

The Sustainability Trends Report 2024

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Credits

“ But be ye doers of the word, and not hearers only, deceiving your own selves.”

James 1:22

Introduction

Dear Reader,

Climate promises are starting to resemble New Year’s resolutions: easy to make, hard to keep.

The worldwide push to stem the climate crisis has drawn in many of the big institutions that most need to act: not just governments but corporations of all kinds, including big banks and other institutional money managers, commodity producers, consumer products companies and many more. Even the companies digging or pumping fossil fuels out of the ground are feeling the pressure to make commitments.

We are disappointed to report that the past few years have seen a wave of backsliding on those climate commitments, however. Some of this regression has occurred in direct response to political pressure in the United States, where right-wing politicians are scoring points by attacking ‘woke capital,’ sometimes using the financial firepower of state governments to get what they want. But the bigger problem has been a lack of courage, fortitude and determination at a global scale as some of the leaders who made big promises at the climate summit in Glasgow in 2021 realise how difficult those promises will be to keep. Like New Year’s resolutions so enthusiastically made in January but forgotten by April, these commitments have lately been falling by the wayside.

We are especially disappointed by some of our colleagues in the financial services industry who took bold stances only a few years ago but are now wriggling out of their promises. Less surprising, alas, is that some of the half-hearted pledges made by oil companies have lately been abandoned. Even stalwart companies determined to act on climate are finding that cutting their emissions is hard going.

Now the biggest climate promise ever made is finally on the table: an agreement, negotiated in Dubai late last year, that committed the entire world to 'transitioning away' from fossil fuels.

Can we do it?

We *must* do it, and the real question: how fast we can go? The faster the nations of the world get moving, the sooner we can achieve net-zero emissions — the point where any remaining greenhouse gas emissions can be balanced out by removals from the atmosphere. Unfortunately, the biggest problem we confront has not gone away: the sheer power of human and economic inertia.

We offer readers the eighth edition of our Sustainability Trends Report, taking stock of the climate and environmental crises at a global scale. Last year's report was buoyed by the passage of the Inflation Reduction Act, primarily a climate law, in the United States and by European success at countering the energy crisis manufactured by Vladimir Putin. This year, we feel compelled to write in detail about the difficulties still facing the world as it tries to bring emissions down.

We have not lost heart. But every single one of us must recognise that we will be working on this problem for the rest of our lives, and at no point is it likely to be easy.

Al Gore, Chairman

David Blood, Senior Partner

Key Messages

01 Year in Focus

‘Transitioning away’ from fossil fuels has now become a formal international goal under the United Nations treaty on climate change. No detailed plans to achieve that goal have been agreed, but countries did pledge to triple the amount of renewable power on the grid by 2030 — a pledge that can be tracked as a measure of how serious their transition plans are.

02 Power

Renewable electricity is now growing rapidly, with solar energy being the breakout star, as the installation of new panels grew 74 percent in a single year. But power demand is starting to grow rapidly too: new data centres are gulping down electricity, and more electric cars and heat pumps are drawing power from the grid. It remains unclear when we will turn the corner and see electricity emissions finally begin to fall.

03 Transportation

The transition to electric cars is hitting speed bumps in some markets, with car-makers like Ford scaling back their transition plans and Volkswagen considering closing German factories for the first time. Meanwhile other countries are moving forward, especially China, where electric cars are now the economical choice and are taking half the new-car market. We have yet to see much progress in cutting emissions from planes, ships or lorries.

04 Buildings

The buildings sector is not on track for the cuts needed to meet global emissions goals. The slow progress from tougher building codes in some countries is being swamped by breakneck urbanisation and weak or non-existent building codes in many other countries. One bright spot is that heat pumps, which can run on clean power, are starting to displace gas furnaces and boilers.

05 Industry

Progress is still slow in the industrial sector, but we are beginning to see movement. Plans were announced for new low-emissions steel plants using clean hydrogen, tripling the number of such factories on the drawing board. Hydrogen is critical to the emissions-cutting plans of some other industries, and factories are finally scaling up to make the equipment required to convert clean power into hydrogen.

06 People, Land & Food

The climate crisis seems to be contributing to high food prices, which have driven up the number of hungry people in the world by an estimated 152 million in this decade. Global hunger worsened during the pandemic in 2020, and the problem has not abated. Far more work is needed to secure the food supply in an overheating climate and to encourage the spread of better farming practices. The destruction of tropical forests has abated somewhat under a new government in Brazil, but deforestation remains an urgent global problem.

07 Financing the Transition

We have finally reached the point where \$2 is being spent on clean energy for every \$1 spent expanding fossil fuels, a ratio that was closer to 1-to-1 only five years ago. But clean investment needs to climb rapidly, to \$4 trillion or \$5 trillion a year by 2030, to meet the world's climate goals. Big banks are still shovelling hundreds of billions into the development of new fossil fuels, despite their pledges to align their lending with the climate transition.

08 Looking Ahead

A fundamental tension has developed in the energy transition: governments want to use it as a core element of their industrial policy, to create new jobs in domestic factories, even as they try to move rapidly to clean energy. The two goals are in conflict, given China's nearly insurmountable head start in solar panels, electric cars, batteries and other green technologies. How this tension gets resolved will determine how fast the energy transition can proceed.

01 Year in Focus

Are we serious yet?

At last, we confront the heart of the matter.

For three decades, international climate negotiations played out as a discussion of targets, timetables and temperatures, but with surprisingly little discussion of the primary cause of the climate crisis.

Early on, the subject did come up. In the 1990s, the countries of the world agreed to a treaty aimed at limiting the damage from global warming. At the first formal negotiating session, in Berlin in 1995, a politician named John Gummer stood up. “In dealing with this complex and difficult issue, we must not be trapped into making a false choice between our children’s interest and our own shorter term interests,” declared Mr Gummer, representing Britain as its secretary of state for the environment. “Climate change and the unsustainable use of fossil fuels threaten us all — economically as well as environmentally.”¹

1. Address by Mr John Gummer, secretary of state for the environment, United Kingdom, to the first Conference of the Parties to the Framework Convention on Climate Change, 5 April 1995, Berlin.

2. John Gummer himself would go on to be ennobled as Lord Deben, and to make seminal contributions to Britain’s efforts to wean itself off fossil fuels, particularly as chairman of the Climate Change Committee, a body charged by law with advising the British government.

3. Formally, the language is a resolution of the Conference of the Parties to the Paris Agreement on Climate Change. The document “calls on Parties to contribute to the following global efforts, in a nationally determined manner,” and then enumerates a string of goals. One of them is: “Transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner, accelerating action in this critical decade, so as to achieve net zero by 2050 in keeping with the science.” United Nations, Framework Convention on Climate Change, Conference of the Parties serving as the Meeting of the Parties to the Paris Agreement, Fifth Session, United Arab Emirates, 30 November to 12 December 2023, Outcome of the First Global Stocktake, p. 5.

His words were quickly forgotten.² No explicit commitments to phase out fossil fuels were made that April in Berlin, nor in any of the 27 subsequent negotiating sessions. After all, modernity was built on fossil fuels, and for decades it was unclear how to move away from them. The temperature goals that countries adopted over the years, especially those agreed to in Paris in 2015, certainly *implied* a radical reduction in the use of fossil fuels, but that rarely became explicit.

Then, in their 28th year of negotiating, climate delegates finally crossed the Rubicon. Meeting in the United Arab Emirates, an oil-producing country, late last year, the world’s climate negotiators finally agreed to state the obvious. Under heavy pressure from environmental activists and forward-looking countries, they declared at the climate talks in Dubai that the nations of the world needed to commit themselves to begin “transitioning away from fossil fuels in energy systems” in order to limit the damage from climate change.³ It was as weak as any agreement mentioning fossil fuels could have been: language calling for a ‘phase-out’ of the fuels was rejected, and no detail about how to achieve this momentous change in the world economy was included in the text.

But still: transitioning away from fossil fuels is now a formal goal of public policy, written into international law.

What will it take to achieve that goal?

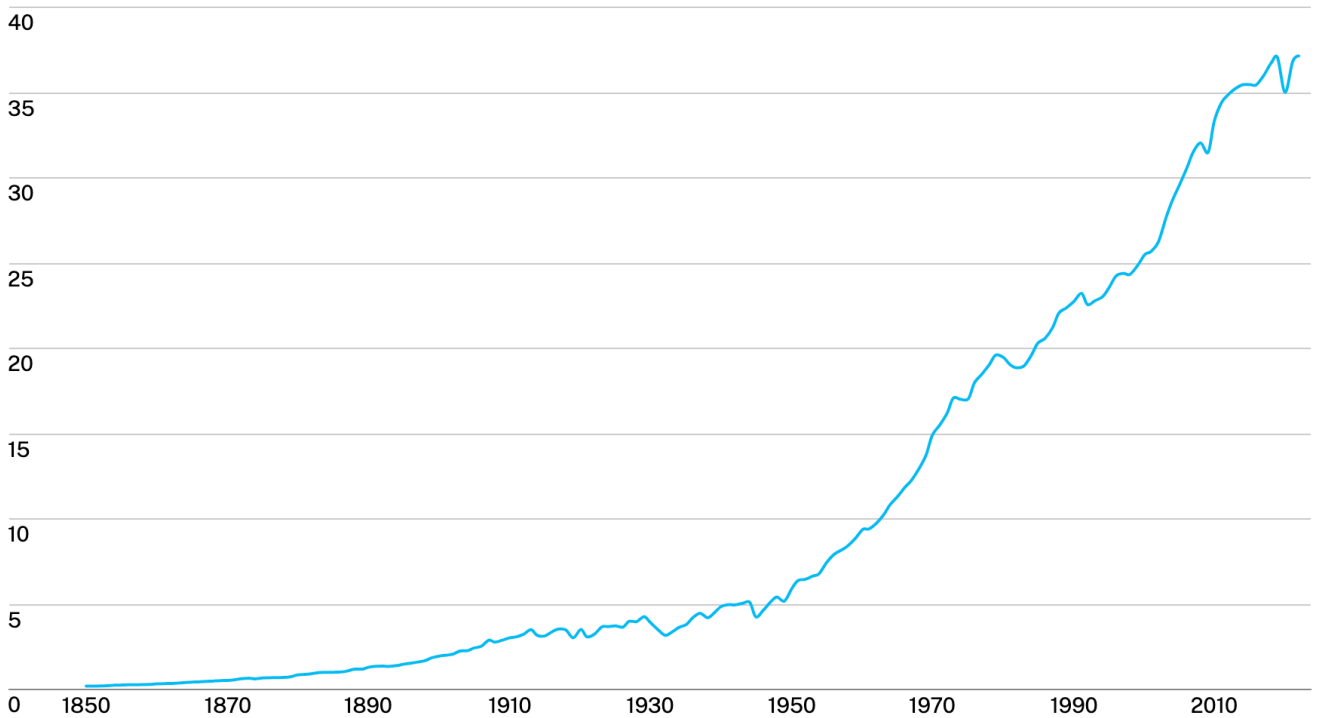
This year, our report looks forward to try to answer that question. We will examine the economy sector by sector, reporting on where the energy transition stands in each segment of the economy.

4. Global Carbon Budget, December 2023: "Fossil CO₂ Emissions at Record High in 2023."

On many levels, the task of phasing out fossil fuels seems as daunting as it ever has. Production of the three main fuels, coal, oil and gas, is at or near record highs. Emissions from the combustion of those fuels hit yet another record in 2023.⁴ Despite occasional dips during economic downturns, global emissions of greenhouse gases have yet to begin the long-term structural decline that would suggest we stand a chance of meeting the targets that countries have set for themselves.

Figure 1: Still rising

Annual CO₂ emissions, in gigatonnes

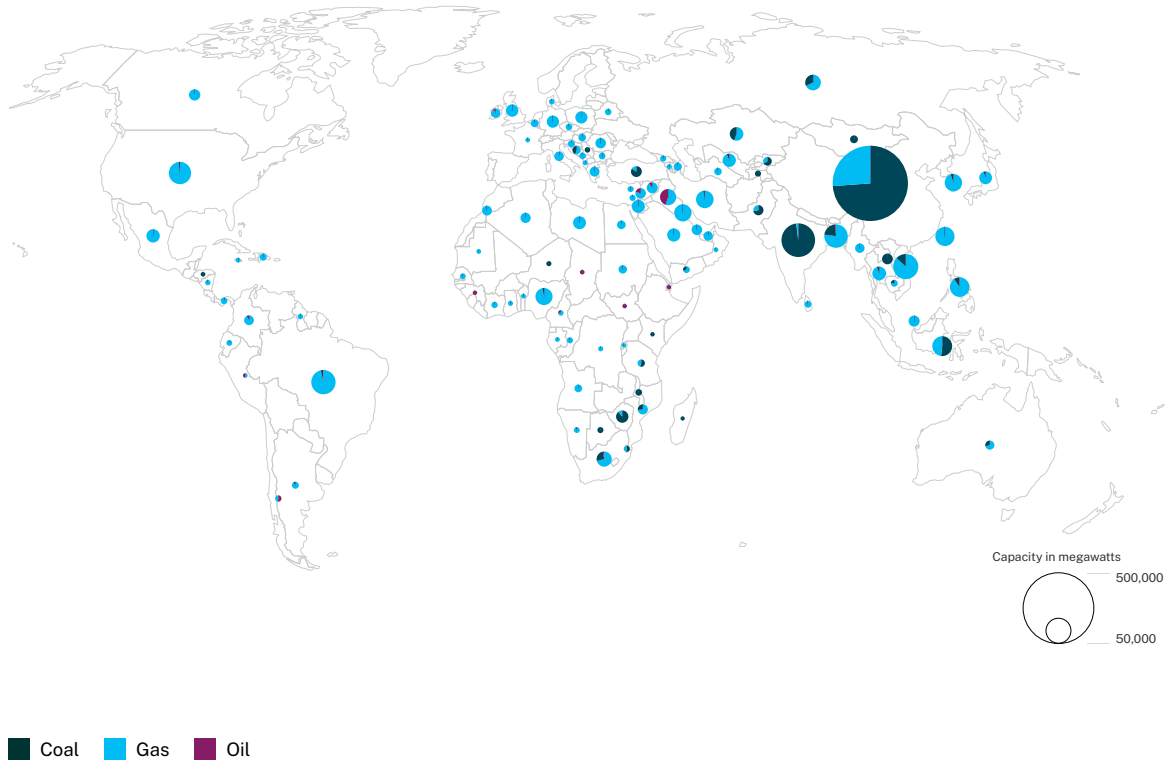


Carbon dioxide emissions from fossil fuels and industry. Land use change is not included, nor are greenhouse gases other than CO₂.

Source: Global Carbon Budget

At the Dubai meeting, the world's climate delegates may have failed to include any meaningful phase-out plans in their main agreement, but numerous countries agreed to side deals setting new goals relating to the energy transition, with some of that language rolled into the final communiqué. Those deals give us new ways to measure progress.

Figure 2: On the drawing board



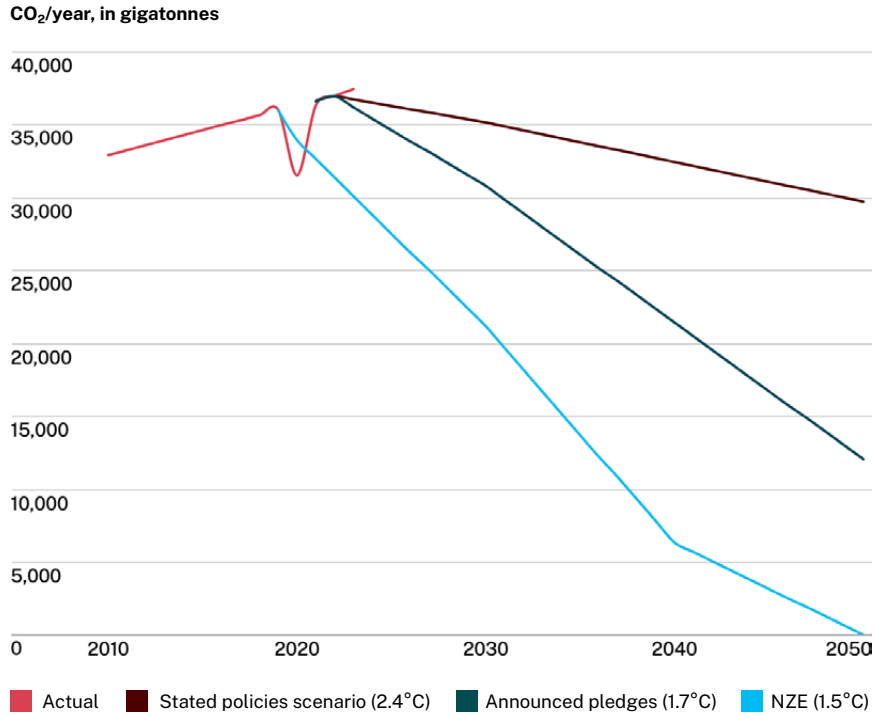
This map shows fossil-fuel power plants that are planned or under construction worldwide. Each pie chart shows the magnitude of the intended generation capacity in a particular country, and the colours indicate the fuel.

Source: Global Energy Monitor

In the most important deal, nearly 200 countries — including almost all the rich ones — agreed to triple the world’s installed base of renewable electricity by 2030, a mere six years from now. This is not a pipe dream: renewable energy is growing so fast that tripling it by 2030 looks achievable, although it will certainly take new national policies.⁵ And meeting the goal would likely mean driving huge volumes of coal and gas out of the electricity system, going a long way to clean up the world’s electric grids.

5. International Energy Agency, October 2023: “Renewables 2023: Analysis and Forecast to 2028,” Paris.

Figure 3: A daunting program



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. The Net Zero Energy, or NZE, scenario is the most ambitious, intended to limit the rise in global temperatures to 1.5°C, but the world is far off track.

Source: IEA

The reason it is so critical is that those grids are the key to the future. As electric cars displace petrol cars, emissions will fall — but those cars need clean power, of course. As electric heat pumps replace gas furnaces and boilers, emissions will fall — but again, clean power is required. Steel and chemicals can be produced with hydrogen made from clean electricity, displacing fossil fuels and driving emissions down further. This list goes on.

