global grain prices escalated during the pandemic and then the Ukraine war, leading to increases in world hunger. This has abated only slightly, with 121 million more people facing chronic malnourishment in 2024 than in 2014. The climate crisis is believed to be contributing to crop failures, adding to strain on the global food system.

Source: FAO

Commodity prices recently hit levels associated with the great global food crises of the mid-1970s and the late 2000s, and have not abated by much. The effects of the high prices have been felt most acutely in poor countries, where more than half of a typical household's budget can go towards buying food,[5] but the food-price inflation of recent years has also roiled politics in even the richest countries, contributing to the public dissatisfaction that has put far-right populists into power.

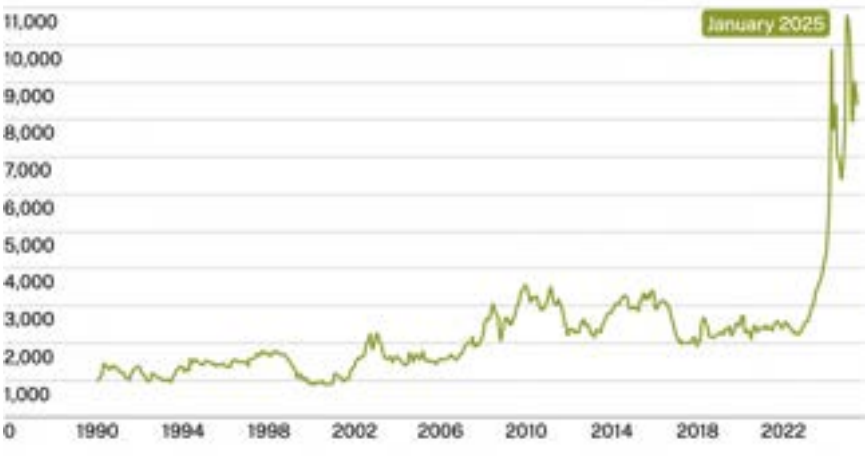
Agriculture is itself a major cause of the global climate crisis, accounting for more than 20 percent of global emissions.[6] Experts have long worried that the food system could fall victim to the very climate crisis it is helping to cause. Now, the climate situation appears to be contributing to the disruption in commodity markets. Certain highly visible crops — including high-grade coffee and the cocoa that is the main ingredient in chocolate — have seen wild price fluctuations as farmers were hit by weather disasters.

5. Ibid.

6. This is a conservative number. The Intergovernmental Panel on Climate Change estimates that the contribution from the agricultural system to the inventory of greenhouses gases lies somewhere within an uncertainty band of 21 percent to 37 percent of global emissions. Part of the reason for the wide band is that the fluxes vary by year. The estimated range includes production, animal grazing, food waste, land-use change and all other activities necessary to grow and supply food to the public. See Mbow, Cheikh et al, "Food Security," chapter 5 in "Climate change and land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems." 2019.

Figure 32: Chocolate at risk

Global price of cocoa in US dollars per metric ton

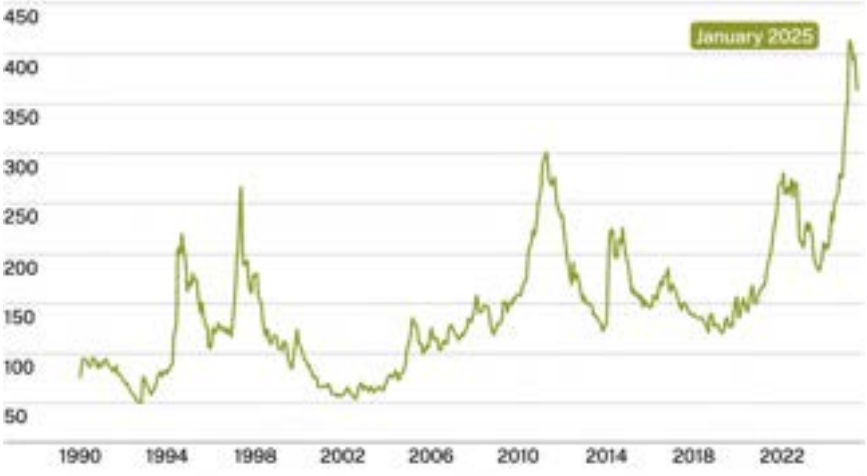


Recent crop failures have led to wild fluctuations in the price of cocoa, the essential ingredient in chocolate.

Source: FRED

Figure 33: Coffee at risk, too

Global price of coffee (US cents per pound)



The better grades of coffee come from a tropical species that is difficult to grow and sensitive to weather extremes. Like cocoa, coffee has seen wild price gyrations in recent years.

Source: FRED

More than 150 winners of the Nobel Prize and the World Food Prize warned earlier this year that governments have failed to take control of the situation. Agricultural research budgets need to be increased, they said, to secure the future food supply, but are instead being cut. "We are not on track to meet future food needs," the laureates wrote in an open letter. "Not even close."[7]

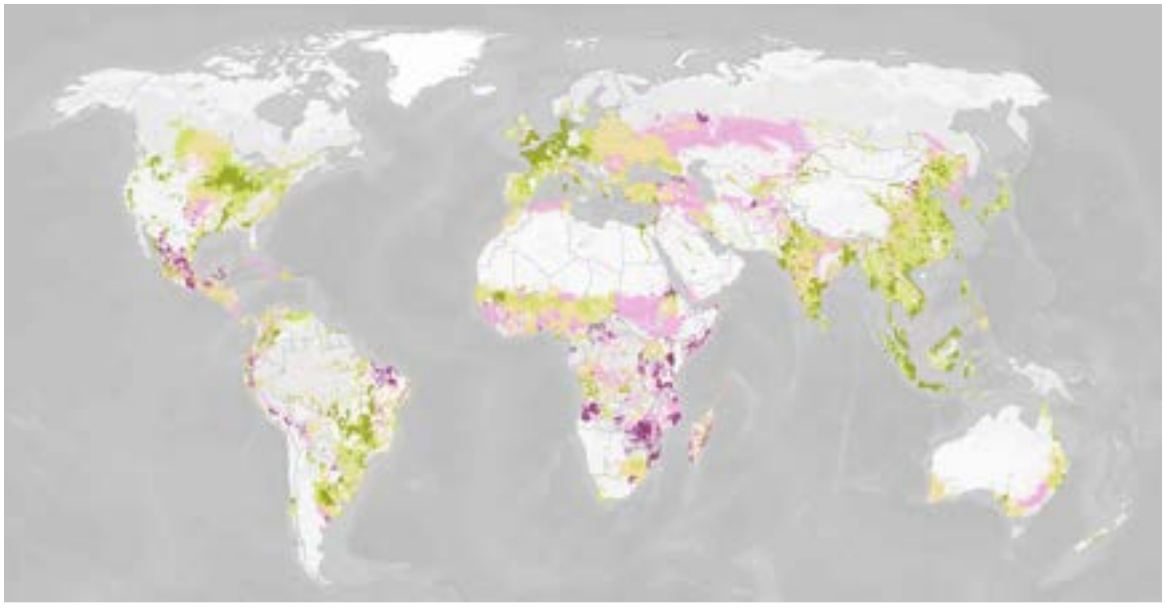
7. As this report went to press, 153 winners of the Nobel Prize and the World Food Prize had signed the public letter of warning. See World Food Prize Foundation, "More than 150 Nobel and World Food Prize laureates issue unprecedented wake-up call over hunger tipping point." Press release, January 2025.

Historically, high food prices have destabilised the governments of poor countries, or even caused them to fall. The current price run-up has not had such effects yet, perhaps because it came at a time of so many other disruptions, including the global pandemic. Yet the price gyrations may foretell worse to come as the climate deteriorates.