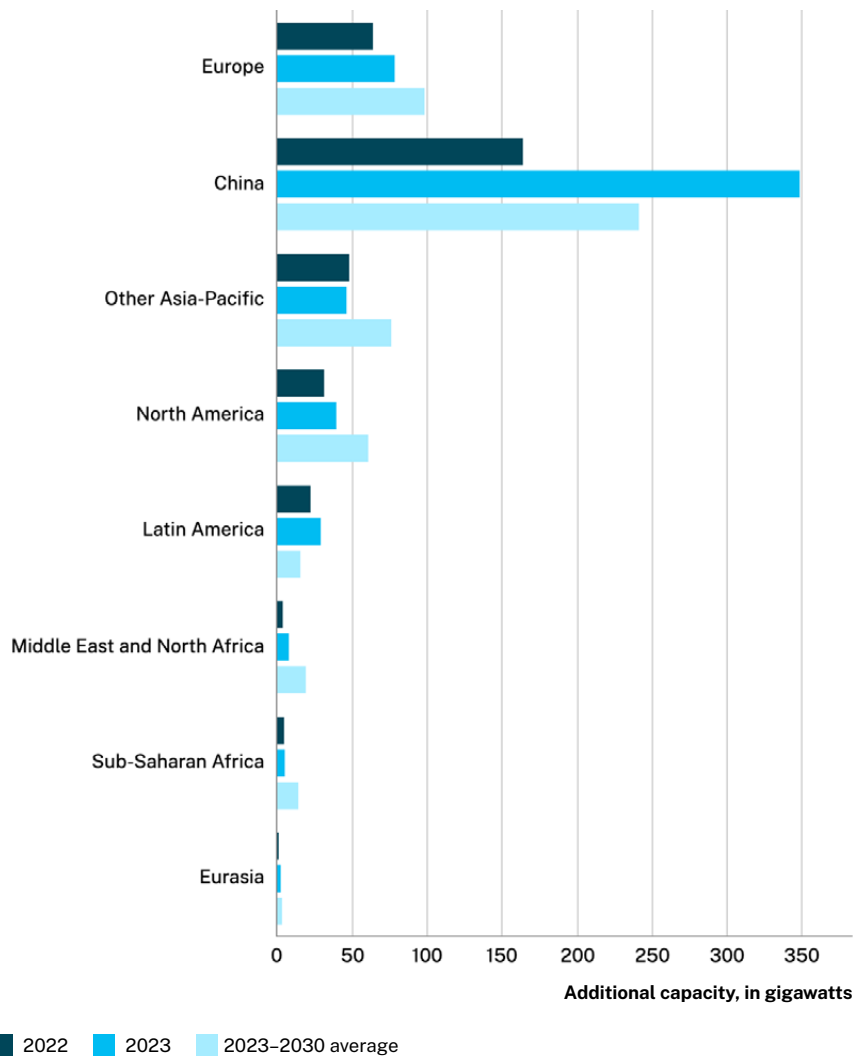
This basic strategy is called ‘electrify everything,’ and it requires running all those newly electrified devices from a clean power grid. The strategy implies that demand for electricity has to rise even as fuel combustion falls. It is starting to work, most visibly in the deployment of electric cars and heat pumps in countries where a substantial clean-up of the power grid has already occurred. Forecasts of power demand are up in many countries for the first time in a decade,⁶ but on the whole, countries are not going fast enough. We will analyse the required pace of change in more detail below, but the critical point is that we now have a way to measure whether countries are on track to create the clean grids that will be central to the transition.

Year by year, we can ask: is their installation of renewable power accelerating to meet the global goal of tripling by 2030?

6. International Energy Agency, July 2024: “Electricity Mid-Year Update,” Paris.

China and India initially resisted the tripling pledge. They were deterred by another part of the deal, a commitment by each signatory country to double the rate at which the energy efficiency of its economy is improving, as well as by language about the need to end new investment in coal-burning power plants. Doubling the rate of efficiency improvement will be no small task in any country, but it may be particularly difficult in those still dependent on energy-hungry heavy industry. Both China and India did agree to the final language of the overall deal, including the ‘transitioning away’ language. China is almost certainly on track for a tripling of renewable energy by 2030, and the task is not out of the question for India, either.

Figure 4: What we need now



This chart shows the recent level of clean-energy development for each region, compared with the average development needed each year between now and 2030 to meet the Dubai pledge. Included in the totals are investments in renewable power, grids and energy storage, energy efficiency, nuclear power and low-emissions fuels — all measured in gigawatts of capacity. China and Latin America are on track, but other regions are not.

Source: IEA

The situation is far more tenuous in other developing countries, even though many of them did sign the pledge. Many poorer countries have yet to take part in any major way in the renewable energy boom, with the exception of some parts of Africa where portable solar gear is providing lights and phone charging to people with no other access to electricity. Large solar and wind farms are difficult to finance in these countries, with money either unavailable or available only at interest rates that are double or triple those in the richer countries.

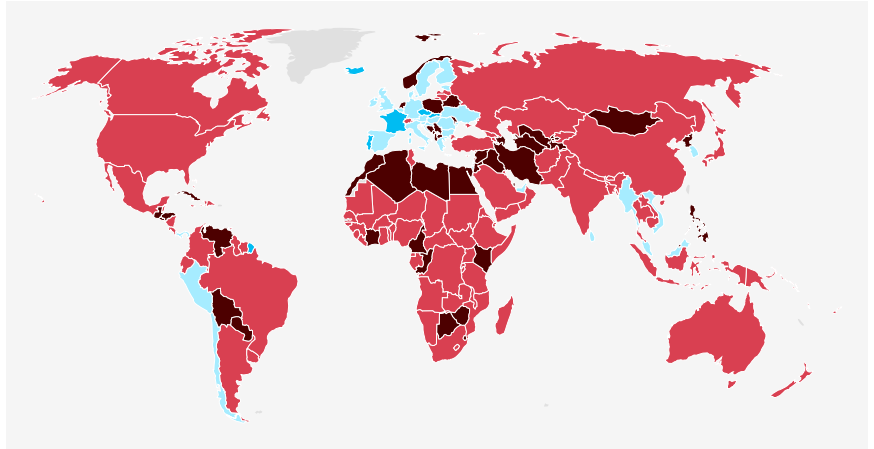
As we will detail below, this financing shortage has emerged as one of the most critical problems of the energy transition, and the world has yet to offer the poor countries any broad solution. The rich countries did agree in Dubai to create a new fund to help poor countries adapt to the climate crisis, but have yet to settle on a target amount. This will be a major topic at the upcoming climate conference this autumn in Baku, Azerbaijan.

A large majority of the world's countries have formally committed themselves to reaching net-zero emissions by 2050 or 2060, meaning any greenhouse emissions remaining by then are supposed to be small enough that they can be balanced with removals from the atmosphere. An organisation called Net Zero Tracker puts the number of countries committed to net zero at 147, out of 197 countries that the group analyses.

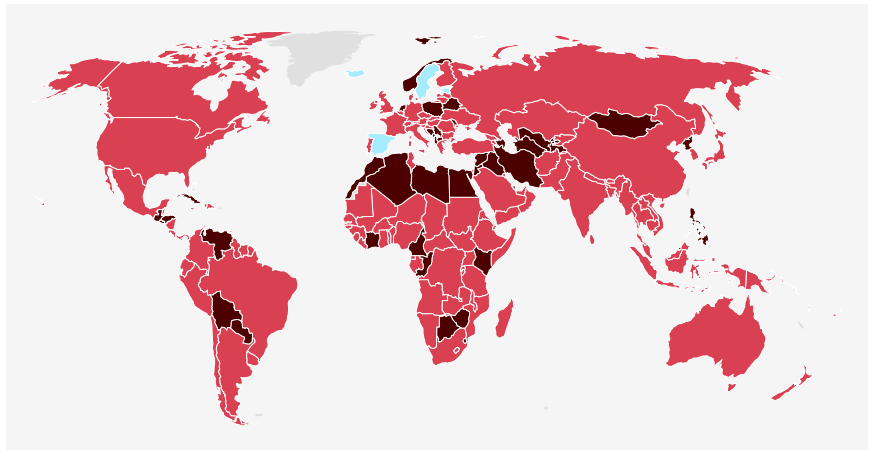
Unfortunately, in most cases, those supposed commitments are not accompanied by any serious plans to meet the net-zero goal. In effect, the political leaders of these countries have made promises but little effort to fulfil them, burdening their mid-century successors — children today, if they have even been born yet — with the task of redeeming those pledges.

Figure 5: Phasing out fossil-fuel use

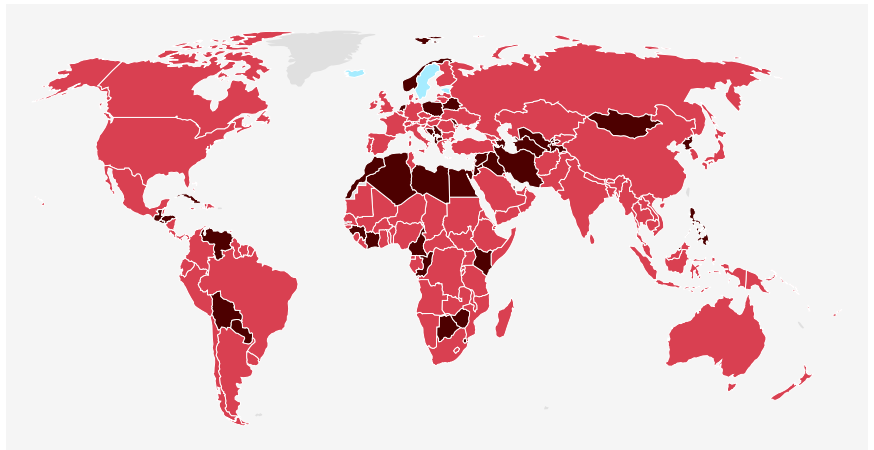
Coal



Oil



Gas



■ Full phase-out
 ■ Partial phase-out
 ■ No phase-out
 ■ No net-zero target

The maps show which countries have committed to phasing out the domestic use of any of the three main fossil fuels. A handful of countries have committed to phasing out exploration for or production of fossil fuels, not shown on these maps.

Source: Net Zero Tracker

Only a handful of countries have fleshed out their plans with serious commitments to phase out fossil fuels. In doing so, they generally consider coal, oil and gas separately, and they may make commitments to phase out *exploration for, production of or use of* those fuels. According to the database maintained by Net Zero Tracker, only 11 countries that have made net-zero commitments have ticked one of those three boxes in relation to a single fossil fuel, almost all of them European countries.

For most countries of the world, the numbers imply a profound disconnect between their stated commitments to net-zero emissions by 2050 and their actual plans with regard to fossil fuels.

We thus see a new frontier dawning in global climate politics. The imperative will be to persuade countries to adopt phase-out targets for all fossil fuels, to write those targets into law and to start crafting the regulations and industrial policies that will allow the targets to be met. This work needs to begin immediately, as the countries of the world are scheduled to present new national plans in 2025, expanding their efforts to tackle the climate crisis. We think no national plan should be regarded as serious unless it grapples with the need to exit from fossil fuels.

In short, we need a worldwide wave of new laws setting legally binding end dates for all activities related to fossil fuels. Even if we pass such laws, it will be difficult to make them stick, but they would send a critical signal in the near term to corporations and capital markets that governments are finally getting serious about the transition.

Backlash

We reported a year ago that the climate crisis had finally moved to the centre of global politics, driven not just by extreme weather disasters but by the war in Ukraine. The outbreak of that war highlighted the hazards of depending on authoritarian states like Russia, as well as the unpredictable fluctuations in the costs of imported fossil fuels. Europe has done a remarkable job of weaning itself off Russian gas, far better than anyone expected it could when the war started. Fears that Europe would burn a huge amount of coal over that winter did not come to pass, partly thanks to unseasonably warm weather.

On renewable energy, European governments have a history of making promises they do not deliver, but this time, with Russian guns at their backs, they are delivering. They have cut red tape to get the installation of renewable energy moving. The government of Germany, Europe's largest economy, once required 36,000 pages of printed documentation for a single small wind farm; it has now slashed such onerous requirements. The pace of wind-power installations in Germany has doubled in two years, and the government is targeting another three-fold increase by 2025.⁷ Other countries are overcoming short-term disruptions in the supply chains for renewable energy.

7. For a detailed account of the German situation, see Martin, Marilen and Rathi, Akshat, 27 August 2024: "The Secret Behind Germany's Record Renewables Buildout." Bloomberg News.

8. The most comprehensive effort to assess the effect of the US Inflation Reduction Act can be found in Jenkins, Jesse D., Farbes, Jamil and Jones, Ryan, 2024: "Climate Progress 2024: REPEAT Project's Annual U.S. Emissions Pathways Update," Princeton University Zero-Carbon Energy Systems Research and Optimization Laboratory and Evolved Energy Research.

9. Tsao, Stephanie, 9 July 2024: "Cancellations reduce expected US capacity of offshore wind facilities." Today in Energy, US Energy Information Administration, Washington.

Money from America's big new climate law, known as the Inflation Reduction Act, is starting to flow in the billions of dollars.⁸

Yet, despite these successes, the politics of climate change are only growing more difficult.

As climate policy starts to bite around the world, we see a rising backlash. A good deal of it is being conjured and financed by the fossil-fuel companies, but certainly not all. Resistance to climate policy is one strand of the right-wing populism that is making waves across the democratic world.

In both the United States and Europe, public opposition to wind and solar farms is making it more difficult to site them. Only a few years ago, the northeastern United States looked to be set for a huge boom in offshore wind production, but rising opposition and rising costs have slowed the build-out.⁹ Farmers in multiple countries are rebelling against modest policies needed to cut the emissions from agriculture. The German government, led by a coalition that includes the Green Party, has been forced to dial back some of its more ambitious climate goals. On its way to losing an election this past summer, the Conservative-led government of the United Kingdom retreated from some of that country's main climate goals. How ambitious the new Labour-led government will be in restoring British ambition is still unclear.

Fighting Brussels



Farmers protest environmental regulations, amongst other grievances, near the European Union headquarters in Brussels.

Source: Luis Miguel Cáceres/Getty Images

10. Reuters, 8 August 2024: "China auto market hits milestone as EVs, hybrids make up half of July sales."

11. For a detailed discussion of the situation with electric vehicles, see International Energy Agency, April 2024: "Global EV Outlook 2024: Moving Towards Increased Affordability," Paris.

Electric cars continue to grow in importance and are on their way to taking over the world's largest car market, in China; electric models are now half of new-car sales there.¹⁰ Yet in some markets the rate of growth has slowed; the torrid pace of the last few years could not have continued indefinitely.¹¹ Many countries have failed to build enough public charging stations. The biggest obstacle has been the price of electric cars compared to petrol cars, but a wave of affordable new models is coming to market. Strong public policies will be required, over the course of at least two decades, to complete the transition to electric vehicles, along with firm commitments and large investments from the legacy car-makers.

In 2021, when the big global climate meeting was held in Glasgow, the British government managed to coax forth a wave of apparent ambition. Coalitions of countries, bankers and insurers formed, all promising greater climate action. Three years later, some of those coalitions are falling apart as leaders realise what it would take to meet their own promises. This unfortunate backpedalling can be taken as one more sign of how hard the climate transition is going to be.

The backlash against climate policy represents yet another political headwind to be overcome. If we are to counter it and keep moving forward, we must conjure a more demanding politics of climate change, one that insists the tough decisions need to be made now, not later.

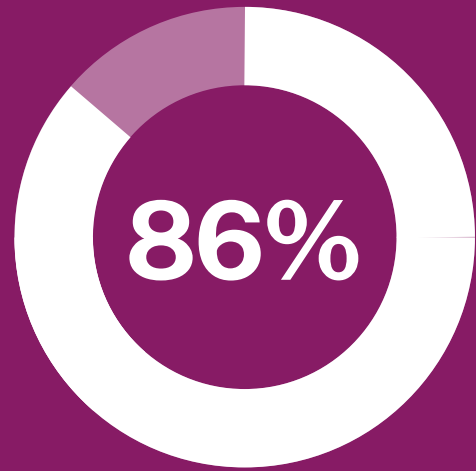
The 30th anniversary of the global climate negotiations is little more than a year away. The history of those decades can be read as one grand exercise in climate hypocrisy, of talking endlessly about the problem without taking the steps necessary to solve it.

If we ever had time for that, we have run out.

02 Power

Renewables made up 86% of installations in 2023

Power



A solar boom is at hand

1. In fact, the International Energy Agency reports that overall emissions, not just power emissions, are at the lowest level in 50 years in the advanced economies — but it is falling power emissions that account for the bulk of the decline. See IEA 2023, “CO₂ Emissions in 2023: A New Record High, but is There Light at the End of the Tunnel?” pp. 11–12. Paris.

2. The last coal-burning power plant operating in the UK, the Ratcliffe-on-Soar Power Station in Nottinghamshire, is due to close shortly after publication of this report, on 30 September 2024.

3. Dhakal, S., et al, 2022: “Emissions Trends and Drivers.” In “Climate Change 2022: Mitigation of Climate Change.” Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK and New York, NY, USA.

4. International Energy Agency, July 2024: “Electricity Mid-Year Update,” p. 10. Paris.

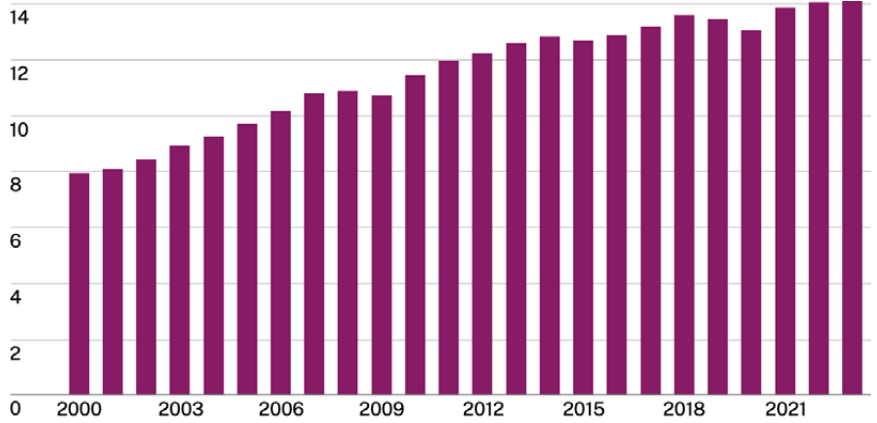
Renewable electricity is growing rapidly now, so much so that emissions from power production are falling sharply in some countries.¹ Last year, coal consumption in the United Kingdom hit its lowest level since the 1730s, and the UK will soon be entirely free of coal as a power source.² In the developed world as a whole, emissions from electricity production peaked years ago and have fallen sharply.

Unfortunately, this trend has still not taken hold at a global scale. While renewables are growing faster than any other source of electricity generation, they are not yet growing fast enough to satisfy all new power demand. This means the power sector is still responsible for about 23 percent³ of global emissions. Moreover, electricity demand is starting to grow in many developed economies where it had been stagnant for a decade. This is mostly good news, as it means that the exhortation to ‘electrify everything’ is working. The spread of electric cars is driving up power demand. So is the rising popularity of heat pumps, which are displacing gas furnaces and boilers. In addition, the rapid growth of data centres for computing is also a fast-rising source of demand. Where worldwide demand for power had been growing by about 2.5 percent a year, the International Energy Agency now forecasts that it will grow at 4 percent for at least the next few years.⁴

That is a big shift, and meeting fast-growing demand entirely with clean energy will be difficult. But it may be possible if countries follow through on the commitment we mentioned earlier, to triple their renewable-energy installations by 2030.