One way to meet future food needs in the face of a deteriorating climate would be to put more land under plough. Yet that would be exactly the wrong strategy, accelerating the destruction of nature and sending much of the world's wildlife and plant life towards extinction.

A better approach would be to close the 'yield gap,' the mediocre per-hectare agricultural production that is commonplace in many middle-and lower-income countries, compared to the high yields that are achieved in rich countries. It has been clear for decades that these yields could be increased, if poor farmers were given access to some of the basic tools of modern agriculture, like fertilisers. But governments nominally dedicated to closing the gap have a mixed track record when it comes to delivering for their farmers, and the yield gap is closing only slowly. If farmers can grow more food on less land, the effect will be to free up marginal farmlands that can be returned to nature.

Figure 34: The yield gap



The redder an area on this map, the more agriculture there is lagging. The map shows the percentage by which production in a given area, in 2010, fell below the maximum achievable yield. The most negative value is 100%, whereas a value of 0% would mean that the best possible yield was achieved in that area.w

Source: Gerber, James S., Project Drawdown, © Mapbox, © OpenStreetMap

Restoring nature to disused farmlands is called ‘rewilding,’ and it is becoming a common strategy across many parts of the world. Immense stretches of forest land have been restored. Sometimes it happens by neglect; in the United States, for example, the farms of New England had become uneconomic by the early 20th century, and were abandoned. The regrowing forests of that region are pulling enormous quantities of carbon dioxide out of the air and turning it into leaves, wood and soil carbon. Many rewilding projects are more deliberate than that, however. The United Kingdom has seen successful efforts to restore beavers, storks, sea eagles and other wild animals to the landscape, a process that always starts with restoring habitat where they can live.

Rewilding the land

Projects are under way worldwide to restore nature to disused agricultural land, a process known as ‘rewilding.’ The bird in this photo is a great white stork flying over the English countryside; after centuries of absence, a rewilding project at the Knepp Estate has helped them return to that landscape.

Source: Sagar Chitnis

The virgin forests at risk of imminent destruction are mainly in the tropics. For decades, rich countries have recognised that they ought to pay less affluent tropical countries to encourage them to save those forests, which — as long as they are standing — help to absorb industrial emissions of carbon dioxide. The funds flowing to poor countries for this purpose typically amount to a few billion dollars a year, whereas the need, according to some estimates, may

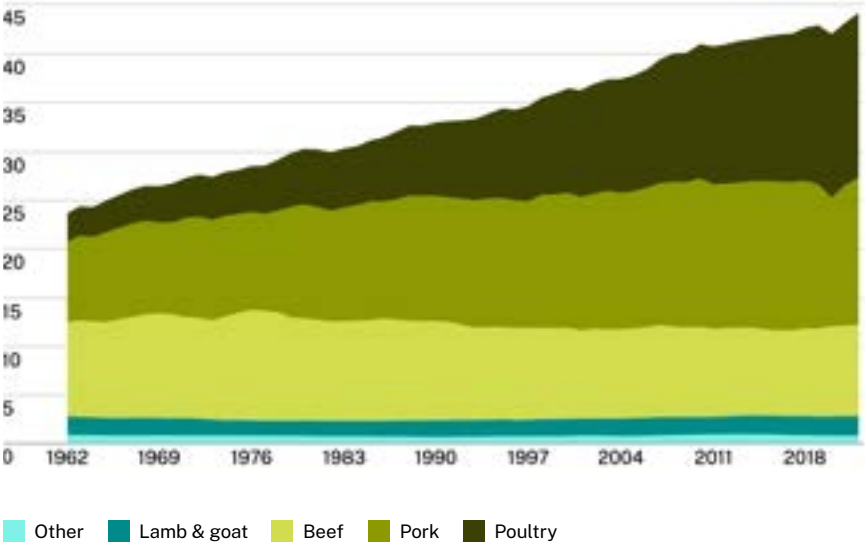
be as high as $470 billion per year.[8] Towards the end of this report, we will discuss a proposal from Brazil that might help to get this effort back on track.

For all its success, the modern food system is wasteful. At least 30 percent of the food farmers grow is never eaten.[9] In Western countries that tends to occur because consumers buy more than they need and throw it out when it spoils, or in restaurants, they may be served meals too large to eat. In poor countries, the waste tends to occur closer to the farm, often due to poor storage conditions or inadequate transport to market. The problem can be as simple as rats or insects infesting the grain.

Globally, dietary habits are also a major part of the problem. Beef and lamb are profoundly damaging to the environment, requiring far more land, food and water than other meats.[10] Diets based as much as possible on plants are not only less environmentally costly but usually healthier, too. Governments have been afraid to touch this problem, refusing even to consider policy options like meat taxes. The bright spot is that many consumers around the world are shifting away from beef and towards chicken, which can be grown more efficiently than cows.

Figure 35: Carnivorous

Kilograms of meat, per year, per person



Overall global meat consumption is rising, putting a huge strain on the food system. The good news is that consumers on average are rejecting beef in favour of chicken, which is a much more efficient meat to produce.

Source: FAO

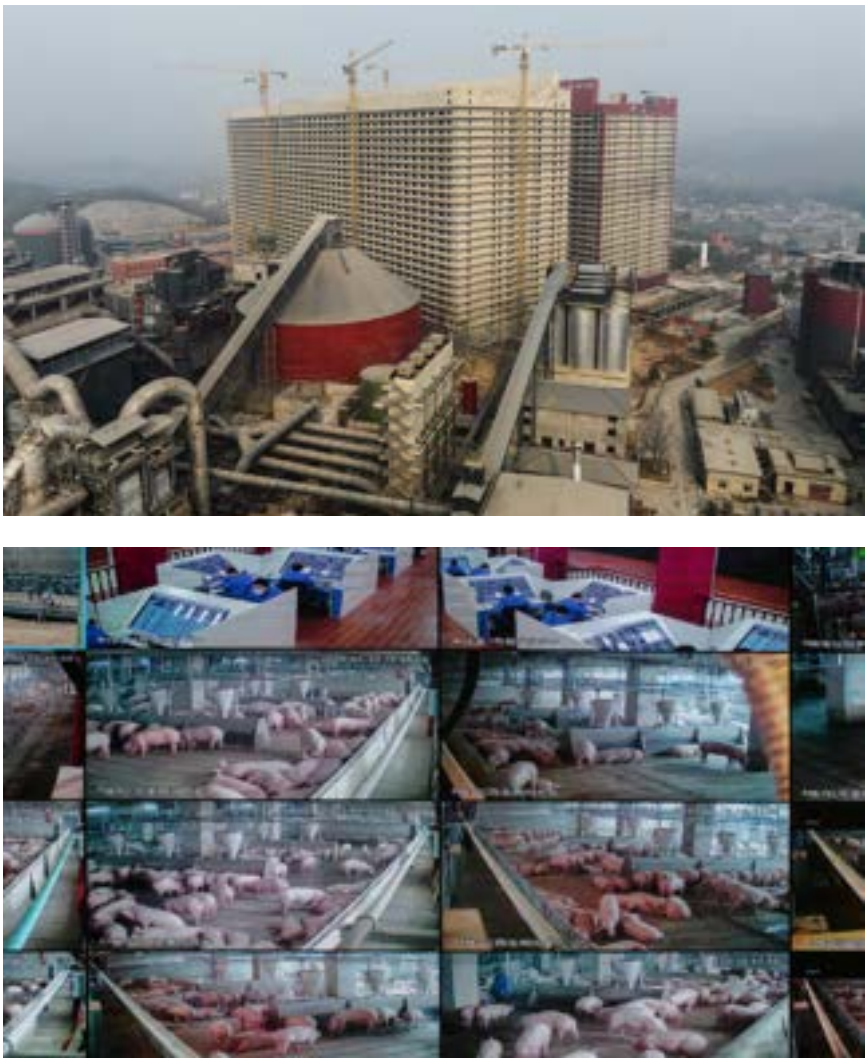
8. Economist Impact, "World still failing to fund forest protection." The Economist, 19 March 2024.