Figure 6: Not falling yet

CO₂e emissions, in gigatonnes



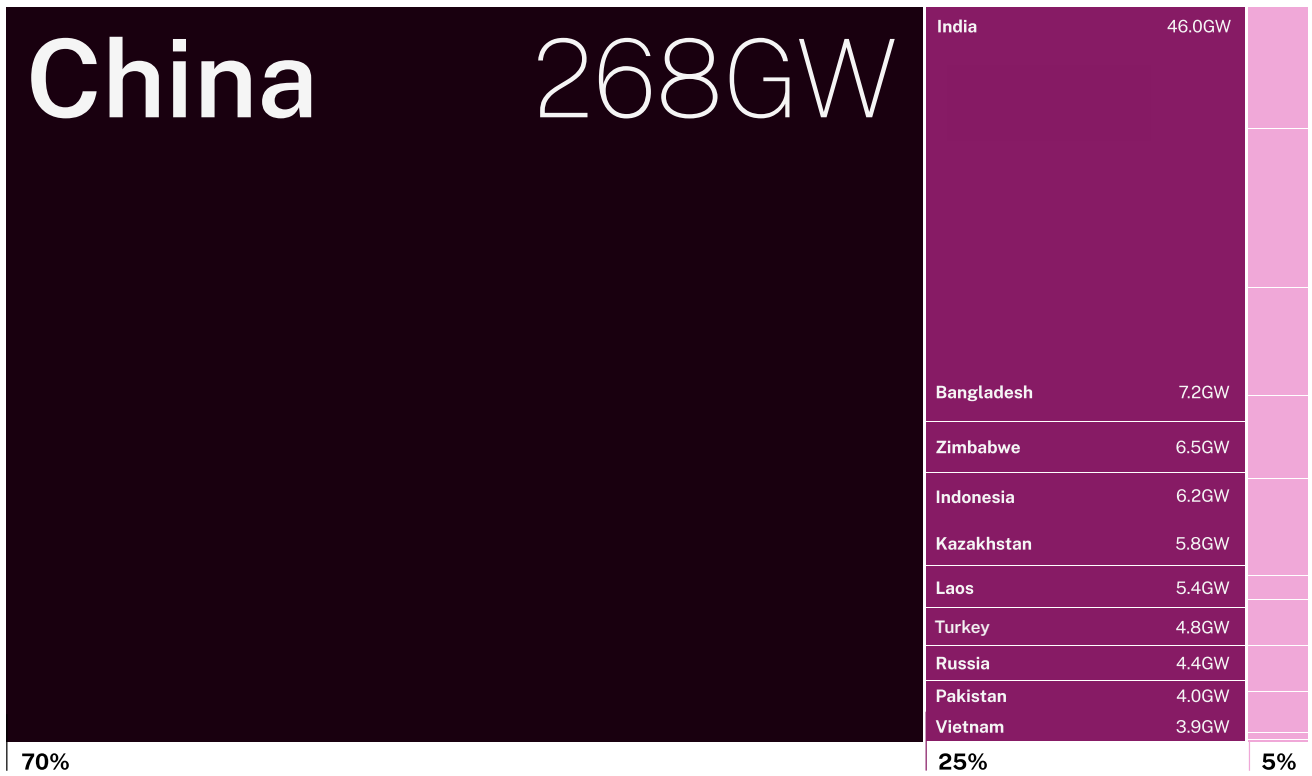
This chart shows worldwide emissions for the power sector. The fast growth of renewables has helped to hold emissions in check compared to what they might otherwise be, but they are still inching upward.

Source: Ember

In recent years, droughts in China cut that country’s production of hydropower, forcing coal-burning power plants to make up the electricity shortfall. Blackouts occurred in some regions. Spooked by the droughts and their effect on its mighty hydropower system, China built a wave of new coal-fired power plants, even as it also carried out the world’s largest installation program for renewable energy. That revival of coal-plant construction in China may now be waning, however. Approvals for new plants fell by nearly 80 percent in the first half of 2024⁵ — a clear signal that the Chinese leadership is tapping the brakes on new coal.

5. Moritsugu, Ken, 2024: “China is backing off coal power-plant approvals after a 2022–23 surge that alarmed climate experts.” Associated Press, Beijing.

Figure 7: The coal behemoth



This chart shows coal-fired power capacity in the planning stages as of January 2024, by country. Note that these figures are smaller than those in Fig. 2, which includes power plants already under construction, whereas this chart covers only those in planning. Plants are often cancelled at this stage.

Source: Ember

Electricity is likely to be the first sector of the economy where emissions go into a long-term structural decline. When that finally happens, it will be a definitive signal that the energy transition is succeeding, due to the success of renewable energy across many parts of the world.

Going big



China is installing more renewable power than the rest of the world combined. This photo shows one of the country's largest solar farms, in Xinjiang, producing power in the winter.

Source: Zhang Bin/China News Service/VCG via Getty Images

6. The exact increase in nuclear output was 2.3 percent. World Nuclear Association, 20 August 2024: "World Nuclear Performance Report 2024." London.

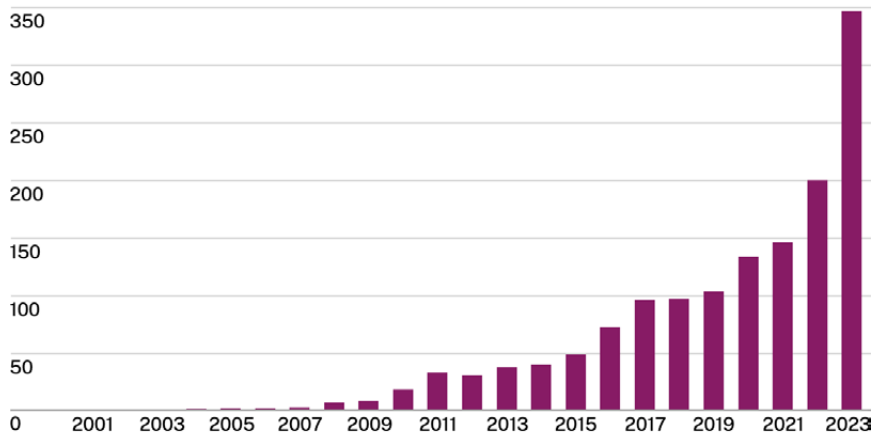
7. The figure of 74 percent is Generation's calculation from the data set provided by the Energy Institute to accompany the "Statistical Review of World Energy," 2024 edition. The data are available at <https://www.energyinst.org/statistical-review>. Note that other sources give somewhat higher increases than 74 percent. The decline of roughly 50 percent in the spot price of solar modules is from the International Energy Agency, 2023: "Renewables 2023: Analysis and Forecast to 2028," p. 9. Paris.

8. Brown, Sarah and Jones, Dave, 7 February 2024: "European Electricity Review 2024." Ember, London.

Solar power is the breakout star: installation of solar panels jumped by 74 percent worldwide last year⁶, even as the cost of solar panels fell by nearly 50 percent.⁷ Production of wind energy rose by about 10 percent last year, with a particularly strong showing in Europe, where inflation and supply-chain disruptions had slowed things down for a while.⁸

Figure 8: Hail the sun

Capacity, in gigawatts

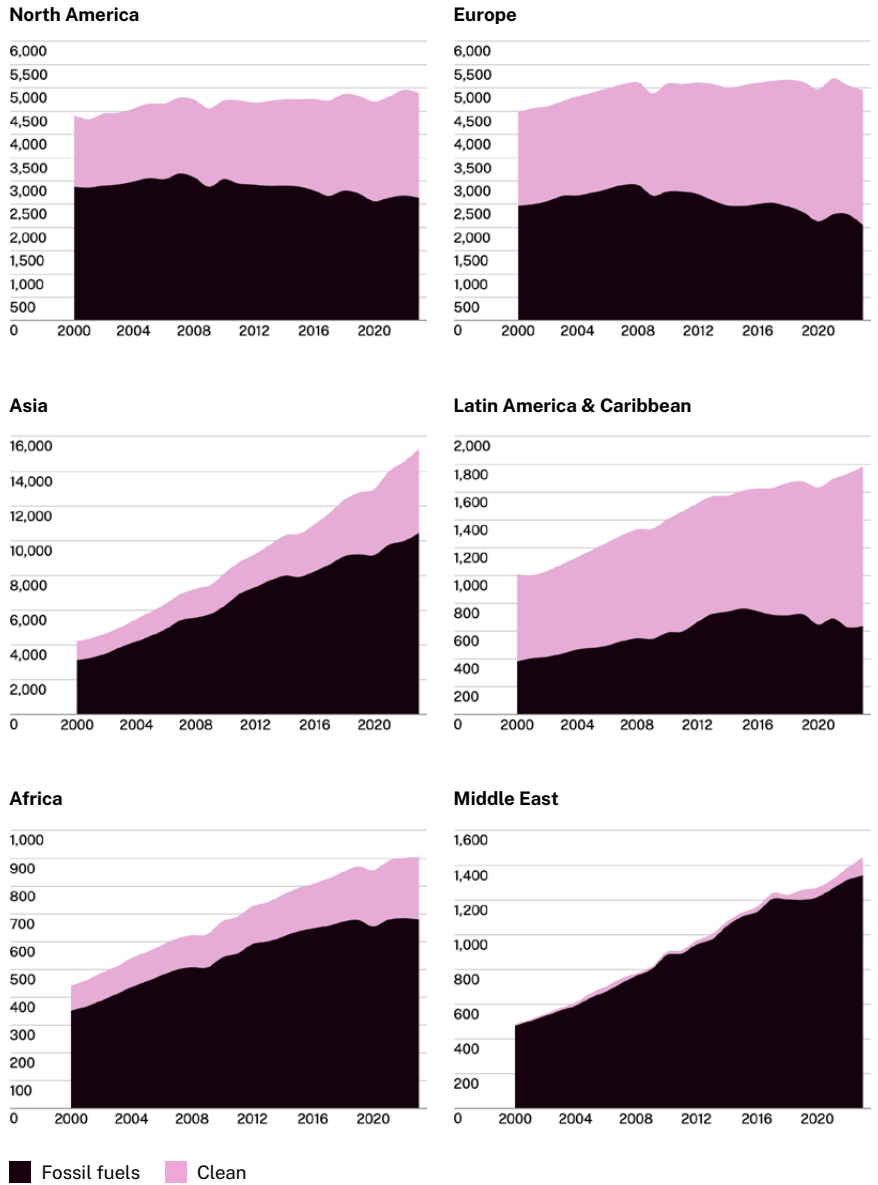


Solar power is booming worldwide as costs fall. This chart shows the capacity of photovoltaic panels and concentrated solar power plants installed each year, in gigawatts.

Source: Statistical Review of World Energy 2024

As power demand rises worldwide, both fossil fuels and renewable energy are growing. Nuclear power is making a modest contribution to the grid clean-up, with production of electricity from nuclear plants rising by about 2 percent last year.

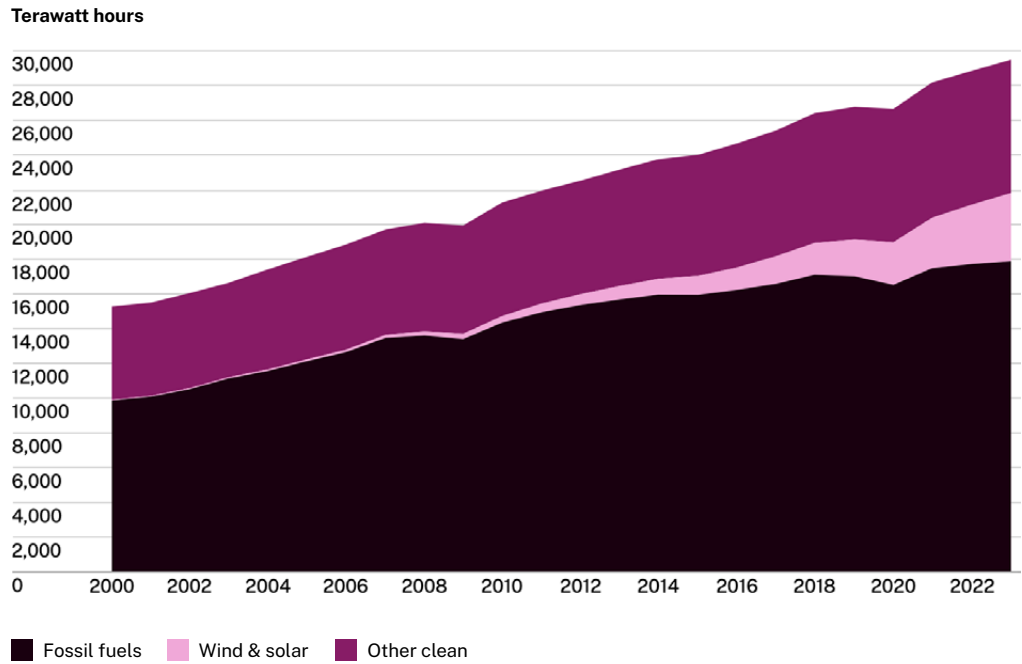
Figure 9: Making the shift



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

Figure 10: A changing mix



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

Source: Ember

9. Plumer, Brad and Nadja Popovich, 4 June 2024: "As Solar Power Surges, U.S. Wind is in Trouble." The New York Times, New York.

We are seeing headwinds in some parts of the world. In the United States, the energy measures that President Joe Biden signed into law have led to a boom in solar power, but wind power there is lagging, bogged down by difficulties in siting new facilities and in securing connections to the grid.⁹ To meet forecasts of rising power demand, utilities are proposing to construct a wave of new gas-fired power plants. Clean-energy advocates are fighting the proposals, arguing that increases in demand can be handled with renewable energy and smarter management of the grid.

Is the clean-up of the power grid happening fast enough to meet our climate goals?

AI & POWER

How worrisome is it that the rise of artificial intelligence is demanding huge amounts of electricity?

The headlines over the past 18 months have been alarming.

*Google's Emissions Climb Nearly 50% in Five Years Due to AI Energy Demand.*¹

*Microsoft's Emissions Soar by 30%.*²

*Power Hungry AI is Driving a Surge in Tech Giant Carbon Emissions.*³

The big technology companies are among the corporations most committed to climate action, yet their emissions are rising, not falling. What's going on, and how serious is it?

The latest factor driving up their emissions is artificial intelligence, or rather, the latest flavour of artificial intelligence, exemplified by the models known as large language models.

ChatGPT, which exploded into public consciousness in late 2022 and early 2023, is only the best known of these creations. All the big tech companies are rushing to deploy one or more versions of these models. They have dazzled the public with their ability to answer questions, write essays and create fake photos that look real. More importantly, they may yield breakthroughs in tackling disease, environmental challenges and many other problems.

These models are computationally intensive, demanding more processing power than other types of online activity. That also means they demand more energy. A complex ChatGPT query can use several times as much computing power, and electricity, as a basic Google search. The tech companies are racing to build new data centres containing racks upon racks of computers to meet the rising load.

This adds to a longer-term trend in which more and more of the world's computing tasks are moving into the "cloud," which is to say, huge data centres built by these same companies. The growth of data centres in general and the sudden growth spurt of AI in particular is driving up their emissions, even though the companies buy renewable power whenever they can.

Some experts fear that companies like Google and Microsoft are now destined to miss their 2030 emissions targets. The companies claim that they are still on track, while acknowledging that the challenge is getting harder. Some analysts are forecasting that electricity demand for data centres, now at or approaching 2 percent of world power demand, could triple or quadruple in the next few years.⁴ This would be such a large new load on the power grid that it could be nearly impossible to meet with clean energy alone.

History suggests, however, that panicky forecasts about power demand from data centres should be viewed with some scepticism.

The demand for computing power has been rising relentlessly for decades, but the associated electricity use has not gone up nearly as fast. That is because computers, and the big data centres that house the most powerful of them, are constantly becoming more efficient.

This fortunate aspect of computer technology is captured in an observation known as Koomey's Law. It is named after Jonathan Koomey, an independent researcher who observed in 2010 that the energy efficiency of computing was doubling roughly every 18 months. This rule of thumb is a close corollary of Moore's Law, the observation that the number of transistors that could be squeezed onto a computer chip was doubling about every two years, making the chips more powerful and more efficient.

While power demand for data centres is certainly going up, we doubt that it will enter some runaway, exponential phase. A tripling of power demand by 2030 would be a worst-case scenario, in our view. A doubling seems more likely, and should lead to a many-fold increase in computing power.

Every company involved in the artificial-intelligence boom has huge incentives to pursue efficiency, with the largest simply being the high cost of electricity. Nvidia, the most important company making computer chips for artificial intelligence, routinely announces huge gains in performance and energy efficiency.

While artificial intelligence could certainly drive up power demand, there's another side to the equation: can it help us cut emissions?

We have no idea yet what these new models will be able to accomplish when turned loose on the biggest problems in the energy system. But there is every reason to think they will help us figure out how to use energy more efficiently.

To cite one inviting target, the energy usage in large commercial buildings is notoriously wasteful, mainly because their air-handling systems are complex and difficult to manage correctly. The problem routinely

defeats the skills of the people who are put in charge of running these buildings. That sounds like the kind of thing a computer, properly trained, ought to be able to do better than human beings can.⁵

Artificial intelligence is just now being deployed on a whole array of problems like this, from designing chemical factories to running steel mills. The computers will surely find savings and tweaks that human beings have not been able to identify.

This is more an intuition than a fact, but we suspect that a world rife with thinking machines will be a cleaner, more efficient world.

1. Milmo, Dan, 2 July 2024: "Google's Emissions Climb Nearly 50% in Five Years Due to AI Energy Demand." *The Guardian*.

2. Symons, Angela, 16 May 2024: "Microsoft's Emissions Soar by 30%: Why is it Building More Data Centres and What is Their Impact?" *EuroNews*.

3. Noble, Gordon and Berry, Fiona, 8 July 2024. "Power Hungry AI is Driving a Surge in Tech Giant Carbon Emissions." *The Conversation*.

4. The 2 percent figure comes from the International Energy Agency; other sources give slightly lower estimates. The IEA base case is that power demand for data centres could nearly double by 2026, and its high case is an increase of 128 percent; the latter figure would roughly equate to adding another Germany to the world's power grids. Çam, Eren et al, 2024: "Electricity 2024: Analysis and Forecast to 2026," p. 31. International Energy Agency, Paris.

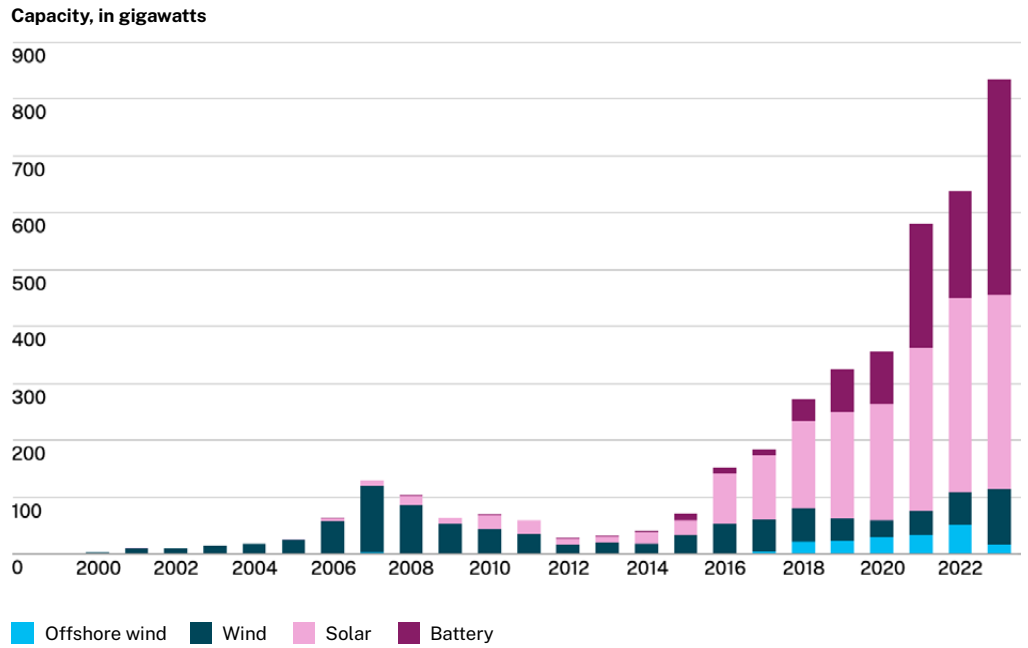
5. This potential use case is such an inviting target that speculation about it is already rife. See for example, Burns, Joe, 2 August 2024: "AI Could Halt Energy Use Growth in US Buildings: LBNL study." *Facilities Dive*.