9. This is slightly conservative estimate. United Nations agencies calculate that 19 percent of food is lost at or near the consumer level, while another 13 percent is lost in the supply chain. Those figures, if correct, would mean that food waste and loss accounts for 8 to 10 percent of all greenhouse gas emissions, several times larger than the emissions from aeroplanes. See United Nations, "Food loss and waste account for 8–10% of annual global greenhouse gas emissions; cost $1 trillion annually." UN Climate Change News, 30 September 2024.

10. For a comparison of the environmental costs of producing different types of food, see Ritchie, Hannah et al, "Environmental impacts of food production." Our World in Data, 2022.

As countries get richer, overall meat demand is rising. That is a major reason for the continued destruction of tropical forests and savannahs: to turn the land into pastures for grazing or fields for the production of feed. In Brazil, for example, millions of hectares have been converted to soyabean farms, with three-quarters of the Brazilian crop shipped to China every year.[11] The Chinese, in turn, use soyabean meal to raise immense numbers of animals for slaughter — one producer there uses skyscraper-like buildings to raise more than a million hogs a year, many times the size of a 'large' hog farm in the United States.[12]

Figure 36: This is a hog farm, really



Two buildings of 26 storeys apiece near the Yangtze River in central China can produce more than a million hogs a year for sale into that country's meat market.

Source: Gilles Sabrié

11. The staggering expansion of soyabean production in Brazil is recounted in Cattelan, Alexandre José and Amélio Dall'Agnal, "The rapid soyabean growth in Brazil." *Oilseeds and Fats, Crops and Lipids*, EDP Sciences, 2019. Note that Brazil's exports to China increasingly include processed soyabean meal used for animal food and other derivative products, not just raw soyabeans. For a discussion of recent export figures, see Yin, Yeping, "China remains top destination for Brazilian soybeans with huge potential: industry insider." *Global Times*, 21 May 2025.

12. Wakabayashi, Daisuke and Claire Fu, "China's bid to improve food production? Giant towers of pigs." *The New York Times*, 8 February 2023.

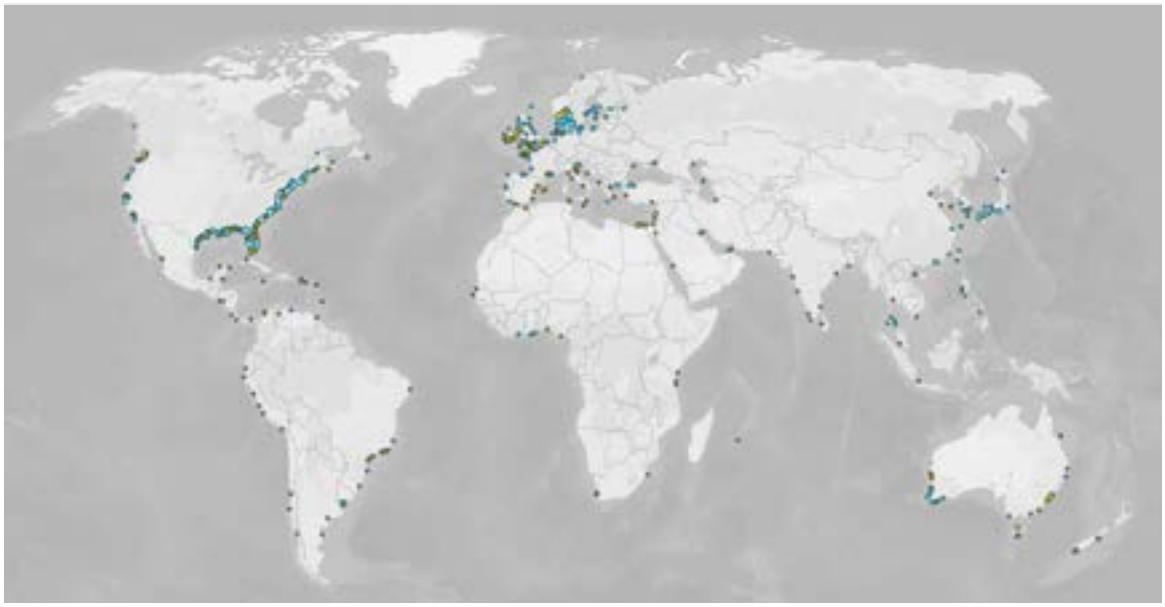
The preference for meat-eating means that much of the world's agricultural land is used to grow feed for animals, not food for humans. The intensive cultivation of maize and other feed grains is a major reason for the heavy use of nitrogen fertilisers, which have to be synthesised in factories that use immense quantities of fossil gas. Nitrogen fertiliser is not used judiciously in much of the world; it is often over-used. Usage is considered somewhat excessive in the United States, with its gigantic maize crop, but the application rates are even higher in China and India.[13]

Some of this excess fertiliser turns into a gas and enters the atmosphere, adding to the overall problem of greenhouse gases. More of it washes down rivers into coastal estuaries. There, the excess nutrients cause harmful blooms of algae; when the algae die, their decomposition consumes most of the oxygen in the water, leading to 'dead zones' depleted of sea life. The dead zone near the mouth of the Mississippi River is sometimes the size of the state of New Jersey,[14] and China also has large ones. Governments have been so hesitant about cracking down on excessive fertiliser use that virtually no progress is being made on this problem.

13. Ritchie, Hannah, "Excess fertiliser use: Which countries cause environmental damage by overapplying fertilisers?" Our World in Data, 7 September 2021.

14. National Oceanic and Atmospheric Administration, "Gulf of Mexico 'dead zone' larger than average, scientists find." 1 August 2024.

Figure 37: Killing the sea



Hypoxic area Eutrophic area

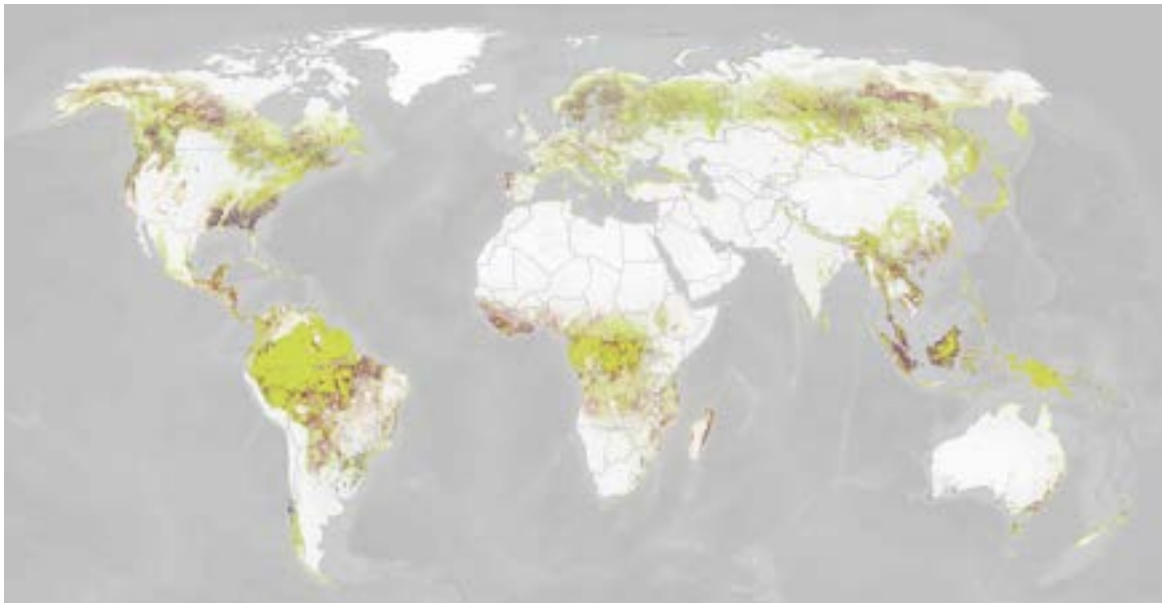
This map displays the world's coastal 'dead zones,' areas of the ocean with too little oxygen to support most forms of sea life. The dead zones, more than 700 of them worldwide, are caused by fertiliser run-off entering coastal regions at the mouths of large rivers. Eutrophic areas are those excessively enriched in nutrients, and hypoxic areas are those where the eutrophication has led to so much oxygen depletion that some creatures cannot survive in the water.