The short answer is no. The countries of the world are not yet on track to triple the amount of renewable electricity by 2030, the critically important promise they made at the climate conference in Dubai. At the same time, it is clear that getting to that point is achievable. The International Energy Agency has calculated that if the goal of tripling is to be met, the share of total energy supplied by renewables must rise by about 13 percent a year between now and 2030, roughly double the rate of increase over the past five years. That is a global average; the required rate varies by country, but it is clearly feasible across much of the world with additional government policies.

Which policies are needed? Given falling costs and strong financial support from governments, the problem in the core renewables markets is not a shortage of capital. In fact, what is really holding back faster growth in these markets is red tape.

Grid operators, utilities and their regulators have essentially been caught flat-footed by the rapidly falling costs and fast growth of renewable energy. Across much of the world, they have failed to build transmission grids capable of handling the new, more distributed flows of electrical power. We are thus seeing the growth of waiting lists across the developed world as renewable energy developers request grid connections — and are told to go to the back of the queue. Waiting times now stretch for years in some locations.

Figure 11: Get in the queue



Due to red tape, the backlog of renewable-energy projects wanting to connect to the grid is growing rapidly in many countries. This chart shows the cumulative backlog in the United States.

Source: Lawrence Berkeley National Laboratory

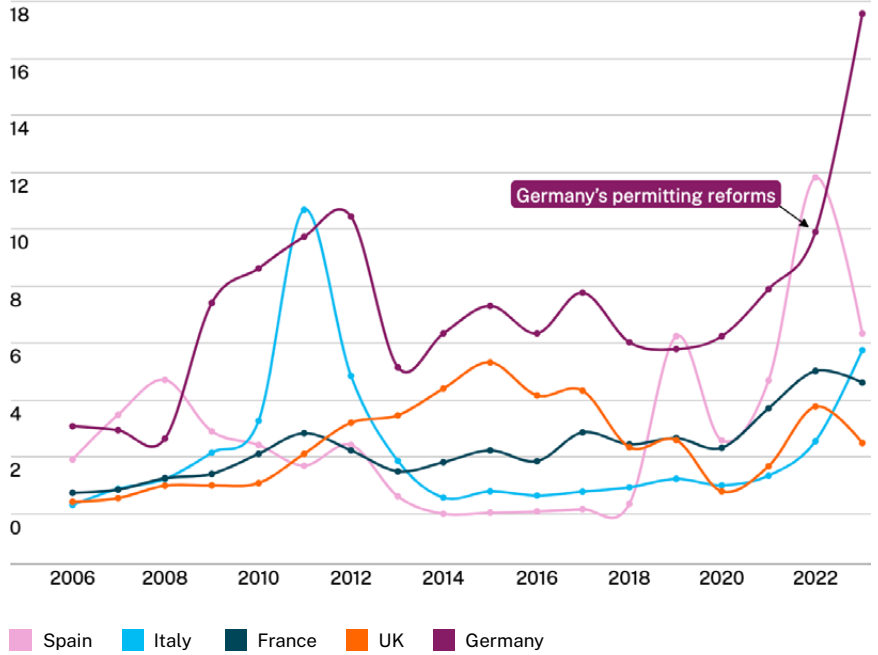
Grid modernisation is now *the* critical issue to get the energy transition moving faster in the big, developed economies. Over the next few years, nothing else will matter as much as this issue. But securing permission to modernise — to build new power lines, to replace ageing ones, to install digital controls that make the grid more efficient — involves slow, cumbersome bureaucratic procedures. It typically entails fights about who is to pay for the upgrades. Modernisation may also involve intense public opposition to new power corridors, and thus require years of engagement to win public consent, where it can be done at all. For years, global investment in the grid had been flat at around \$300 billion a year, but is forecast to rise to \$400 billion this year.¹⁰ This is a hopeful sign, but much greater effort is needed.

The climate movement must turn its political firepower onto this problem. In the United States, the Federal Energy Regulatory Commission has just come out with new rules that should help get things moving, but the most important decisions will be made in the 50 public utility commissions that control the power grid for each of the 50 states. Those bodies need to hear from the public about the need to streamline the bureaucracy around the power grid.

10. International Energy Agency, 2024: "World Energy Investment 2024," p. 9. Paris.

Figure 12: Reforms pay off

Additional capacity, in gigawatts



This chart shows approvals for new wind and solar projects by year for several European countries. Germany's permitting reforms have led to a sharp increase in project approvals in that country, though many of these are not yet built.

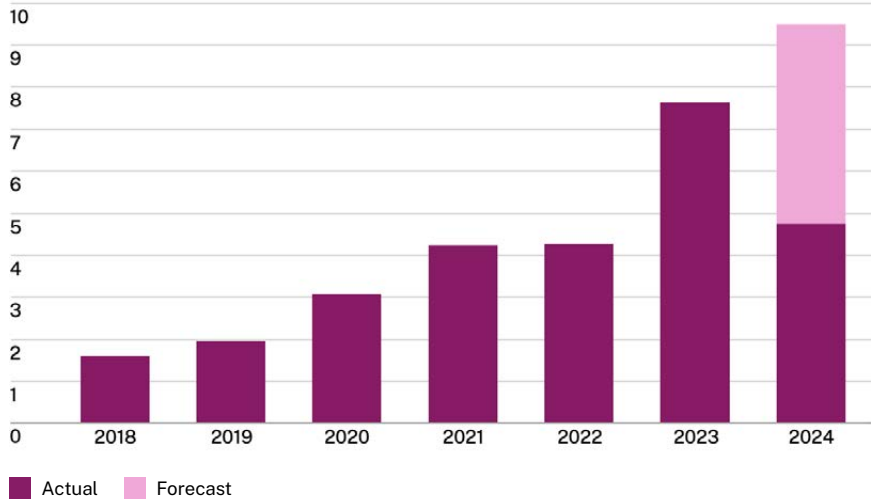
Source: Ember

In other countries, these decisions are typically made at a national level, even though many of the underlying political dynamics are the same. We find some hope in the recent actions of several European countries. In Germany, for instance, decisions about renewable energy and the grid had seemed hopelessly bogged down for years. But the current government has adopted a bold reform package to simplify permitting and other rules, and as a result, installations of both wind turbines and solar farms are moving much faster.¹¹

11. Martin, Marilen and Rathi, Akshat, 2024: "The secret behind Germany's record renewables build-out." Bloomberg News.

Figure 13: Hail the wind

Capacity, in gigawatts

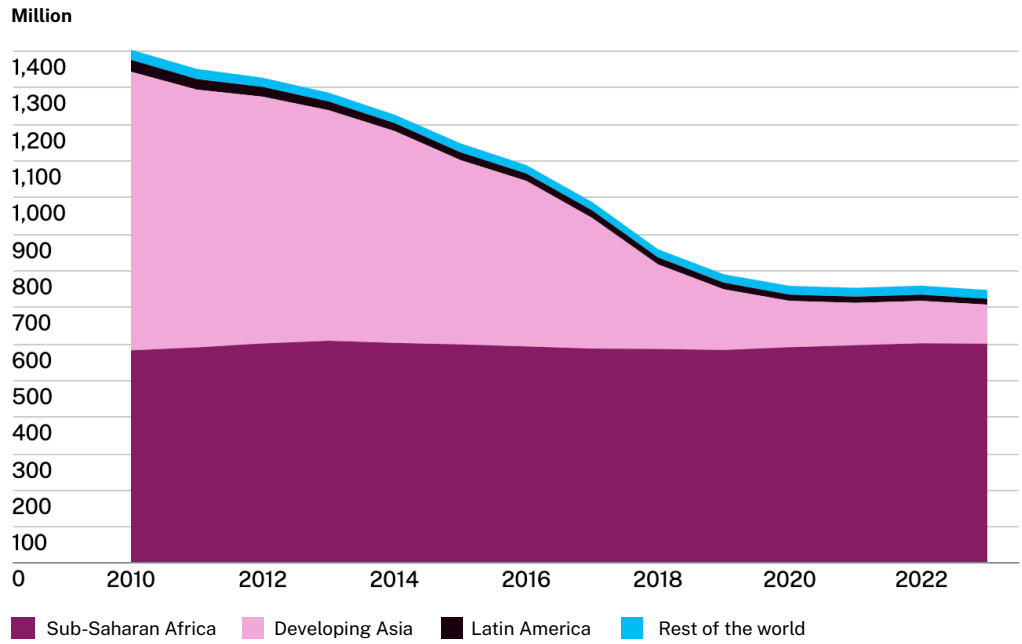


This chart shows the capacity of new wind farms approved in Germany, showing the government's effort to speed approvals. Full year 2024 numbers reflect likely capacity if the second half of the year resembles the first half.

Source: Fachagentur Windenergie An Land

Another major problem is that renewable energy has yet to break out of its core markets — China, the United States, the European Union, Latin America and India — and spread to poorer countries like those of sub-Saharan Africa. Many of these countries still lack robust electric grids, and even the ones that do have grids are burdened by high financing costs for renewable energy projects — much higher than the costs in the core markets. As our Chairman Al Gore likes to point out, the immense continent of Africa has less solar power installed than the American state of Florida, a state with policies not especially favourable to solar energy.

Figure 14: Still off the grid



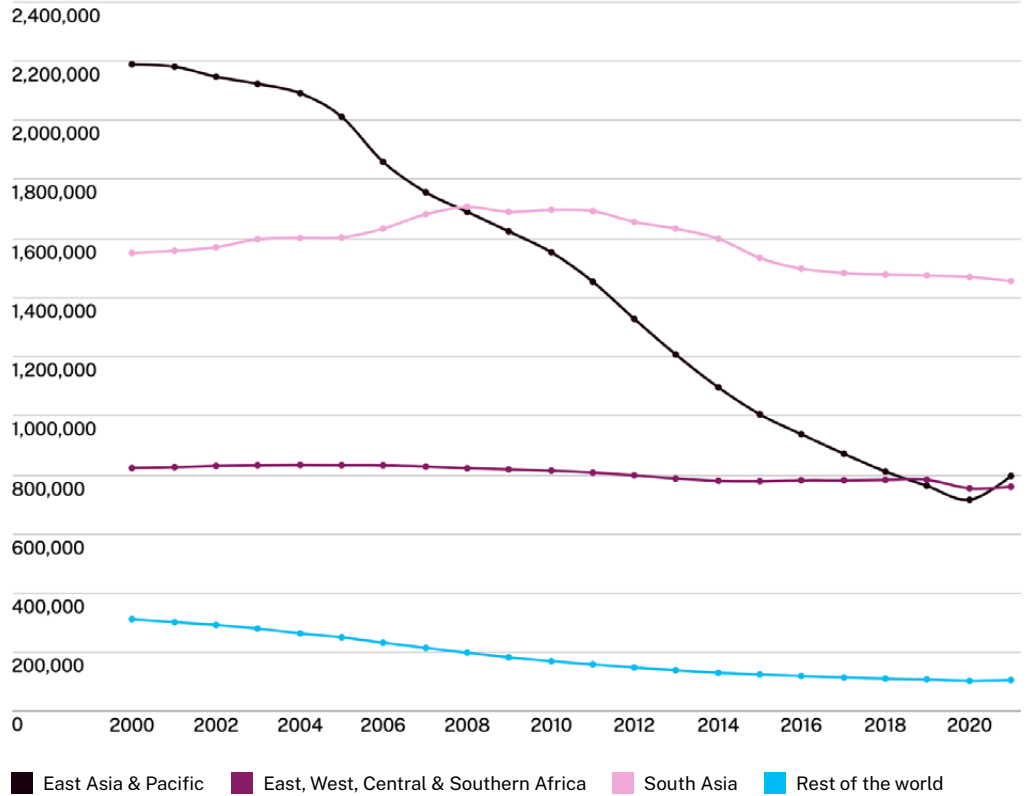
This chart shows the number of people without access to electricity, by region.

Source: IEA

The slow development of electric grids in poor countries means that many millions of people still do not have access to reliable electricity. As the above chart shows, the problem is gradually getting solved in much of the world, but it has been stubbornly persistent in Africa, where almost 600 million people still do not have power. In large parts of Africa and developing Asia, people still cook over open fires, inadvertently polluting their homes with smoke that causes millions of deaths a year. The need to gather wood, charcoal or dung to burn becomes a major burden, and contributes to the destruction of nearby forests.

Figure 15: Choking

Number of deaths



This chart shows annual deaths from household air pollution. Deaths have dropped overall, driven in part by a shift to cleaner fuels in China.

Source: State of Global Air 2024

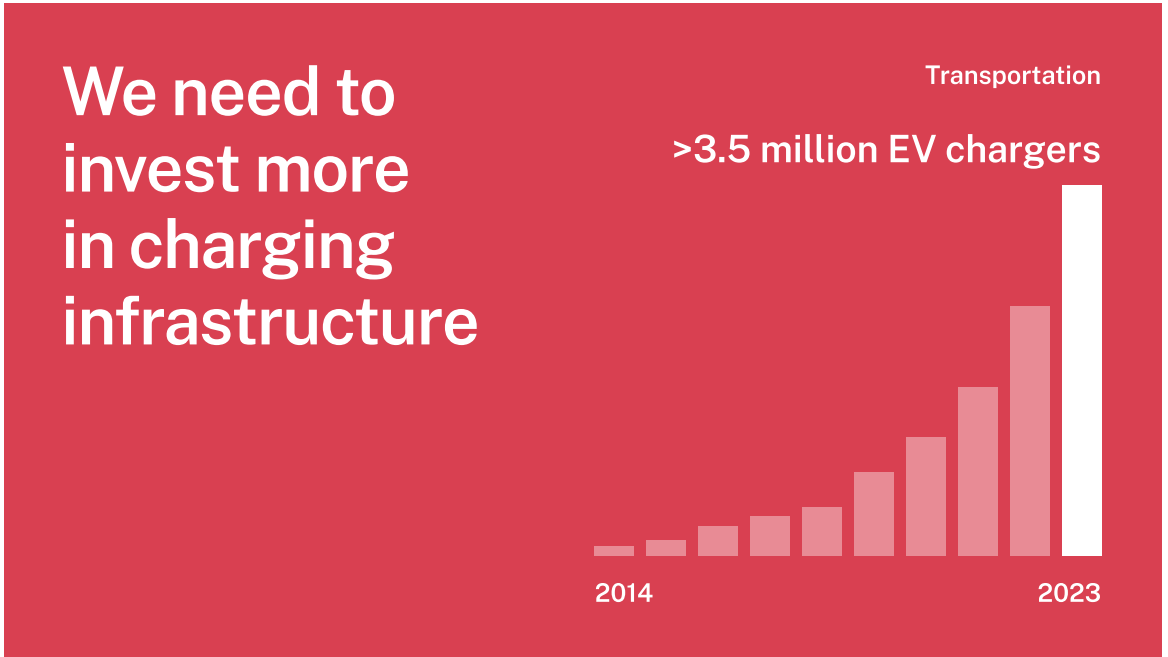
In rural areas, the electricity problem can be ameliorated in the short term by off-grid solar systems that provide lights at night and charging for mobile phones; millions of Africans and Indians have already gained some access to electricity through these systems. But for the long term, the more plausible approach is extending and improving power grids, and the high cost of financing such projects in developing countries is the core issue. Early efforts to help are under way: for instance, rich countries have promised South Africa an initial \$8.5 billion to assist the country in moving away from its heavy reliance on coal¹², but so far there is little to show on the ground.

Poor countries need help to leapfrog the fossil era and move to clean power; helping them would be more than smart public policy. It is an urgent moral imperative.

12. European Commission, 7 November 2022: "Joint Statement: South Africa Just Energy Transition Investment Plan." Brussels.

03

Transportation

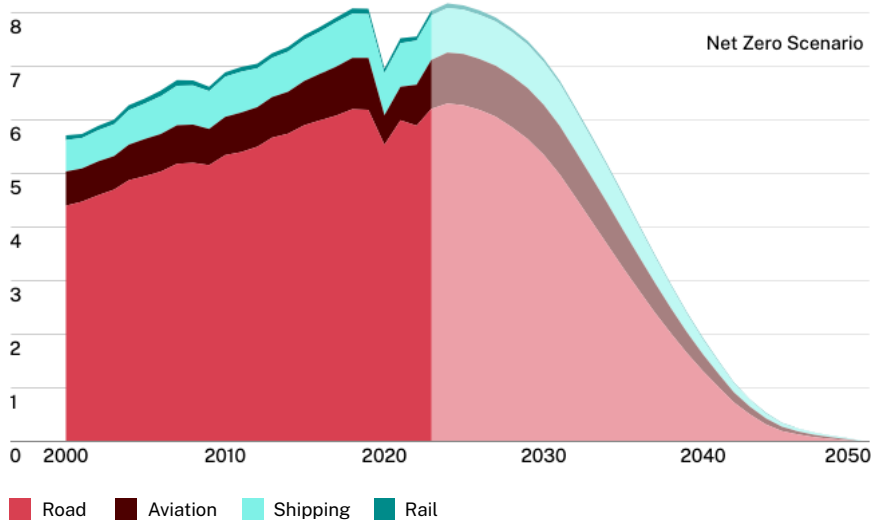


Speed bumps for electric cars

Early this year, a flood of bad news about electric cars created a widespread impression that the transition to these vehicles was at risk of stalling. What is really happening, we think, is a phenomenon we predicted in this report last year: as electric cars become a larger share of the overall market, the rapid growth of recent years is slowing down.

Figure 16: Out of the exhaust pipe

Annual CO₂ emissions, in gigatonnes



This chart shows historical emissions from transportation on the left. The shaded area on the right shows the rapid decrease in emissions required to meet global climate goals.

Source: BloombergNEF

1. The average figure hides significant shifts in sales from country to country, driven primarily by changes in government subsidies or tax rules. See Rho Motion, 12 July 2024: "EV Sales H1 2024: Europe Slowest Growing Region."