Source: World Resources Institute, © Mapbox, © OpenStreetMap

Western consumers are sometimes startled to learn that their consumption patterns can lead directly to the destruction of tropical forests. Much of the deforestation in Indonesia in recent decades — think of terrified young orangutans fleeing burning hellscapes — was carried out to grow palm oil for sale into Western markets. That ingredient is sometimes listed on labels for ice cream and lipstick as 'palmitic acid,' 'palmate' or 'palmitate.' Under heavy international pressure, the Indonesian government has made headway in slowing the rate of forest loss.[15]

15. Jong, Hans Nicholas, "Who is clearing Indonesia's forests — and why?" Mongabay, 8 August 2025.

Figure 38: Any trees left?



Destruction of forests is one of the hallmarks of the human imprint on the planet. Forests can and do recover, however, if allowed to do so. This map shows forest gain and loss over the past quarter-century.

Source: Global Forest Watch, © Mapbox, © OpenStreetMap

The hardest-fought battles over forest destruction, however, have been in Brazil. Deforestation hit a peak in Brazil in the early 2000s, then was brought down under the presidency of the liberal president Luiz Inácio Lula da Silva. It started to rise under the right-wing government of Jair Bolsonaro, but with Lula back in office since 2023, deliberate destruction of the forest appears to be falling again.[16] Suppressing deforestation in Brazil has taken tremendous political courage, and activists, journalists and prosecutors have been murdered for their involvement in the cause.

16. Butler, Rhett Ayers, "Amazon deforestation in Brazil plunges 31 percent to lowest level in nine years." Mongabay, 10 November 2024.

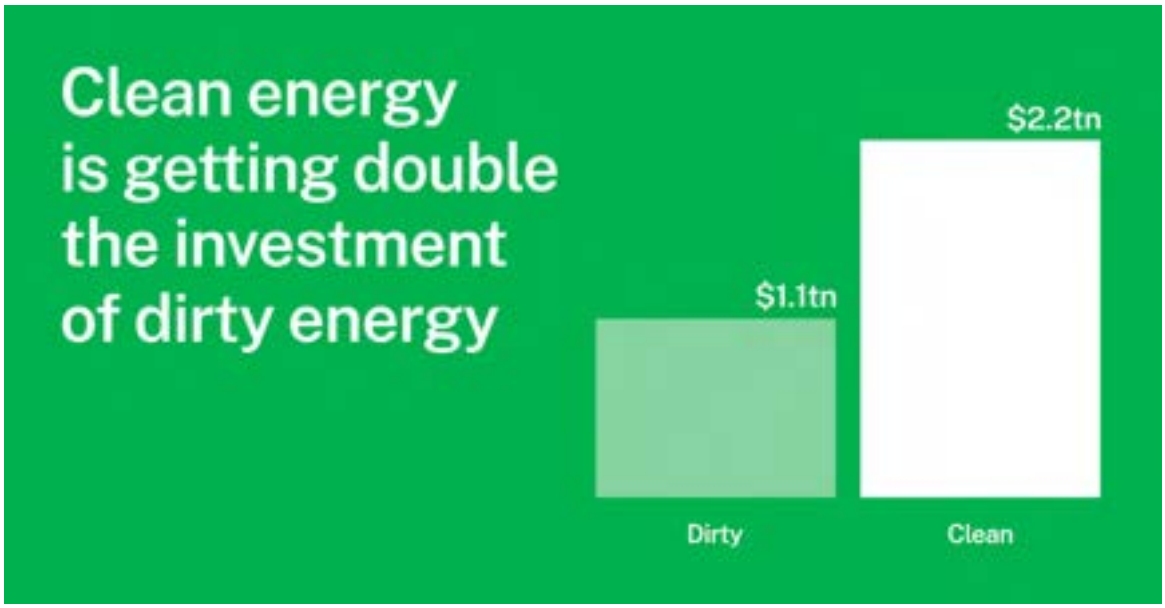
The Amazon is not saved, however. The forest has been hit in recent years by intense droughts that may have been worsened by global warming. The droughts, in turn, set the stage for immense destruction of forest lands by

fire. Last year's fire losses nearly matched the high losses of 2016. For many years, computer models of the forest have been signalling the possibility that it could essentially collapse in an overheated world, giving way to grasslands that would be biologically much poorer.

The risk of human destruction has not ended, either. An estimated 13 percent of the Amazon has already been destroyed,[17] and additional lands have been degraded. The mighty forest covers parts of nine countries, and suppression of deforestation in Brazil has pushed deforestation into neighbouring countries. How much of the Amazon can be salvaged over the coming decades remains an open question.

17. Kimbrough, Liz, "How close is the Amazon tipping point? Forest loss in the east changes the equation." Mongabay, 20 September 2022.

06 Financing the Transition



Under pressure

Public finance for the sustainability transition is coming under severe pressure from strained budgets and competing priorities, not to mention the populist revolt that is upending politics in virtually every democratic country.

The European Union has cut its proposed €10 billion Strategic Technologies for Europe Platform — designed, in part, to support low-carbon innovation — to €1.5 billion and redirected the remaining funds to defence.[1] The Scottish government has diverted £460 million from its green energy fund to meet public-sector pay demands, scrapping its intention for that money to support renewable energy.[2]

Unsurprisingly, the Trump administration, which is withdrawing the United States from the Paris Agreement on Climate Change, is also cutting funding for the transition. It has rescinded a $4 billion pledge to the Green Climate Fund,[3] one of the most important efforts to aid the transition in poor countries. Fortunately, other countries appear committed enough to the fund that they may make up for the American shortfall.

The US Environmental Protection Agency under Trump announced that it intends to claw back $20 billion in funding that was allocated in the previous administration for reducing pollution in disadvantaged communities[4] — a tragic development given the health benefits that the investments could have brought to these communities.

At the 29th Conference of the Parties to the United Nations Framework Convention on Climate Change, in Baku late last year, the strained budgets of the rich countries contributed to a tense negotiation. A group of the least

1. European Parliament, "Deal on STEP: Supporting EU Competitiveness and Resilience in Strategic Sectors." Press release, 7 February 2024.

2. Harvey, Fiona, "Scottish government raids £460 million green energy fund for public sector pay rises." The Guardian, 3 September 2024.

3. Gabbatiss, Josh, "Analysis: Nearly a tenth of global climate finance threatened by Trump aid cuts." Carbon Brief, 10 March 2025.

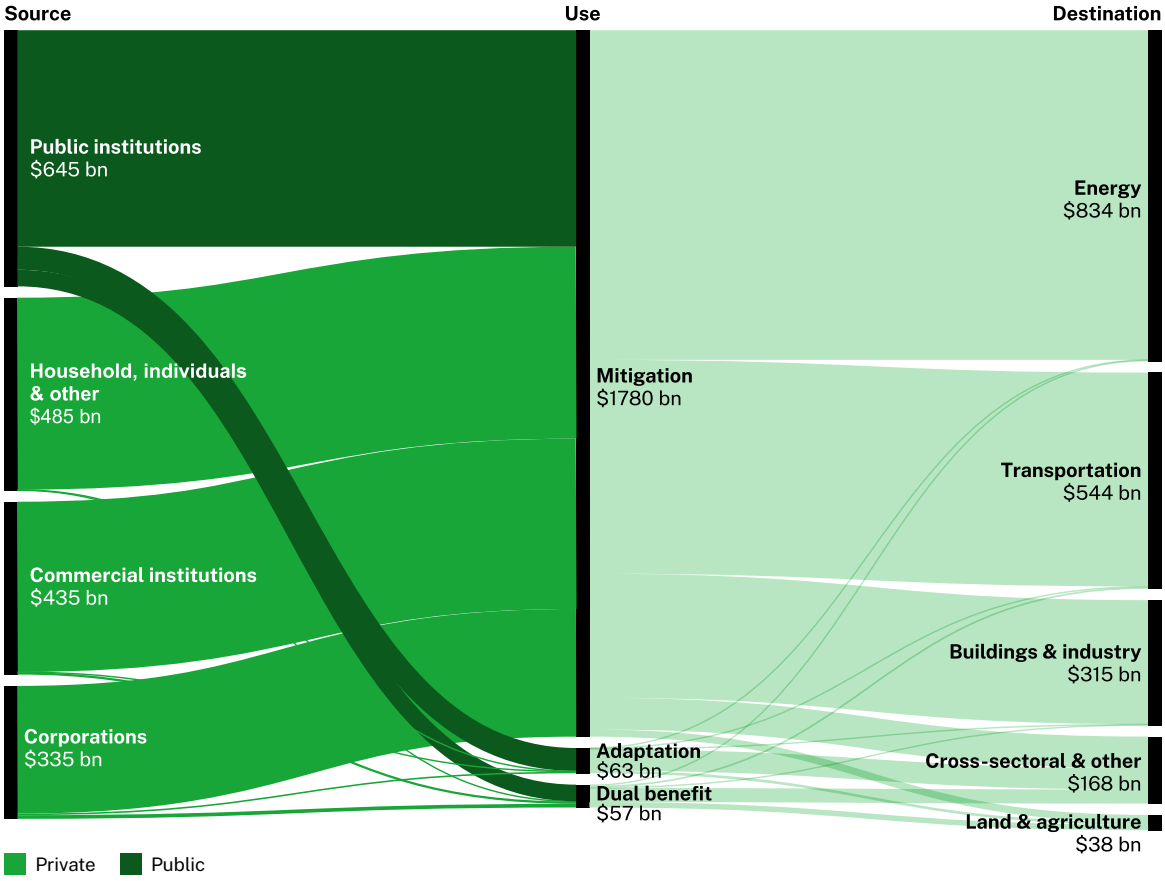
4. Volcovici, Valerie, "EPA chief seeks to claw back $20 billion in climate funding." Reuters, 13 February 2025.

developed countries, who have long argued that they need more help to cope with the climate crisis, walked out in protest at one point. Eventually, negotiators agreed that developed countries would channel a rising annual sum to developing countries, reaching $300 billion a year by 2035.[5] Many developing countries still regard the deal as inadequate, and are doubtful that even that sum will be delivered; thus, continuing tensions over finance are likely at the next Conference of the Parties, late this year in Belém, Brazil.

5. United Nations, "COP29 UN climate conference agrees to triple finance to developing countries, protecting lives and livelihoods." UNFCCC News, 24 November 2024.

Figure 39: Climate finance flows

In US dollars



This diagram shows the origin and disposition of climate finance in 2023, the latest year with full data, as estimated by the Climate Policy Initiative. The left panel shows the parties putting money into climate-related finance, the middle section describes the use of the money and the right shows the receiving sectors.

Source: Adapted from Climate Policy Initiative

In the climate struggle, public finance is particularly important because it has the potential to catalyse deals where private financiers are willing to participate but unwilling or unable to bear the entire risk. In addition to the new $300 billion goal, a commitment was made to deliver a 'Baku-to-Belém Roadmap' at the forthcoming conference on how to scale up total finance volumes, both public and private, across all sources to $1.3 trillion by 2035.[6]

6. United Nations, "Message to parties and observers: Baku to Belém roadmap to $1.3 trillion, notification to parties and observers." UNFCCC Secretariat, 21 February 2025.

The roadmap is expected to cover five strategic priorities, the first of which is the reform of large global development banks, such as the World Bank, with the aim of freeing up additional climate capital and reducing bureaucracy. Such reforms are thought to have the potential to significantly increase supplies of the most important types of finance that can catalyse further pools of capital.

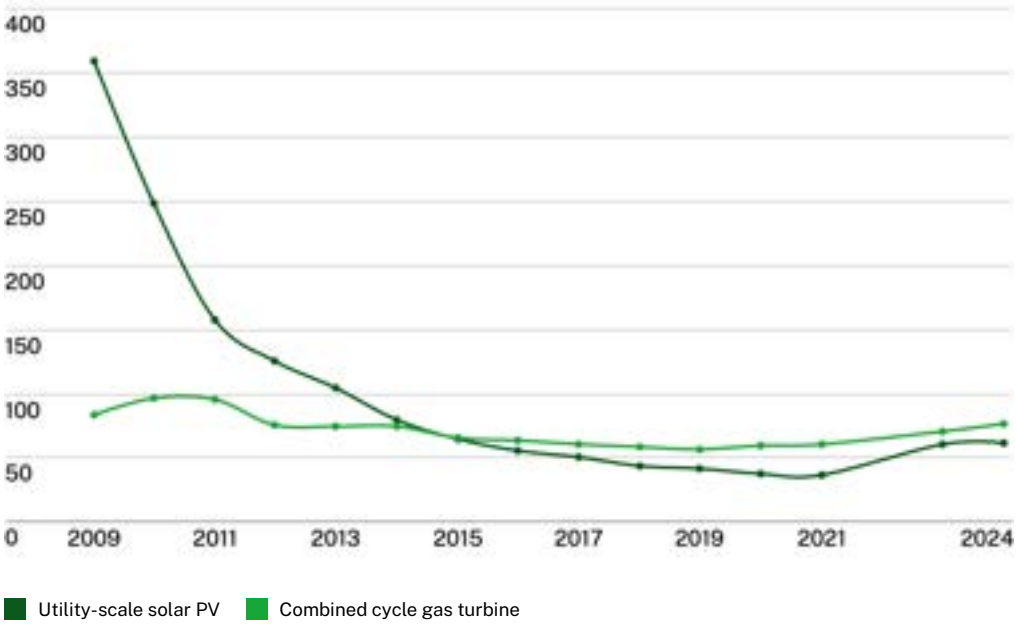
A climate finance-focused think-tank, the Climate Policy Initiative, estimates that total flows to climate change mitigation and adaptation have been roughly half public and half private historically.[7] This is now shifting as growth in private finance outstrips public, largely driven by the increasing cost competitiveness of clean technologies versus fossil. For example, the cost of one unit of electricity from utility scale solar has plummeted almost 85 percent since 2009, whereas the cost of an equivalent unit of electricity produced by a gas turbine was less than 10 percent lower in 2024 than it was in 2009.[8]

7. Climate Policy Initiative, "Global landscape of climate finance 2025." 2025.

8. Lazard, "Levelised cost of energy+." June 2024

Figure 40: Cost competitiveness

Levelised cost of energy, dollars per megawatt-hour



The declining cost of large-scale photovoltaic arrays has made solar power highly competitive with gas as a source of new electrical generation.