2. Randall, Tom, 28 May 2024: "The Slowdown in US Electric Vehicle Sales Looks More Like a Blip." Bloomberg News.

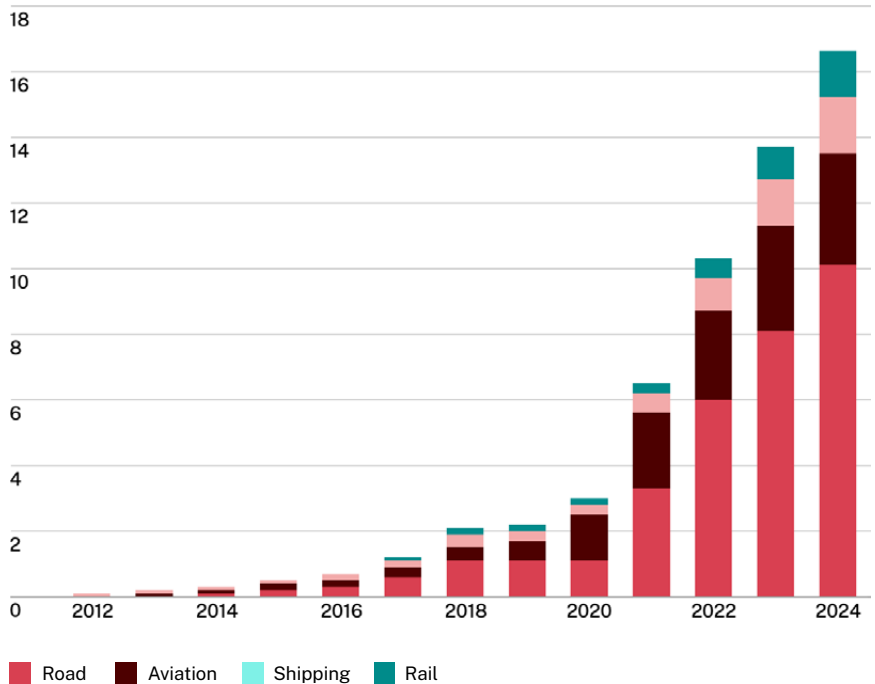
3. All figures cited in this paragraph are from the International Energy Agency, April 2024: "Global EV Outlook 2024: Moving Towards Increased Affordability." Paris.

With countries rejigging or withdrawing their subsidies, electric-car sales in Europe were up only 1 percent in the first half of 2024.¹ Much of the bad news came from the United States, however. Tesla, the electric-car pioneer, was forced to slash prices and lay off workers as demand for its cars weakened. Since Tesla has long commanded half the electric-car market in the United States, its woes have a big effect on overall sales numbers there. Much of the damage seems to be self-inflicted: Tesla has been slow to refresh its model line-up, and many potential buyers appear to be waiting for the new versions of the cars. The erratic behaviour of its chief executive Elon Musk has likely put off some potential buyers. The established American car-makers had their own problems: Ford and others slowed some of their planned electrification investments amid soft demand. In addition, higher interest rates have made their plans more costly to execute. General Motors discontinued its popular Bolt car in late 2023, a year before it plans to bring a replacement to market.

Yet, as the year has unfolded, it has become clear that the American situation is likely a blip.² Sales of cars with plugs were still up 40 percent in the American market in 2023 — a slowdown from the 57 percent growth of the year before, but a healthy figure nonetheless. In two years, electric car sales in America have more than doubled. The International Energy Agency forecasts that cars with plugs will represent 11 percent of all new-car sales in the United States in 2024, up from practically nothing a decade ago.³

Figure 17: Up and away

EV sales, in millions



This chart shows sales of cars with plugs since 2012, with a projection for full year 2024.

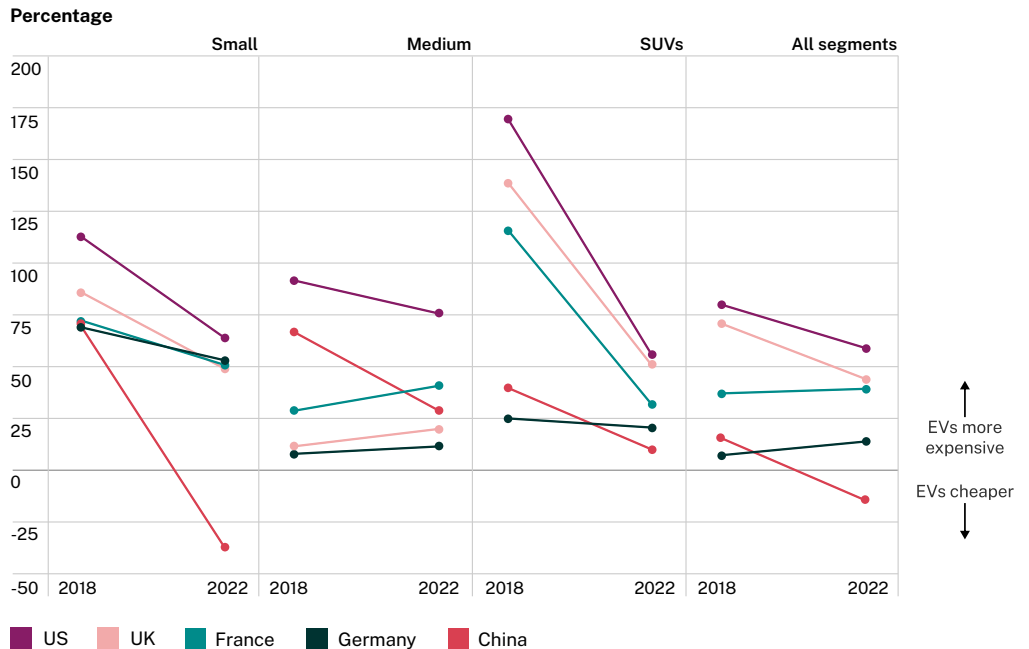
Source: IEA

4. All figures cited in this paragraph are from the International Energy Agency, April 2024: "Global EV Outlook 2024: Moving Towards Increased Affordability." Paris.

Worldwide, sales of electric cars rose by 35 percent in 2023, and they now represent 18 percent of the world's new-car market. China has become by far the largest marketplace for the cars; in July, for the first time, cars with plugs took more than half the Chinese market. The cars were more than 20 percent of the market in Europe last year, including shares of roughly 25 percent in Germany, France and the United Kingdom. Norway continues to lead the world, with 93 percent of the new cars sold there having plugs.⁴

So, while the percentage sales growth for 2023 was lower in some major markets than in 2022, we do not think that is particularly surprising in a maturing industry. And developments now under way in the marketplace mean that a broader embrace of electric cars, beyond enthusiastic early adopters, may be about to materialise. For one thing, the cars are steadily getting cheaper. That Tesla was forced into price cuts may have been bad news for Tesla, but it was good news for the car-buying public. General Motors is on the verge of introducing a wave of new models specifically designed to appeal to American buyers, at reasonable prices. Chinese manufacturers have flooded their domestic market with hundreds of well-built, affordable electric car models, and these Chinese cars are now being exported to many parts of the world at prices below \$20,000. Up to now, sales of electric cars have been concentrated in China, Europe and North America, but we are starting to see growth elsewhere, including parts of Latin America, Africa and Southeast Asia.

Figure 18: Getting closer



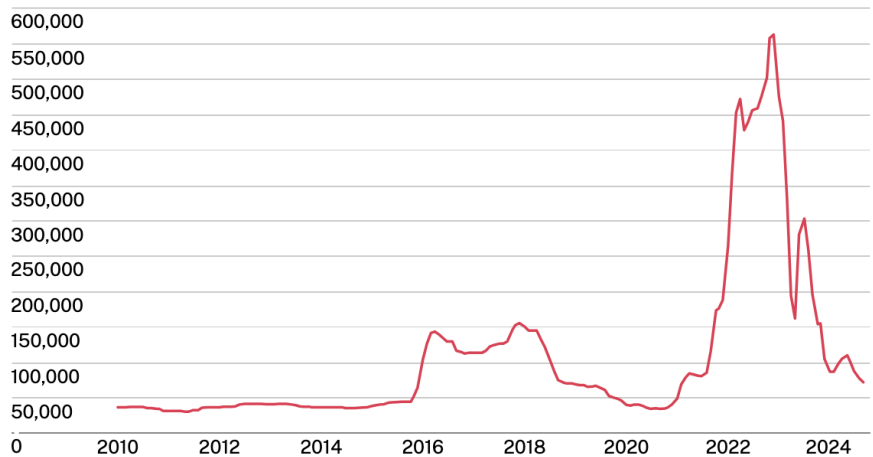
This chart compares the average prices of electric cars with those of petrol cars in selected countries. The zero line represents the average cost of petrol cars in that country and size category, while the sloped lines show how the relative cost of electric cars changed from 2018 to 2022. The chart is based on prices before any government subsidies.

Source: IEA

Moreover, electric cars have now been out long enough that a robust market in used ones is beginning to develop. This is critically important, for in markets across the world, the majority of people do not buy new cars; they buy used. Electric cars are now holding their value better than they did a few years ago, a sign of how much the cars themselves have improved. And in many of the world’s vehicle markets, it is becoming entirely possible to pick up a used electric model for \$15,000 or less.

Figure 19: Lithium gets cheaper

Real 2023 dollars per kilowatt-hour



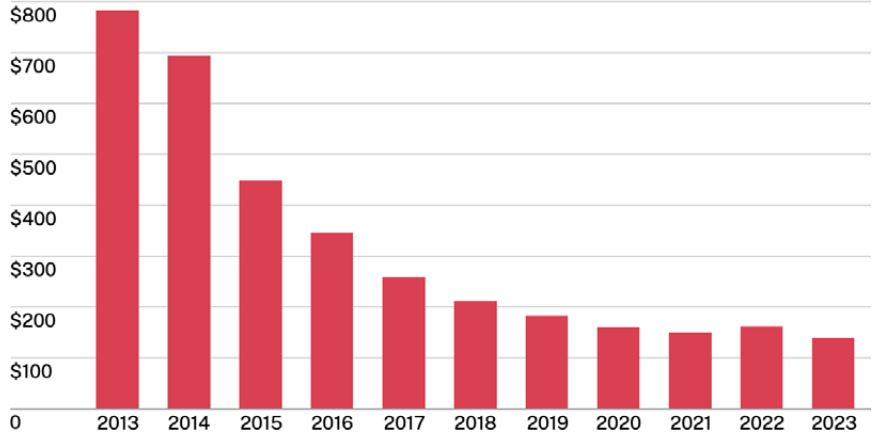
The price of lithium, an essential ingredient in most of the batteries that power electric cars, has come down sharply from its peak.

Source: Bloomberg

A couple of years ago, many people were panicking about whether enough metals like lithium, cobalt and manganese would be available to support the electrification of the vehicle fleet. But the price spikes that accompanied that panic brought a flood of new supply to the market, and metals prices have come off their recent peaks. The metals situation certainly remains complex and worrying for the long term, part of a geopolitical struggle for advantage that we will discuss later in this report. But in the near term, falling commodity costs are allowing battery manufacturers to cut their prices, making electric cars more affordable. Businesses are starting up to recycle lithium batteries, and we think that will become an important source of future supply.

Figure 20: Batteries get cheaper too

Dollars per metric tonne



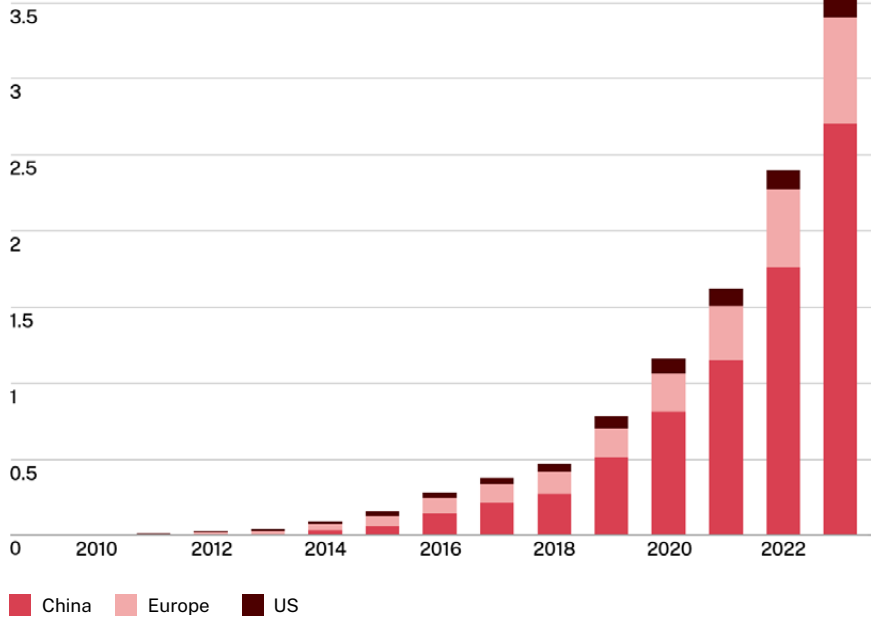
This chart shows the volume-weighted average price of lithium-ion battery packs and cells.

Source: BloombergNEF

The cars are still being subsidised in many markets, including a new \$7,500 subsidy for many models sold in the United States, as well as tax abatements and other incentives in European countries. But more and more governments, including China, are withdrawing these subsidies as no longer necessary, or they are realigning the subsidies to support domestic manufacturers, meaning fewer car models and fewer buyers are eligible. The good news is that many governments are turning their focus to the single most critical issue: building robust national charging networks. This may be the final hurdle to mass adoption of electric cars: reaching a point where drivers on long trips are confident the cars can be charged as easily as petrol cars can be refuelled. Worldwide, the number of public charging stations rose by 40 percent last year, but the network is still far from adequate; at least another decade of breakneck construction will be required to create a dense network.

Figure 21: Plugging in

Number of EV chargers, in millions



The number of public car chargers is rising rapidly worldwide, albeit with some countries lagging.

Source: IEA

Countries are converging on 2035 as the date they want to end sales of cars with petrol engines. More and more of them are writing this deadline into law, sending a clear signal to industry that a full transition is coming. We have seen some unfortunate backsliding on targets of this kind — the United Kingdom, for instance, moved its target for the end of petrol cars from 2030 to 2035 — but in most of the world, the deadline appears to be holding against political attacks fomented by the oil companies.

Jammed

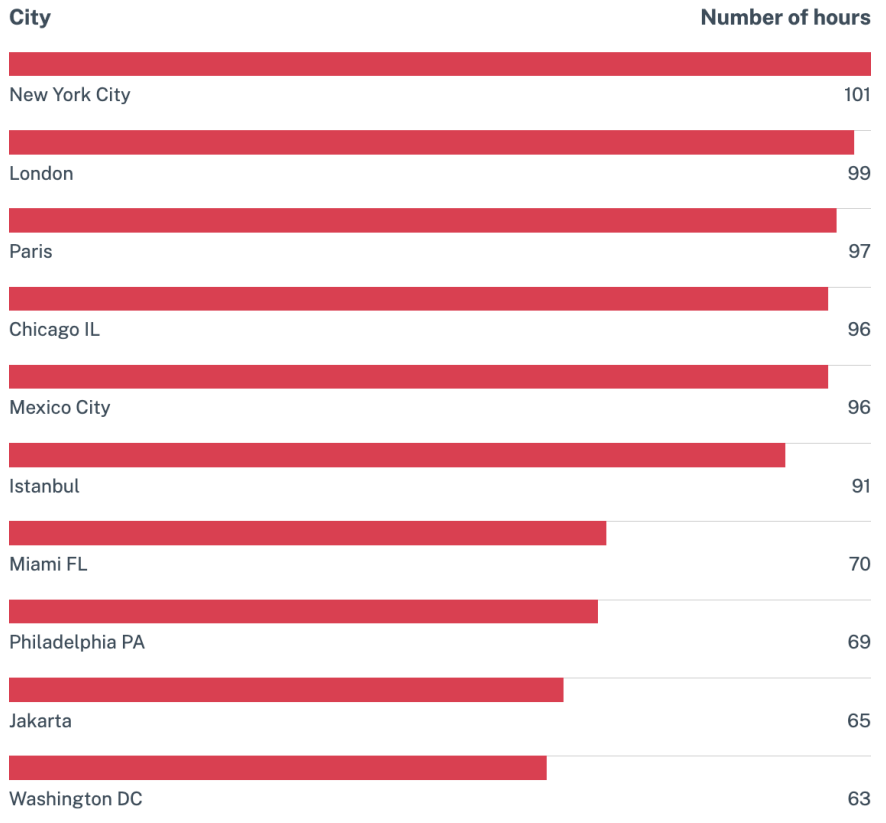


Traffic in midtown Manhattan, New York City, in early 2024. The governor of New York killed a congestion charge meant to reduce traffic.

Source: Associated Press / Alamy

Electric cars, even if they are much cleaner than petrol cars, are hardly a perfect answer to the world’s transportation woes. Smart transportation policy entails giving people alternatives to driving, including public transport, cycling and walking — that is to say, getting people out of cars. On this score, we are sad to report that 2024 featured a major setback.

Figure 22: Stuck in traffic



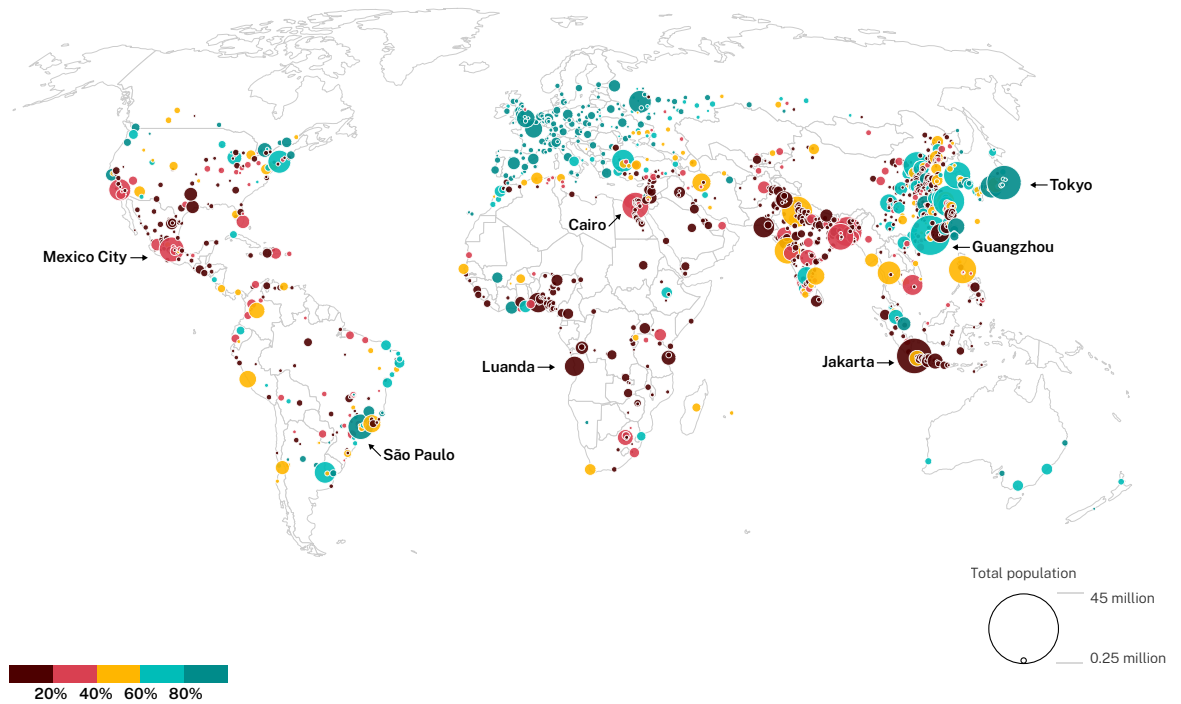
This chart shows the hours lost per driver, per year, sitting in traffic jams.

Source: INRIX

Singapore, London, Stockholm and Milan have proven that one of the best ways to manage traffic is a ‘congestion charge’ — a fee for driving a car into the densest parts of the city. They put the money raised into public transport, so that people have workable alternatives to driving. After decades of political struggle, New York City was poised to follow their lead, introducing the idea of congestion charging to the world’s most car-dependent country, the United States.

The plan, carefully negotiated over a decade of political struggle, was to impose a congestion charge of \$15 for cars driving into lower Manhattan, the most overcrowded part of the city.

Figure 23: Can you take the train?



This map shows the percentage of the population in each major metropolitan area having convenient access to public transport in 2023.

Source: Center for International Earth Science Information Network

5. Kaske, Michelle, 23 July 2024: "NYC's Transit System Faces Another Budget Crisis With Congestion-Pricing Pause." Bloomberg News.

6. The congestion charge was authorised by state law and the governor is being sued over her actions, so there is some prospect her policy will be reversed in the courts.

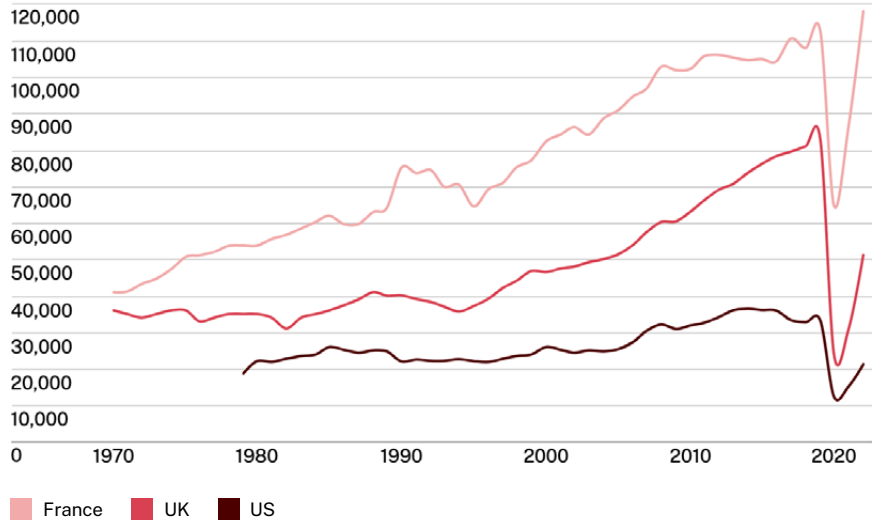
7. The most dramatic turnaround in public opinion occurred in Stockholm, after an experimental congestion charge over a period of months convinced sceptical voters of the merits of the plan. They then approved making it permanent in a referendum. For a detailed recounting of the saga, see Harvey, Hal and Gillis, Justin, 2022: "The Big Fix: 7 Practical Steps to Save Our Planet," Chapter 5, pp. 117-120. Simon & Schuster, New York.

Unfortunately, the governor of New York, Kathy Hochul, panicked at the last minute and pulled the plug on this carefully negotiated plan, blowing a \$16.5 billion hole in New York's transport plans.⁵ Apparently, she was worried about the political consequences of angering suburban drivers in an election year.⁶

The governor ought to have known the history of these plans: people profess to hate them until they go into effect, but then they see how well it works to thin traffic, and public opinion turns around.⁷ We fear the idea of congestion charging in America may now be dead for another generation due to the governor's actions. We can only hope that some bold American city, perhaps on the West Coast, picks up the mantle and demonstrates to the rest of the country that congestion pricing is an intelligent urban policy. This is exactly what happened in other countries: after the success of congestion tolling in London and Stockholm, smaller cities in Sweden and the UK picked up the idea and put successful schemes into place.

Figure 24: All aboard

Passenger kilometres



Countries like France that have invested heavily in their rail networks have seen rising ridership, compared to countries like the United States with poor passenger rail. Rail ridership in virtually all countries collapsed during the pandemic and has not recovered everywhere.

Source: OECD

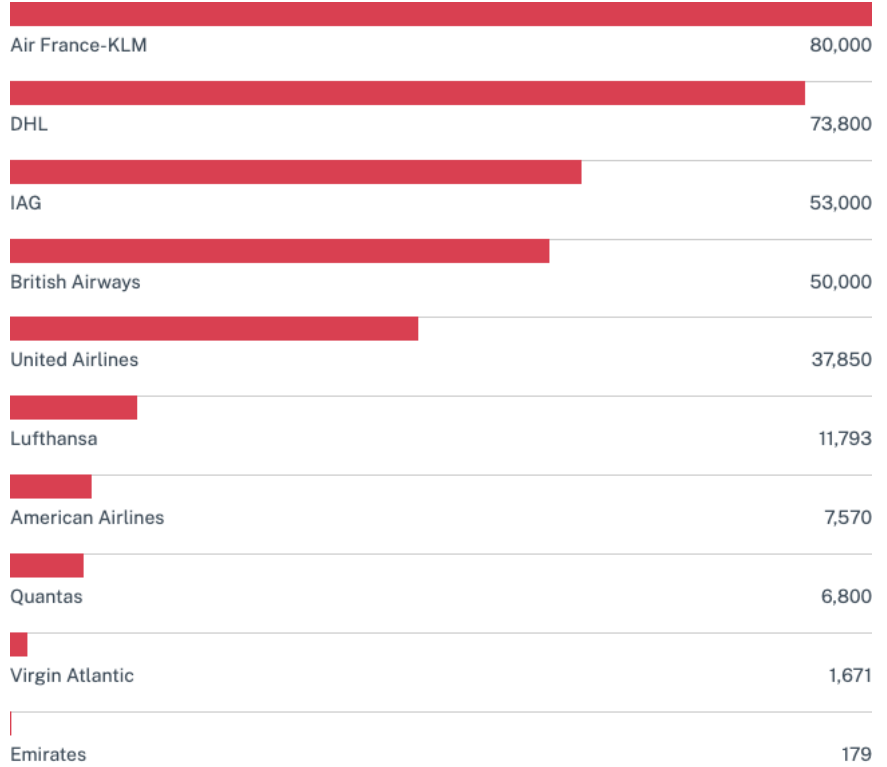
If the transition to electric cars is fully under way, the conversion of heavier vehicles is lagging. For ships, planes and heavy lorries or trucks, plans to cut emissions are still in their infancy, though 2023 and early 2024 did see incremental progress.

While Airbus, the European aircraft manufacturer, is experimenting with a plane designed to run on clean hydrogen, most experts believe the path forward will be to use conventional jet engines powered by ‘sustainable aviation fuel,’ essentially identical to jet fuel made from oil. But the feedstock to make this fuel would likely be plants, with early efforts focusing on converting waste oils to jet fuel. The supply of waste oils is limited, though, so the industry has been looking at Brazilian sugar cane and American maize as potential feedstocks. So far costs are quite high, but governments are supporting the effort to get a sustainable fuel industry off the ground. More importantly, the airlines are finally beginning to support it, and to procure small quantities of fuel from the earliest factories. As with electric cars, sustainable aviation fuel will not be a perfect answer to the problem of greenhouse emissions from planes, but there are hopes that the best schemes will be able to cut emissions by more than 50 percent.

In an intriguing development in public policy, some European countries have already banned short-haul flights if a high-speed train competes on the same route, essentially forcing people to take the train, with its far lower greenhouse emissions. It is on these short routes that electric aeroplanes might ultimately prove workable; if Europe were to allow them onto routes where fuel-burning planes are banned, that might be a way to jump-start

the market for these planes. The airlines are fighting the bans, belying their claims to be working toward sustainability.

Figure 25: Searching for an alternative



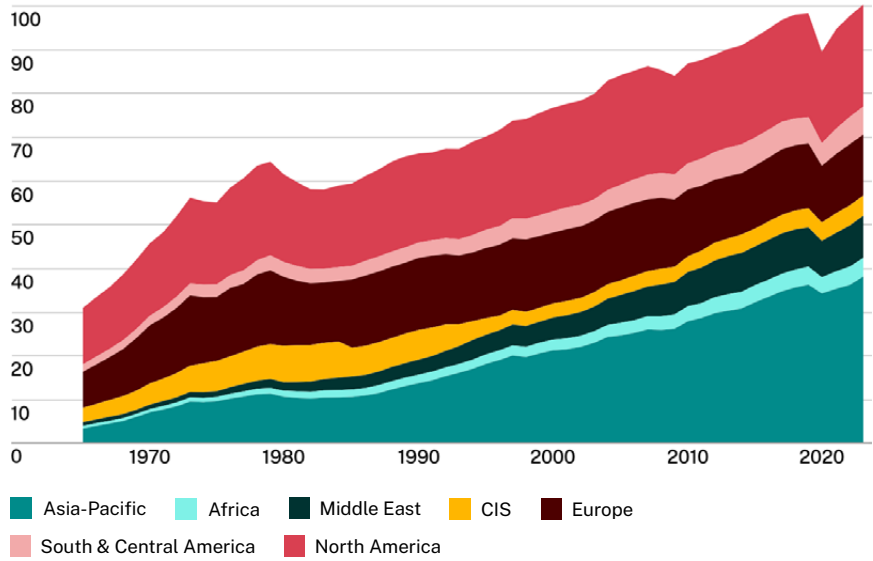
The chart shows that airlines are finally starting to buy meaningful quantities of 'sustainable aviation fuel,' made from plants or from waste cooking oil. The volumes are still low, however, compared to their use of jet fuel. Air France-KLM, for example, purchased 80,000 tonnes of the sustainable fuel in 2023, but this represented only 1 percent of its total fuel consumption.

Source: Generation analysis of airline disclosures

The options are somewhat broader when it comes to shipping. Ships, too, could run on fuel made from plants, but they may have cheaper possibilities. Short-haul ships, like ferries, can be electrified, and in fact some battery-powered ferries have already gone into service. Shipping goods across the ocean is likely to require burning fuel; the best choice might be ammonia, which can be made from clean hydrogen with minimal emissions of greenhouse gases. The fuel itself will need to be transported, as oil is today: 2023 saw the first big orders of tankers designed to carry large quantities of ammonia across the sea. The shipping giant Maersk is pushing particularly on ammonia as the potential shipping fuel of the future.

Figure 26: A thirst for crude

Million barrels per day



This chart shows global oil consumption from 1965 to 2023. The CIS category includes the former Soviet Union and its successor states.

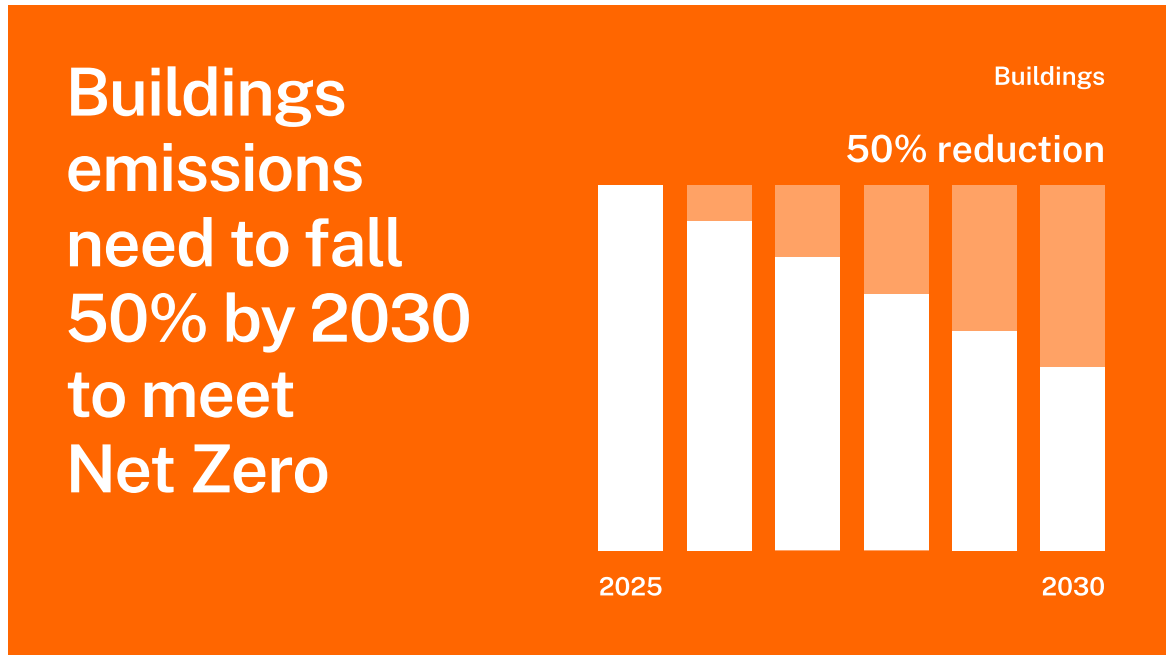
Source: Statistical Review of World Energy 2024

For a long time, it was unclear whether electrification would be a workable strategy for the primary mode of goods-hauling on land: long-distance trucking. But batteries are improving so rapidly that this is starting to look like the best way forward, and 2023 saw production announcements and orders for electrified Class 8 tractors, the largest lorries on the roads. The market is still small and tentative, and complete electrification of these vehicles might easily take until the 2040s, but we do seem to be at the beginning of a trend. Already, the spread of electric city buses, school buses and urban delivery lorries has proven that the size of the vehicle is no intrinsic barrier to electrification. Across large urban areas, China has already replaced fuel-burning buses with electric ones.

The trick with long-distance haulage trucking will be figuring out how to charge the vehicles. Trying to charge such large vehicles rapidly at depots could place enormous strains on the power grid, and it is unclear if this will be the cheapest option. Other possibilities include embedding charging coils in roads, so the lorries could charge as they travel, or using robotic systems to switch out the batteries in the vehicles for fresh ones. Such a system would entail large upfront investments, but once those are in place, the battery changes could be done in 45 seconds; it may prove to be the simplest method. Experiments are under way with all these approaches.

04

Buildings



Far off track

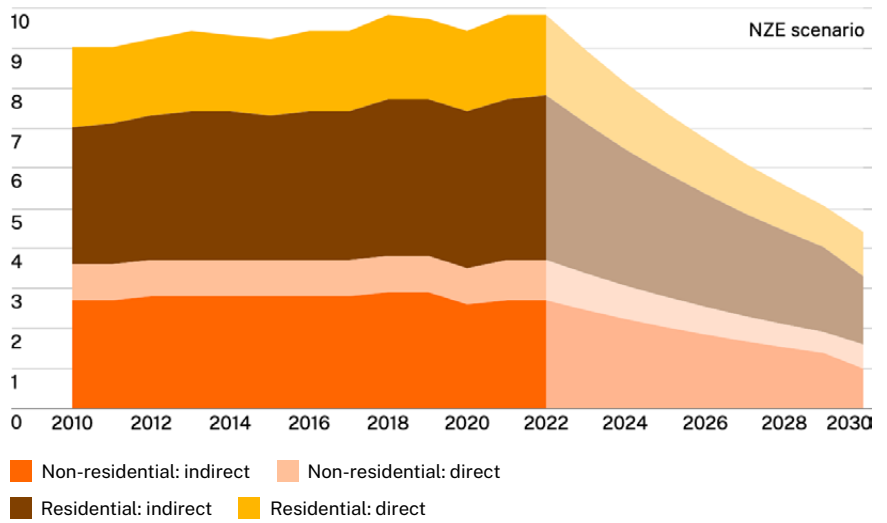
The buildings sector is not on track to help meet the world’s climate goals. Modest improvement in the efficiency of buildings is occurring at a global scale, but this is being swamped by the construction of new buildings, most of them in the developing world and many of them built to standards far below what is achievable. Counting the electricity they use, buildings account for 26 percent¹ of the world’s energy-related emissions, so cleaning them up is critical.

Building emissions did fall somewhat during the pandemic years, and there was hope those declines might be the beginning of a sustained trend. It turned out to be a vain hope: building emissions recovered in 2022, then dipped only slightly the next year due to milder weather. There is no sign yet of the sustained downturn in building emissions that is urgently needed.

1. Note that the denominator for this statistic is energy-related emissions, not all global emissions. See International Energy Agency, 2023: “Buildings,” in “Tracking Clean Energy Progress.” Paris.

Figure 27: Holding steady

Annual CO₂ emissions, in gigatonnes

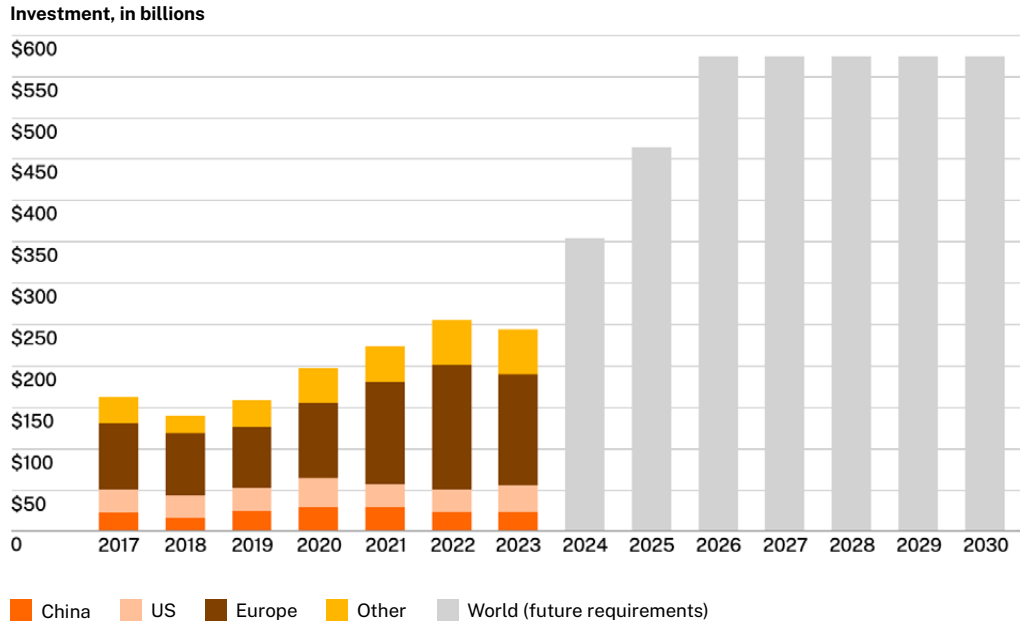


The chart shows building emissions through 2022 at left. At right, it shows the steep decline in emissions that would be required to meet the International Energy Agency's Net Zero Energy scenario, designed to fulfil the goals of the Paris Agreement. Direct emissions are those from burning fossil fuels like gas on-site, and indirect emissions are those from electricity and heat created off-site and delivered to buildings.

Source: IEA, Generation analysis

One of the prime measuring sticks for tracking progress on climate goals is the Net Zero Energy by 2050 scenario published by the International Energy Agency. That scenario calls for total building emissions to fall by about 50 percent by 2030, but all indications are that they are likely to keep rising in the near term, despite a small dip in 2023 from milder weather. The 2030 goal looks quite challenging in this sector.