Source: Lazard

Despite the overall increase in private finance, we have yet to see any real solution to one of the biggest issues of the climate transition: the concentration of financial flows in Europe, the United States and China. These regions mobilised more than 75 percent of total climate finance in recent years, and the concentration has been increasing over time. The International

Energy Agency estimates that developing countries will receive 18 percent of the world's investment in clean energy sources in 2025, but 44 percent of its investment in fossil fuels.[9]

Whilst greater public finance can help redress this imbalance, the biggest barrier to investment in developing countries is often a perception of risk that does not always match reality. Emerging markets often face a much higher cost of capital even after risk measures like credit ratings are taken into account. The perception gap has developed from multiple factors: volatility in currency exchange rates, fears of political instability, historical market performance and others.

Much work is being undertaken to address the gap: for example, the global development banks have started to publish decades' worth of data on default frequencies and recovery rates in emerging markets. This information enables the broader market to more accurately price risk based on real-world data and reduce the potential influence of sentiment. In other areas, smart guarantee mechanisms are being put in place to give project developers and lenders confidence that currency or default losses will be covered in the event that risks materialise; these guarantees can unlock up to 10 times their value in private funding, but tend to be relatively small.[10] Scaling up these mechanisms is imperative if we are going to meet the volumes of finance required to prevent runaway climate change.

Elsewhere in the world of finance, some governments have been stalling on tighter financial rules relating to climate risk and disclosure. The United States, for instance, has sought to undermine climate rules for banks enforced by a global supervisory committee in Basel, Switzerland. And the securities regulator in the United States is backing away from rules adopted by the previous administration that would have required a modest level of climate-risk disclosure from companies listed on American exchanges.

In the EU, recently adopted regulations on sustainable business and finance are under attack as financial institutions and regulators realise the full administrative burden that some of the regulations entail. Simplification and streamlining of disclosure standards has become the rallying cry in Brussels. To meet these demands, the European Commission has proposed legislation that would roll back some of the regulatory requirements. Already, certain disclosure regulations have been pushed back, smaller companies exempted and requirements reduced.

A global consensus about the way forward may be emerging, however. At the time of writing, 36 jurisdictions around the world were adopting, or preparing to adopt, disclosure and auditing standards created by the International Sustainability Standards Board.[11] If this global alignment goes forward, that could reduce the reporting burden for companies that operate across jurisdictions, who might otherwise be subjected to conflicting or duplicative disclosure rules. In another hopeful move, the same body is expected to

9. International Energy Agency, 16 June 2025: World energy investment 2025 datafile.

10. Climate Policy Initiative, "Landscape of guarantees for climate finance in EMDES." 2023.

11. IFRS Foundation, "IFRS foundation publishes jurisdictional profiles providing transparency and evidencing progress towards adoption of ISSB standards." 2025.

embed material corporate impacts and dependencies on nature into its disclosure framework. This would mark a critical evolution in global reporting norms, reinforcing the idea that long-term economic value is linked to the preservation of nature.

Away from disclosure standards, investor support for shareholder proposals on climate and sustainability issues has dropped sharply.[12] In the United States, the Trump administration has adopted rules making it more difficult for investors, including professional asset managers, to pressure companies on their sustainability commitments. However, those investors who understand that fiduciary duty means considering issues relevant to the long-term health of a business or portfolio, and that climate change is such an issue, are pressing on. Some forward-thinking asset owners have even gone a step further by using sophisticated techniques informed by top climate science institutions to help guide their investment decisions.

12. White, Alexandra, "US shareholders fail to pass any green proposals for first time in 6 years." *Financial Times*, 1 September 2025.

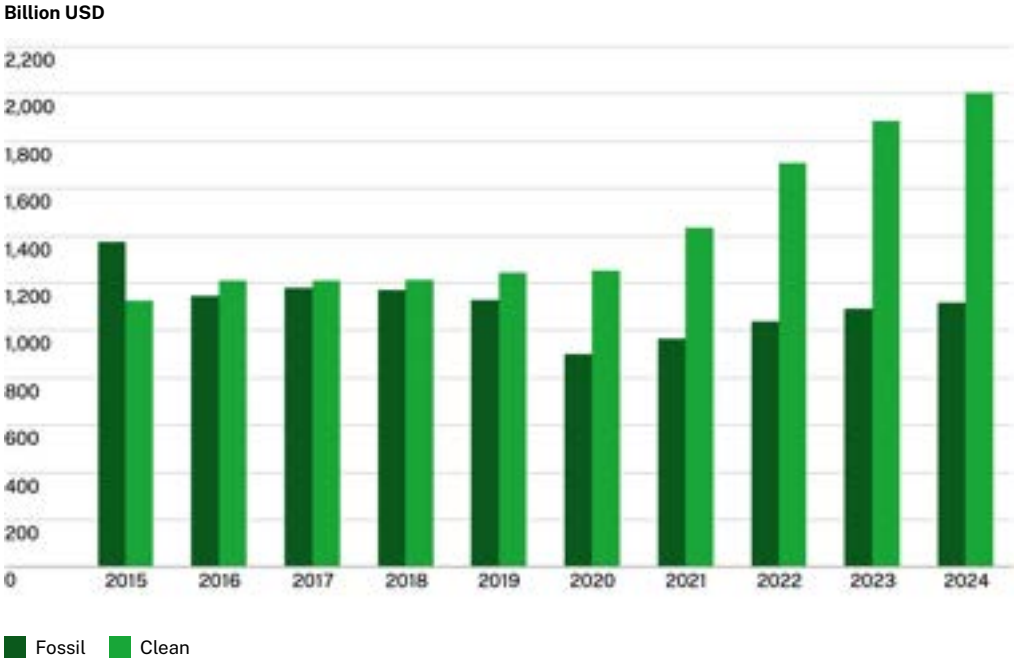
Over the past year, some banks and insurers have back-pedalled on climate commitments they made at the big Glasgow climate summit in 2021. Bank financing for fossil fuels rose in 2024, after having fallen the previous two years.[13] It remains to be seen whether this is the beginning of a broader trend.

13. Banking on Climate Chaos Coalition, "Banking on climate chaos: fossil fuel finance report 2025." Rainforest Action Network, BankTrack, Indigenous Environmental Network, Oil Change International, Reclaim Finance, Sierra Club and Urgewald. June 2025.

The insurance industry stands at the forefront of climate change. Its window of insurability is narrowing as extreme weather events grow in both frequency and severity. In parts of the United States, private insurers are withdrawing entirely, as escalating wildfires and hurricanes render some regions effectively uninsurable — leaving state programmes to fill the gap where possible. Financial innovations, such as parametric insurance (which pays out quickly once an observable trigger is met, e.g., rainfall above a set threshold), offer partial relief. Yet, the only sustainable path forward lies in decisive action to halt climate change as well as climate adaptation measures. Today just 7 percent of total climate finance is directed towards adaptation.[14] This imbalance must be corrected urgently, as what were once considered extreme events are fast becoming the new normal. Nature-based solutions, which can abate emissions as well as improve crop resilience, cool cities or reduce flood risks, may offer a scalable route to both mitigation and adaptation simultaneously.

14. Climate Policy Initiative, "Global landscape of climate finance 2025." 2025.

Figure 41: Clean tops dirty



Spending on clean-energy technologies is now double the spending on dirty energy — a sea change from a decade ago. But clean spending will need to double again, and quickly, if the world's climate goals are to be met.

Source: IEA

Notwithstanding the political headwinds in some jurisdictions, financial flows continue to shift away from dirty energy and towards clean energy. The International Energy Agency forecasts, for instance, that $2.2 trillion will be spent to develop clean energy this year, compared to $1.1 trillion that is likely to be invested in extracting fossil fuels.[15] This is still more fossil expenditure than needed if the world's climate goals are to be met, and it is less than half the spending on clean energy that will be needed by 2030, just a few short years away.[16] But we are, at least, still headed in the right direction.