Figure 28: Action needed



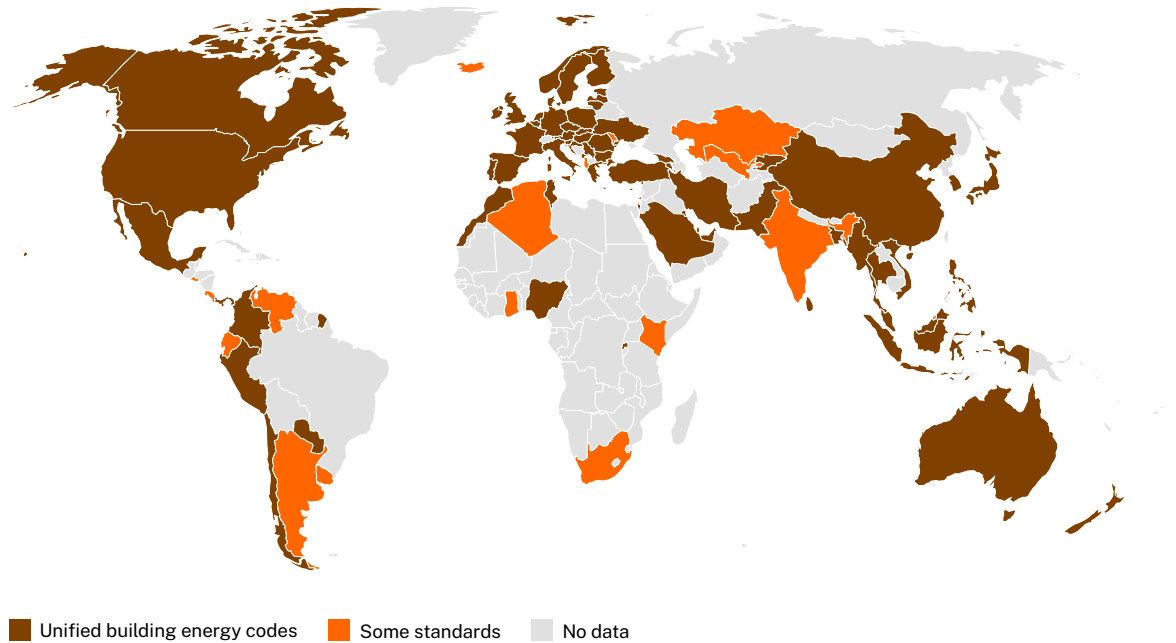
This chart shows historical investments in the energy efficiency of buildings, compared to what would be required to meet the International Energy Agency's Net Zero Energy scenario. Note that Generation has interpolated values for 2024 and 2025 by assuming a linear progression toward the \$547 billion annual requirement that starts in 2026.

Source: IEA

As with most of the other ways we are off track, this is a failure of public policy. Governments have not adopted sufficiently strict building codes; when they do adopt them, they fail to enforce them. This problem is pervasive even in the rich countries, where builders and property brokers have done their best to torpedo tough standards on the grounds that it raises the cost of construction. It does do that, slightly, but building occupants recover the money in lower energy costs, leaving them better off in the long run.²

2. Hammond, Geoffrey P., and Harvey C. K. Lee, 2021: "Thermal Engineering, Renewable and Sustainable Energy Reviews." *Energy*.

Figure 29: Follow the rules



This map shows countries with legal standards designed to save energy in buildings.

Source: IEA

The problem is greater in the developing world, where breakneck urbanisation means that millions of buildings are going up with inadequate construction standards or oversight. Every bad building we put up wastes energy for decades, so the neglect of this problem means we are locking in unnecessary emissions for the long term.

Roughly half the world’s population lives in hot climates, and the International Energy Agency found that only about 15 percent of them had air-conditioning as of 2021. In fact, for most of history, new buildings going up in tropical countries had neither heat nor air-conditioning, so the energy problem was not so acute. But that is changing fast: as the climate crisis unfolds and killer heat waves become more common, a mad rush to install air-conditioners is under way. This is not necessarily a luxury: as global overheating reaches life-threatening levels, access to air-conditioning is becoming a necessity. At least a quarter of the world’s population is potentially exposed to heat stress due to a lack of indoor cooling.³

³ International Energy Agency, 2023: “Sustainable, Affordable Cooling Can Save Tens of Thousands of Lives Each Year.” Paris.

Breakneck construction



A building under construction in Lagos, Nigeria.

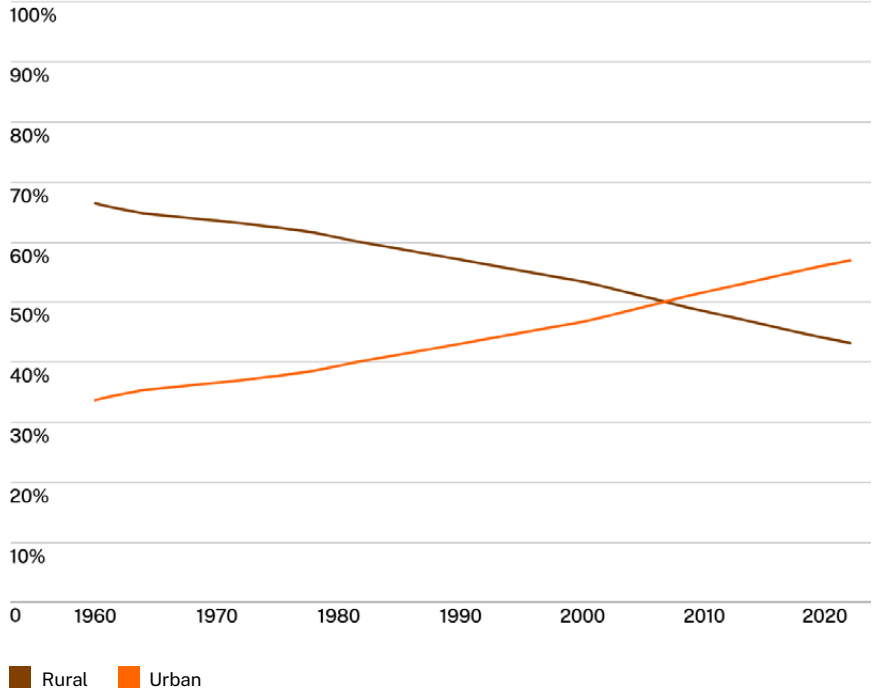
Source: Colin C. Hill/Alamy

4. International Energy Agency, July 2023: "Tracking Buildings," in "Tracking Clean Energy Progress 2023." Paris.

This bleak picture does feature a few bright spots. Only a third of the emissions from buildings come directly from the burning of fossil fuels on-site. The bulk of the energy used is electricity from the grid.⁴ This means that as the world's grids are cleaned up, buildings will get intrinsically cleaner without their owners or occupants having to do anything. However, we need to worry about the overall strain on the power grid as we electrify more and more of the economy, so having buildings wasting power is far from ideal. Tighter construction standards in buildings would be good for the grid as well as for the people paying the energy bills in those buildings.

Figure 30: Moving to the city

Percentage of total population



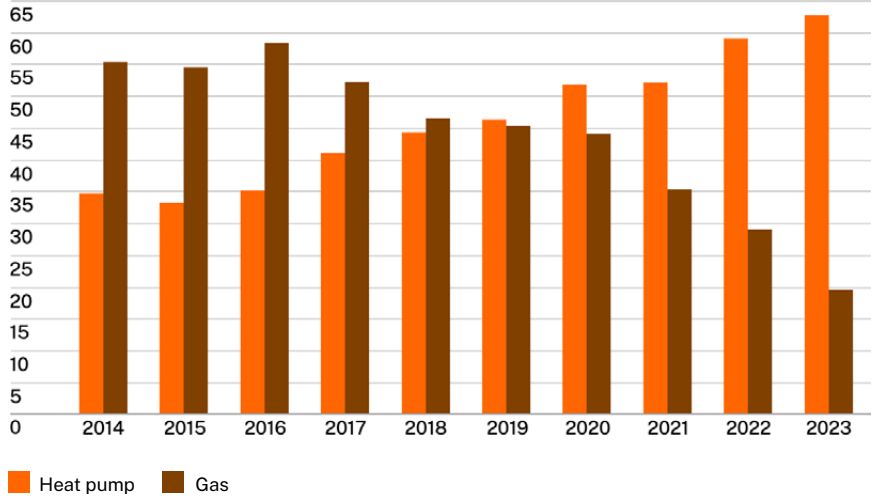
The human population became primarily urban in 2007, and the trend continues. Rapid urbanisation is leading to breakneck construction of new buildings, often to poor standards.

Source: World Bank

The proportion of building energy coming from fossil fuels is on track to shrink. Heat pumps — electrically powered devices that can replace both furnaces and air-conditioners — are claiming market share from gas boilers and furnaces. Heat-pump sales actually dipped in 2023, but in many countries, sales of gas appliances fell further. A combination of factors seems to be at play: the rush to heat pumps that occurred during the energy crisis has abated somewhat; households squeezed by inflation are putting off major purchases of all kinds; and in some countries, subsidies for heat pumps have been reduced. Still, the case of Germany shows how heat pumps are continuing to claim market share.

Figure 31: Out with the old

Number of installations, in thousands



With government encouragement, German builders are increasingly choosing heat pumps over gas furnaces in newly constructed properties.

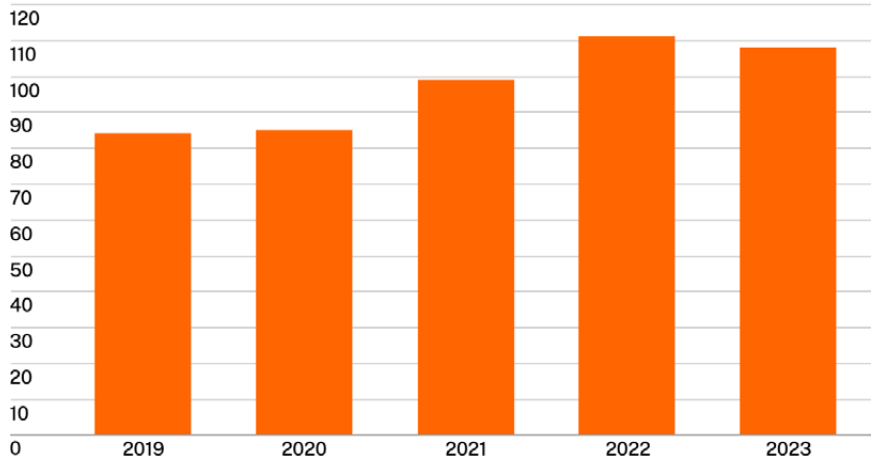
Source: Federal Statistical Office (Destatis)

This trend is important for the climate because heat pumps are far more efficient than furnaces. In China, emissions over the life cycle of even the least efficient heat pumps are nearly 50 percent lower than from gas boilers, and in Canada, that figure is 75 percent.⁵ If heat pumps run on clean electricity, they may create no operational emissions at all. In many countries, they do still cost more up-front than furnaces or boilers, so governments have supported the switch to heat pumps with subsidies and other incentives. It is one of the few areas where public policy has led to a genuine climate success in the buildings sector.

5. International Energy Agency, 2022: "The Future of Heat Pumps." Paris.

Figure 32: Making the switch

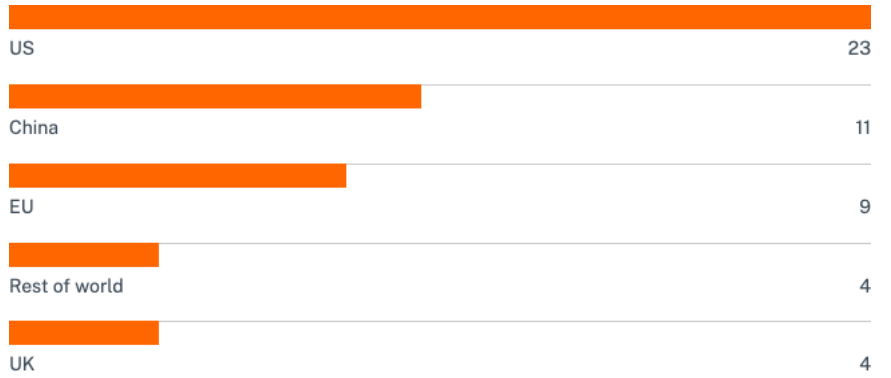
Thermal output, in gigawatts



This chart shows global sales of heat pumps by year, in gigawatts of thermal output.

Source: IEA

Figure 33: Cleaner and greener



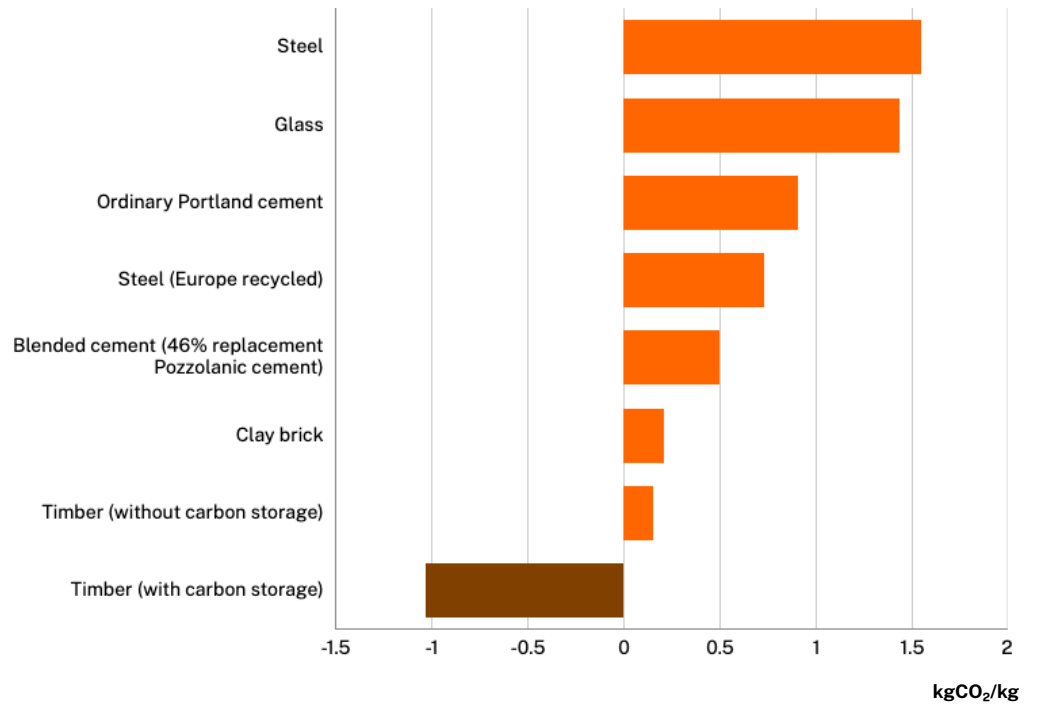
This chart is an estimate of the total emissions avoided in 2023 by the level of heat-pump deployment that occurred from 2019 to 2023.

Source: IEA

Another big problem with buildings has to be tackled promptly. While most of a building’s emissions are caused by operating it over its lifetime, a significant fraction — often a third to half — of the emissions are in the form of ‘embedded carbon.’⁶ This term describes the emissions of carbon dioxide and other greenhouse gases that were used to create the building materials used to construct the building.

6. World Business Council for Sustainable Development, January 2023: “Net-Zero Buildings: Halving Construction Emissions Today.”

Figure 34: Embedded emissions



This chart shows the embedded emissions, in kilograms of CO₂, for each kilogram of building material produced.

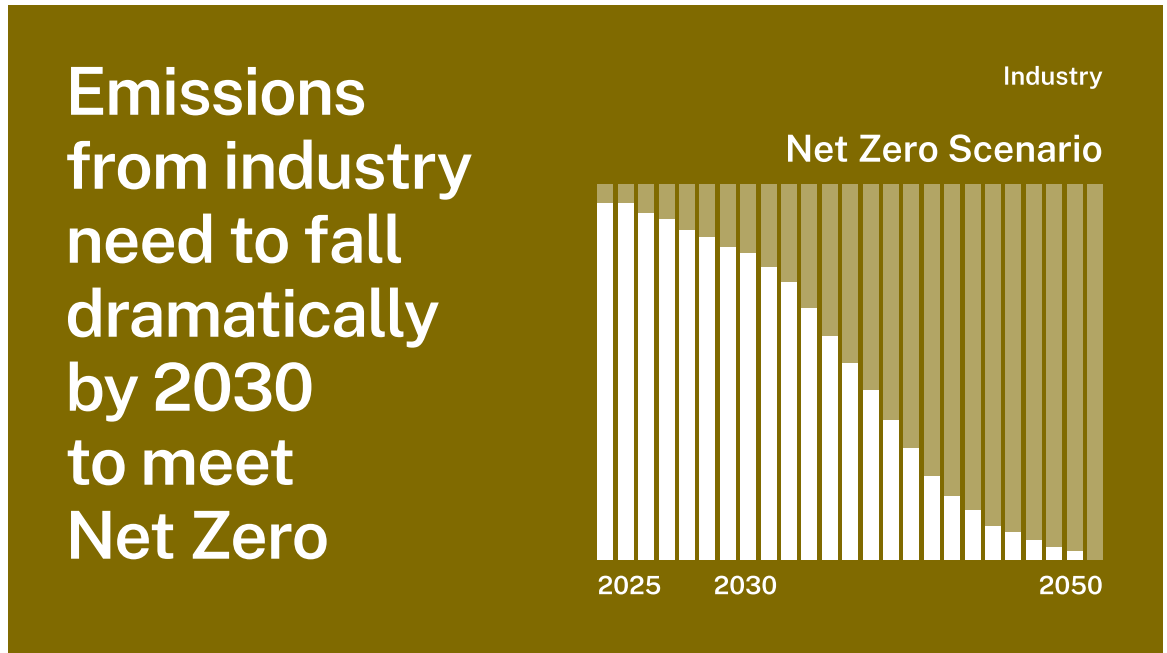
Source: ICE database

In principle, these emissions can be lowered, either by substituting materials or using less material overall. Countries need to adopt national regulations requiring such calculations, and setting standards regarding how fast the embedded emissions of new buildings need to fall. Countries that have recently adopted regulations on embedded emissions, or are on the verge of doing so, include France, Denmark, Finland, Sweden, the Netherlands and New Zealand.

For decades the construction industry fought off such requirements, but they are finally starting to lose the battle, and more progressive builders are embracing the need to find a better way. Some are experimenting with building materials that can cut emissions sharply, or even store away carbon for decades. Timber used in construction, for example, stores carbon away from the atmosphere, assuming trees are allowed to grow back in place of those that are cut. Efforts are under way to prove that timber, specially treated with modern techniques, can be the main structural material even in very large buildings.⁷

7. Roberts, David, 15 Jan 2020: "The Hottest New Thing in Sustainable Building is, Uh, Wood." Vox.

05 Industry



Market signals needed

The world’s most successful environmental treaty was adopted in the late 1980s, with a push from two leading lights of the conservative movement: British Prime Minister Margaret Thatcher and American President Ronald Reagan. Both were instinctively suspicious of the United Nations and its attempts to make international law. Mrs Thatcher, however, was also an Oxford University-educated chemist who understood the scientific finding that certain industrial substances were destroying the layer of ozone gas high in the atmosphere. That layer protects the Earth’s surface from deadly levels of ultraviolet radiation.