Giving us confidence in this direction is one huge area of opportunity: countries with high power prices where renewables have barely taken off. Building renewables in these markets can be highly profitable. In fact, some of the most successful infrastructure funds of the last decade have found their success by being renewable energy first-movers in these regions.[17] Furthermore, while investment in advanced economies needs to double by 2035, investment volumes in the rest of the world need to increase by a factor of more than six, indicating plenty more runway for these capital flows.[18]

15. International Energy Agency, "World energy investment 2025." 5 June 2025.

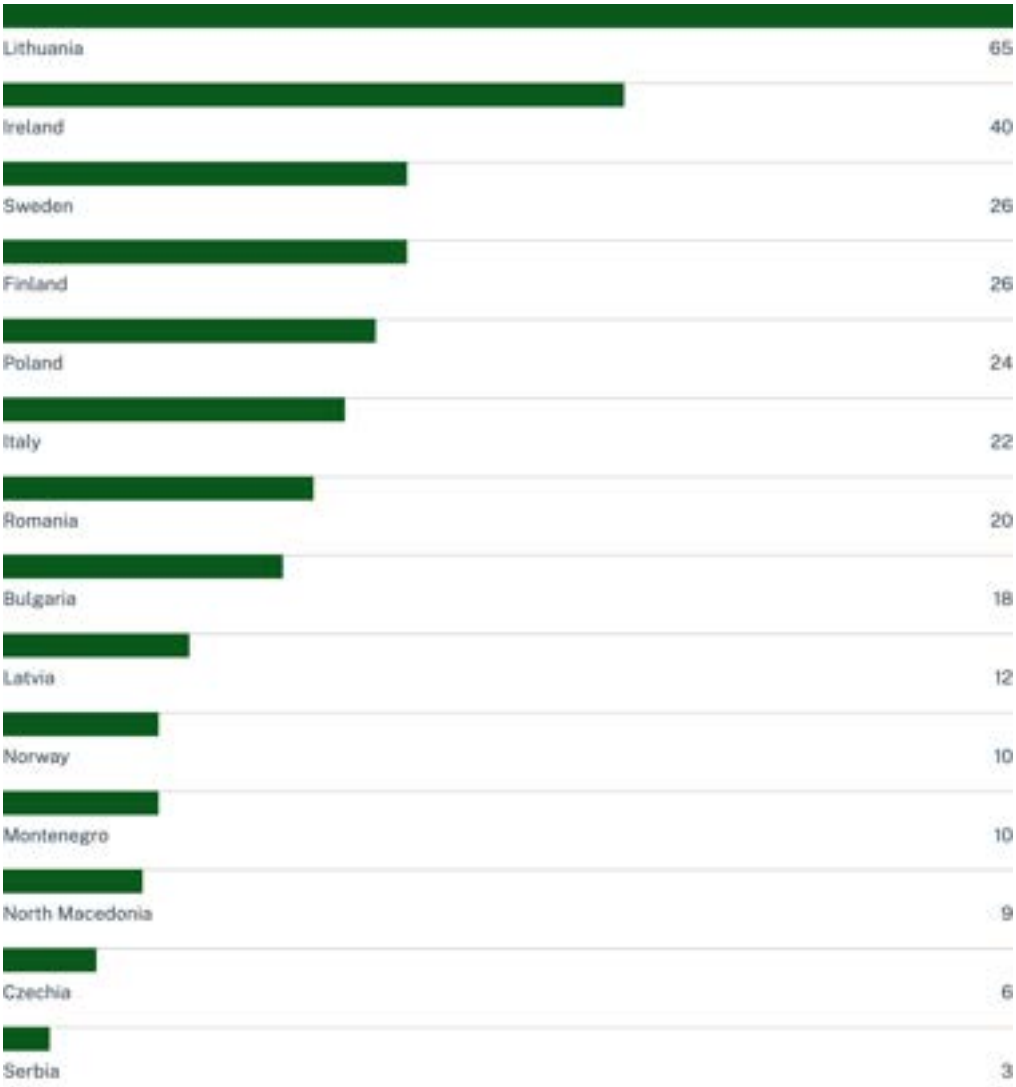
16. Climate Policy Initiative, "Global landscape of climate finance 2025." 2025.

17. Liebreich, Michael, "The best markets for wind and solar are not where you think — episode 216: Daniel Calderon." Cleaning Up podcast episode, 10 July 2025.

18. International Energy Agency, "Baku to Belém roadmap to $1.3 trillion." IEASubmission to UNFCCC, 26 March 2025.

Figure 42: Renewable penetration is variable

% electricity generation from wind and solar in 2024



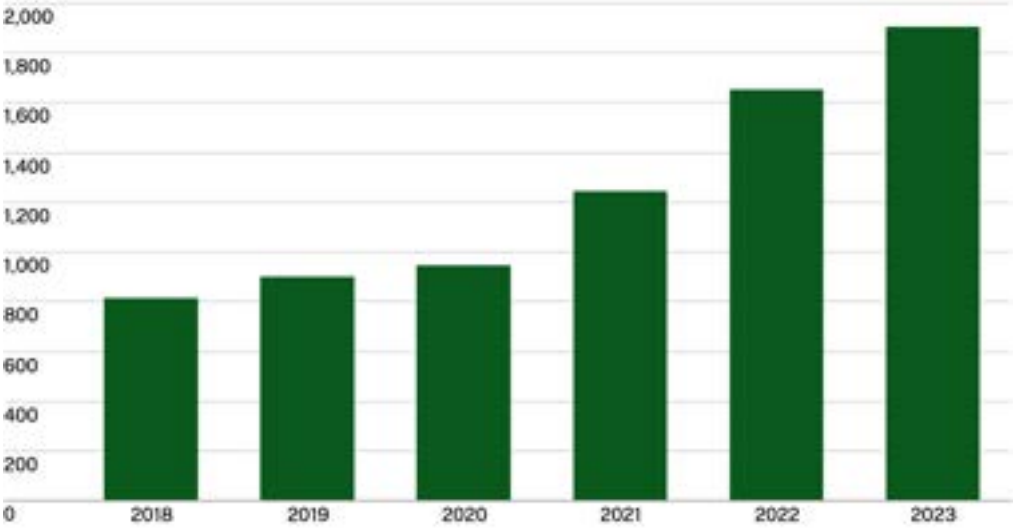
Even in Europe, some countries have only just begun to embrace wind and solar power. Several of the countries on this chart with low penetration may represent prime opportunities for developers of wind and solar farms.

Source: Ember

Despite the bleak headlines of recent months — strained budgets, regulatory back-pedalling and broken commitments — we remain optimistic for the longer term. We have seen setbacks in sustainable investing before, but it always comes back stronger. Climate finance has more than doubled in six years, private finance is starting to flow and the cost declines that are driving investment in renewable energy show no sign of abating. A few years from now, we hope and trust, this period of turbulence will have become a brief, bad memory.

Figure 43: Steady climb

Global climate finance volumes in billions of US dollars



The sums flowing to global climate finance remain inadequate to meet the world's temperature goals, but they nonetheless show a steady trend in the right direction.

Source: CPI

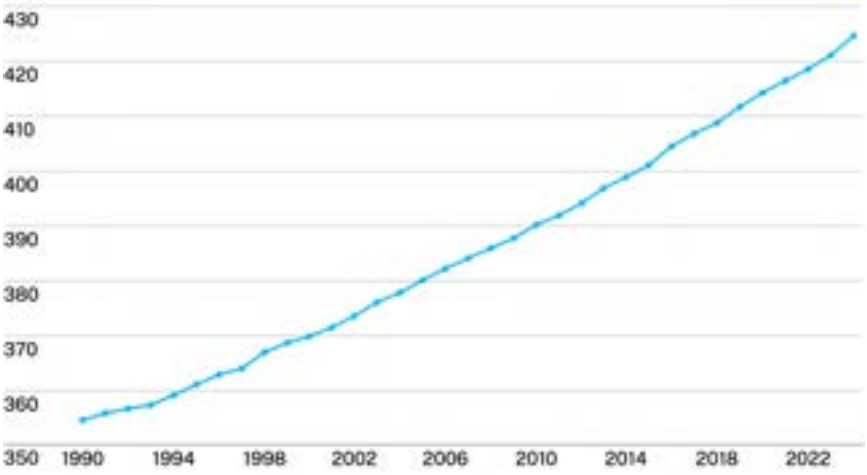
07 Looking Ahead

Getting back on track

Since the United Nations treaty designed to limit climate change went into effect in 1994, international negotiators have met 29 times, in cities all over the world, to try to achieve its goals. Below is the record of carbon dioxide in the atmosphere across those three decades.

Figure 44: The Keeling Curve

CO_2 in parts per million



This figure shows the average annual concentration of carbon dioxide in the atmosphere across three decades, as measured on the slopes of the Mauna Loa volcano in Hawaii. The relentless rise has continued despite a global climate treaty and considerable efforts to slow it down. This curve is known as the Keeling Curve after Charles David Keeling, the first scientist to make accurate measurements of carbon dioxide in the atmosphere.

Source: NOAA

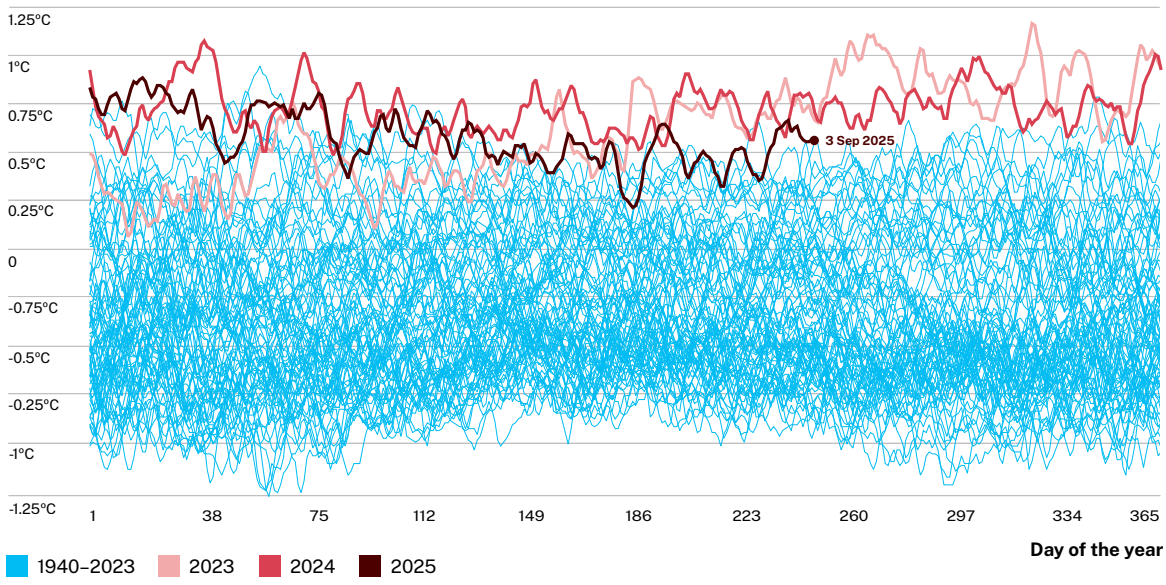
The 30th meeting will occur this November in Belém, the large Brazilian city that serves as a gateway to the Amazon River system. It is a homecoming, in a sense: the famous Earth Summit, a set of meetings that ultimately led to the adoption of the United Nations Framework Convention on Climate Change, occurred in 1992 in Rio de Janeiro. Until now, none of the negotiating sessions called into existence by that treaty had occurred in Brazil.

Most likely, the ongoing rise of carbon dioxide in the atmosphere, and the climate disasters that rise is causing, would have been even worse without these three decades of negotiations. An organisation called Climate Action Tracker has estimated that international pledges have shaved almost a full degree Celsius, or nearly two degrees Fahrenheit, off the likely rise in global temperatures.[1] Nonetheless, it is hard to look at that relentless curve of rising CO_2, known as the Keeling Curve, and see anything but failure. Politicians made a promise to young people and future generations that emissions would peak and then begin to fall, and they have yet to fulfil that promise.

1. Before the Paris Agreement was signed in late 2015, Climate Action Tracker estimated that then-current policies would lead to a catastrophic 3.6°C of warming by the end of the 21st century. By 2021, as the Paris Agreement brought forth greater ambition, countries had adopted policies sufficient to lower the estimated warming to 2.7°C, still far above the targets embodied in the agreement. The forecast has not really moved in the past four years, a measure of the way that climate ambition has stalled. See Climate Action Tracker, "Warming projections global update." November 2024.

The consequences grow more ominous by the year. The overheating of the ocean and atmosphere seem to be accelerating. Heatwaves, heavy rains, droughts and floods are all intensifying. Events are unfolding essentially as climate scientists predicted decades ago, but faster than they predicted.

Figure 45: Temperature rising



The hottest years on record have all occurred in the 21st century, as the relentless rise in greenhouse gases continues to overheat the planet.

Source: Climate Pulse

The upcoming meeting in Brazil represents a chance to start over. The meeting is to occur there at the invitation of Lula, the Brazilian president we mentioned earlier. He has offered ambitious plans to get the climate talks back on track. That includes looking for ways to ease the decades of hostility between rich and poor countries that have plagued the climate talks. Two years ago, countries pledged that they would begin to 'transition away' from fossil fuels, but have yet to devise any real plans for doing so. This is an urgent imperative, and perhaps a difficult one for the Belém talks, given that Brazil itself has been moving to develop new oil fields.[2]

One of the potential bright spots of the conference is that Lula has offered a creative proposal for a new global fund designed to save tropical forests. The proposed fund, to be known as the Tropical Forest Forever Facility, would introduce a new financial architecture to reward countries for protecting and restoring their forests. In the past, money has been offered to countries or landowners to stop them from cutting forests down, but the new plan would instead pay them for the forests they leave standing. Payments would be awarded for each hectare of maintained or increased forest cover, with

2. Petróleo Brasileiro S.A., the Brazilian national oil company, is already one of the world's top producers. Multinational oil companies also operate in Brazil, and massive discoveries are still being made there. For instance, see Moore, Malcolm and Michael Pooler, "BP makes its largest oil and gas discovery in 25 years off coast of Brazil." Financial Times, 4 August 2025.

deductions applied for forest losses. The mechanism could provide a powerful incentive for countries to halt and reverse deforestation in their territory, potentially one of the fastest and most effective ways to limit climate change.[3]

We do not know if Lula's plans will succeed. The tardiness of countries in submitting their new emissions-limiting plans, which we mentioned at the beginning of this report, is certainly an ominous sign. Rich and poor countries remain bitterly divided over money, with the poor countries arguing that they deserve far more help to cope with a problem not of their making.

Getting ready

President Luiz Inácio Lula da Silva announces new investments in public-works projects in the Brazilian city of Belém as it prepares to host the big United Nations climate conference in November.

Source: Filipe Bispo, via Alamy

We hope the Brazilian president uses his famous negotiating skills to secure a solid agreement in Belém. With luck, the decision of the United States to walk away from the talks will backfire, prompting other countries to see that it is in their interest to stick together against Donald Trump's bullying and threats. The best possible outcome would be a new determination by the rest of the world's governments to redeem the promises that an earlier generation of leaders made in Rio de Janeiro more than 30 years ago.

3. For a basic description of the forest fund and how it would work, see the concept note published by the Brazilian government: Government of Brazil, "Tropical forest forever facility: Large-scale financial incentives for tropical forest countries to conserve and increase tropical forest cover." 24 February 2025.

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Copernicus Climate Change Service

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