Worldwide alarm led to the push for a treaty to control those substances. Mrs Thatcher supported the goal, and she persuaded Mr Reagan to overrule his advisers and support it. With the American and British governments playing constructive roles in the UN negotiations, the Montreal Protocol on Substances that Deplete the Ozone Layer went into force in 1989. As a result, ozone-depleting gases in the atmosphere are falling and the ozone layer is recovering.¹ Some of the destructive substances are also strong greenhouse gases, so the protocol — after nine revisions to add new rules — is also helping to limit global warming. It was the first treaty in history to achieve universal ratification, standing as a shining example of what is possible in protecting the environment.

1. World Meteorological Organization, 2022: “Executive Summary, Scientific Assessment of Ozone Depletion, GAW Report No. 278.” Geneva.

A walk in the woods



President Ronald Reagan with Prime Minister Margaret Thatcher at Camp David, in Maryland, in 1986, the period when the Montreal Protocol was being negotiated.

Source: Wiki Commons

Now, the countries of the world are trying to negotiate a new treaty, with the Montreal Protocol as a model. The goal is to protect the world from the rising tide of plastic pollution. Negotiations have entered a feverish stage, and are due to conclude late this year in Busan, South Korea, though the possibility of delay cannot be ruled out. A weak outcome would be a treaty that merely takes some steps to improve the dismal rates of plastic recycling and discourages the most wasteful single-use plastic products. A strong treaty would be one that follows the example of the Montreal Protocol, setting explicit limits on what kinds of plastic can be produced, in what quantities. It would require that only genuinely recyclable plastics be created, and would contain strong measures to encourage the development of a ‘circular economy’ in which plastics are never discarded into the environment or burned.

Without such limits, some analysts warn that the production of plastic could nearly triple by 2060.² Plastics — in visible chunks or as ‘microplastics’ too small to see — already litter the depths of the ocean, the tops of the highest mountains and everywhere in between. Microplastics contaminate the food supply as well as human bodies, and have been found lodged in people’s brain tissue.³ Whether they are causing damage to human health is an area of active research, though it is clear that plastics represent a threat to wildlife. The great Pacific Ocean garbage patch has become a symbol of humanity’s woeful stewardship of the environment.

2. Organisation for Economic Cooperation and Development, 2022: “Global Plastics Outlook: Policy Scenarios to 2060,” p. 26. OECD Publishing, Paris.

3. Main, Douglas, 21 August 2024: “Microplastics Are Infiltrating Brain Tissue, Studies Show: ‘There’s Nowhere Left Untouched.’” *The Guardian*.

The plastic threat



A black-footed albatross chick with plastics in its stomach lies dead on Midway Atoll in the Pacific Ocean.

Source: The Syndicate / Alamy

4. "Plastics — The Fast Facts 2023." Plastics Europe, 2023.

5. Winters, Joseph, 16 August 2024: "The US Says it Now Supports a More Ambitious Plastics Treaty. Industry Groups are Furious." Grist.

6. Dhakal, Minx and Toth et al: "Emissions Trends and Drivers," in "Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change." Cambridge University Press, Cambridge, UK and New York, NY, USA: p. 237.

7. International Energy Agency, 2020: "Iron and Steel Technology Roadmap." Paris. The figure in the original source has been amended to use total global emissions, rather than energy-only emissions, as the denominator.

8. International Energy Agency, 2023. "Tracking Cement," in "Tracking Clean Energy Progress 2023." Paris. The figure in the original source has been amended to use total global emissions, rather than energy-only emissions, as the denominator.

Something like 400 million tonnes of plastic is produced every year.⁴ The main feedstocks used to create it are oil and certain liquids associated with the production of fossil gas. The fossil-fuel industry thus sees the plastics treaty as a threat to a major and growing part of its business, and is attempting to torpedo the global negotiations. The American government was kowtowing to these interests until recently, but as this report was going to press, announced that it would switch gears and support firm limits on plastic production⁵. Some other governments are still obeisant to the fossil-fuel interests, however, and the outcome of the negotiations is far from certain. Rwanda and Norway are leading a coalition of 65 countries and the European Union in seeking a strong treaty.

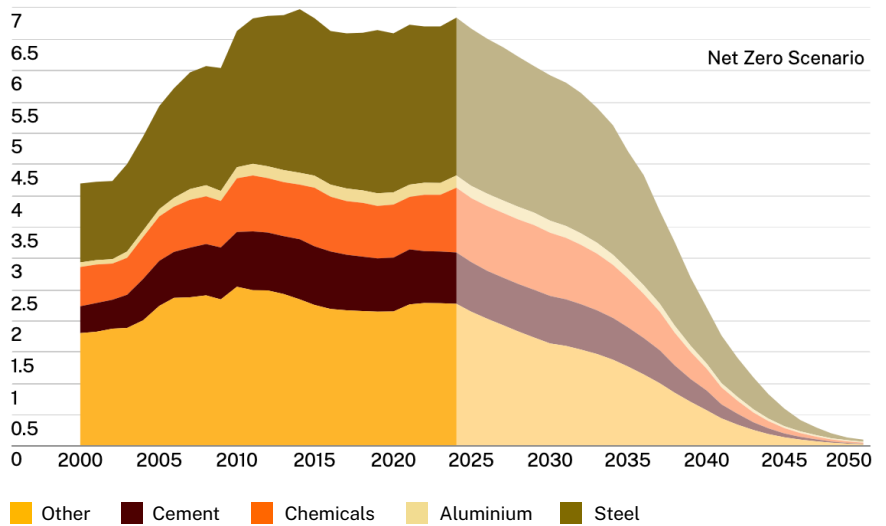
We are hoping for a bold outcome in the negotiations, and not just because the world needs to get control of plastic pollution. If we can prove that the Montreal Protocol was not a one-off — that limits on the production of problematic substances can be written into international law — then the prospects improve for other agreements that could help to bring down greenhouse gas pollution from the world's industries.

Industry is responsible for 34 percent of the excess carbon dioxide entering the atmosphere, making it the largest emitter of the sectors we analyse.⁶ Plastic accounts for about 3 percentage points of that total; plastic is arguably more important as a source of litter than as a source of greenhouse gases. Production of steel⁷ and cement⁸ each accounts for at least 25 percent more greenhouse gas pollution than does the plastics industry.

Overall, the world’s factories and mines constitute one of the most problematic sectors, with clean production methods still in their infancy for many industries. The International Energy Agency reckons that industrial emissions need to begin falling between now and 2030 if we are to stand a chance of meeting the most ambitious goal of the Paris Agreement: limiting global warming to 1.5 degrees Celsius above pre-industrial levels. But so far, those emissions are not falling. They have been essentially flat for five years, and may start rising again as the Chinese economy recovers from its recent downturn. New steel plants, new cement plants and new chemical factories are under construction or on the drawing board all over the world, with few of them expected to use low-emissions technologies.

Figure 35: From the smokestack

Annual CO₂ emissions, in gigatonnes



This chart shows historical emissions from industry on the left, and in the shaded area at right, the steep decline required to meet global climate goals. There is no sign so far that industries are preparing to cut their emissions as rapidly as required.

Source: BloombergNEF

The biggest problem is that demand in the marketplace for cleaner production has yet to emerge in a significant way. Many of the biggest emitters are producing commodities like cement and steel at low margins, and are extremely sensitive to higher costs. Ultimately, public standards are the only way out of this conundrum: rules that require a rising percentage of clean steel or cement, for example, would level the playing field and give industries the incentive to invest in new methods. That would ultimately bring costs down, but it would take time.

Making steel



Most mills producing virgin steel use fossil fuels and emit prodigious quantities of greenhouse gases. Here, a worker performs his duties at a steel mill in Ukraine.

Source: Ukrinform/NurPhoto via Getty Images

Fortunately, we are beginning to see early signs of such marketplace demand for cleaner methods. A coalition of European companies recently announced, for instance, that they would buy ‘green’ steel and pay a premium for it. Emissions from steel production can be cut sharply by replacing fossil fuels in a furnace with hydrogen; the hydrogen must be made using renewable electricity. The resulting product is known as green steel. A Generation subsidiary, Just Climate, and its clients invested in one of the first such plants, H2 Green Steel in Sweden, a few years ago. (As this report was going to press, the company changed its name to Stegra.) Just within the past 18 months, the number of such plants on the drawing board has tripled, from two to six.⁹ At the moment, green steel is costlier to make: the initial premium over regular steel is expected to be in the order of 25 percent, and the companies willing to pay it include manufacturers of wind turbines and of electric cars.

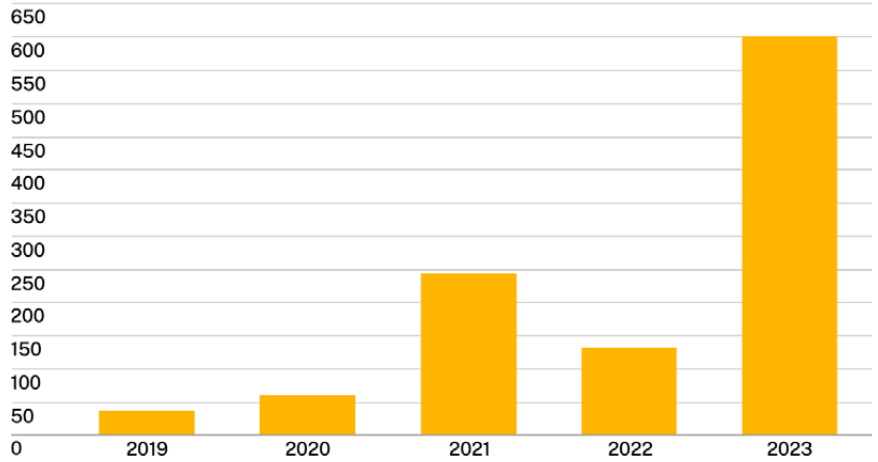
Green hydrogen, produced by using renewable electricity to split water molecules with no resulting greenhouse emissions, will be a critical input for the first green steel plants. An abundant supply of green hydrogen would also be a boon for the chemicals industry, a prodigious source of emissions. It could help to clean up plastics production. It could be used to completely decarbonise the production of ammonia, a fertiliser critical to the world food supply.

Two things will be vital for producing abundant green hydrogen: a piece of kit called an electrolyser, and plentiful clean electricity. Electrolysers use power to split water into hydrogen and oxygen, and they will need to be deployed in the tens of millions to make a real dent in industrial emissions. Fortunately, electrolyser manufacturing is beginning to scale, and costs are falling.

9. LeadIT, 2024: “Green Steel Tracker.” Leadership Group for Industry Transition.

Figure 36: Split those molecules

Capacity, in megawatts



This chart shows shipments of electrolysers capable of making hydrogen by splitting water molecules, measured by megawatts of electrical input.

Source: IEA

You might have supposed, from all the hype around green hydrogen in recent years, that a vast surfeit of it must be on the way. Unfortunately, this is not the case, as the hype sped ahead of reality. Green hydrogen is still three to four times more expensive than dirty hydrogen produced from fossil gas,¹⁰ and that cost can only be brought down by scaling the market — which means somebody has to ‘overpay’ for the first projects using green hydrogen.

This is the kind of problem classically solved by government intervention to subsidise early developments and create demand, but in this instance, as in others, governments have talked a bigger game than they have played. Many hundreds of green hydrogen projects are on the drawing boards of hopeful developers, but few of them are proceeding to final investment, with financiers worried about the lack of a market for such a costly product. Some projects, announced with great enthusiasm only a few years ago, have already been cancelled.¹¹ The city of Hanover in Germany figures it is out of pocket €10 million of taxpayers’ money on a failed project.¹²

It is true, however, that subsidies are finally beginning to flow from governments in Europe, Japan and the United States to develop the market for green hydrogen. The United States government in 2023 awarded \$7 billion in grants for seven ‘hydrogen hubs’ spanning the country, and some of these are already under construction. Japan is keenly interested in developing an international market for trading clean hydrogen or its derivative, ammonia, by ship. Within a few years, we should begin to get an idea of how fast the costs can come down. China is making a big push to cut the cost of electrolysers and is already selling them more cheaply than other countries, though the quality of the Chinese equipment has been questioned. If China can solve that,

10. International Energy Agency, 2023: “Global Hydrogen Review 2023.” Paris.

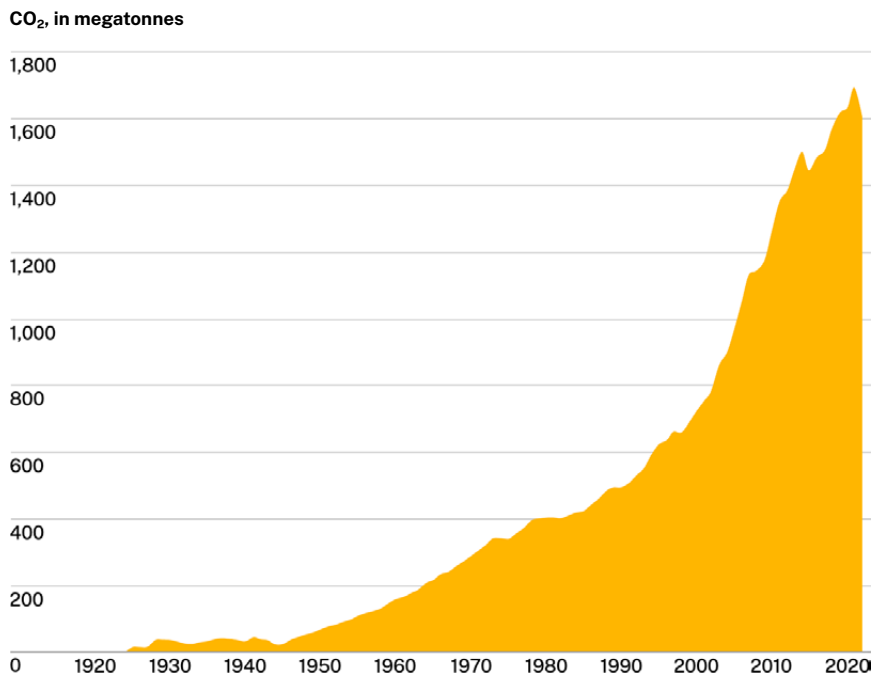
11. The landscape is already littered with scrapped projects, unfortunately. See Memija, Adnan, 4 March 2024: “SSE, Equinor Ditch Green Hydrogen Plans for Dogger Bank D Offshore Wind Farm.” Offshore Wind. Also See also Memija, Adnan, 14 March 2024: “Vattenfall Scraps Hydrogen Turbine Pilot Project.” Offshore Energy. And see Martin, Polly, 2 February 2024: “Government-Backed Green Hydrogen-to-Methanol Pilot in Belgium Scrapped Due to Escalating Costs.” *Hydrogen Insight*.

12. Parkes, Rachel, 14 August 2024: “No Firm Customers; Failed Hydrogen Project Leaves €10m Hole in City’s Accounts Amid Spiralling Costs.” *Hydrogen Insight*.

it might end up owning a large share of the equipment market, as it has done for other green industries.

In the cement industry, emissions are basically static, not falling at the brisk clip necessary to achieve climate goals. Cement is a special case, because the emissions come not primarily from burning fossil fuels; they are an inherent part of the chemical process of turning limestone into ‘clinker’ — the binder that is the critical ingredient in cement. The chemical transformation throws off carbon dioxide as a waste product. Methods to lower the carbon footprint of cement are under development, but would drive up costs in a low-margin industry, so they have not been widely embraced.

Figure 37: Cement emissions



This chart shows global emissions from cement production since 1920.

Source: Global Carbon Budget

Tentative change is occurring as governments impose emissions standards for the cement they buy to build roads and bridges; such civil engineering projects can be half the cement market in some countries. These governments are sending a market signal that is inducing cement-makers to look closely at their options, and a few clean-cement projects are moving forward. But we are not likely to make fast progress until that market signal becomes much stronger, with most or all buyers of cement demanding a low-emissions product.

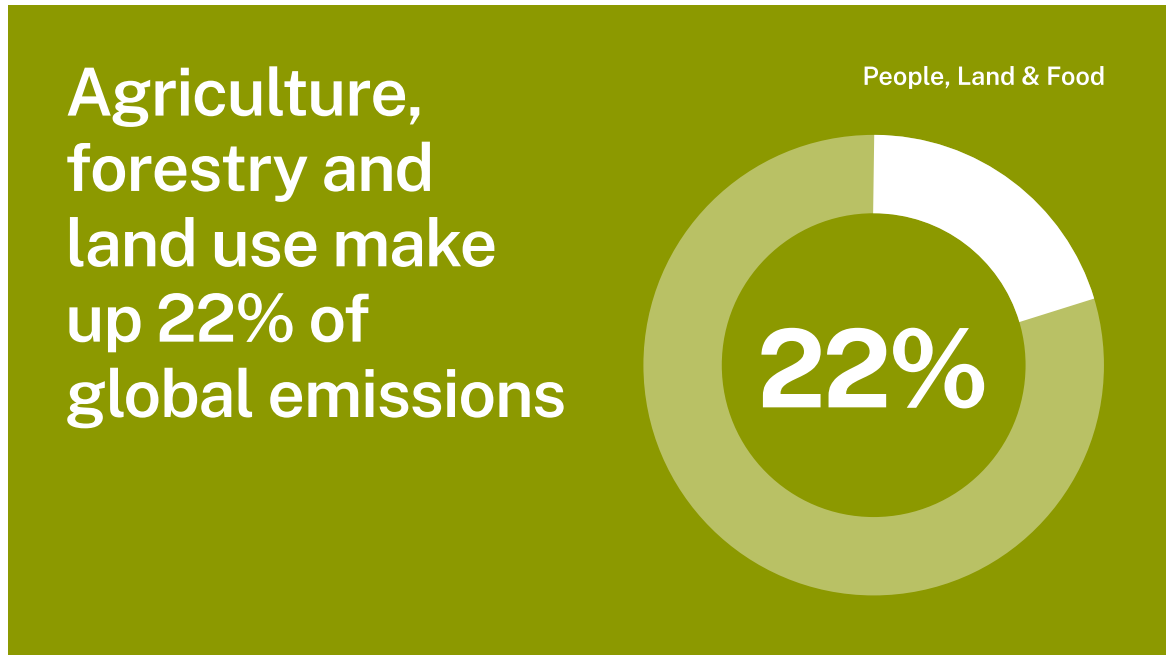
Though change is not happening fast enough, we are beginning to see the development of the kinds of public policies that could ultimately transform whole industries. The European Union, for instance, has just put into effect an instrument called a carbon border adjustment mechanism. As of 2024,

importers of several high-emissions industrial products, including cement and steel, are having to report the emissions created by their products. Beginning in 2026, the EU will levy tariffs on these products designed to reflect their emissions intensity. Producers within the EU already face emissions taxes, so the idea in the short term is to create a marketplace in which importers do not enjoy an unfair advantage over domestic producers.

The long-term goal, of course, is to encourage all countries wishing to export their goods to the EU to adopt emissions taxes or other strong policies to clean up their economies. Wider adoption of carbon border taxes by countries beyond the EU could have a dramatic effect in encouraging cleaner production worldwide.

06

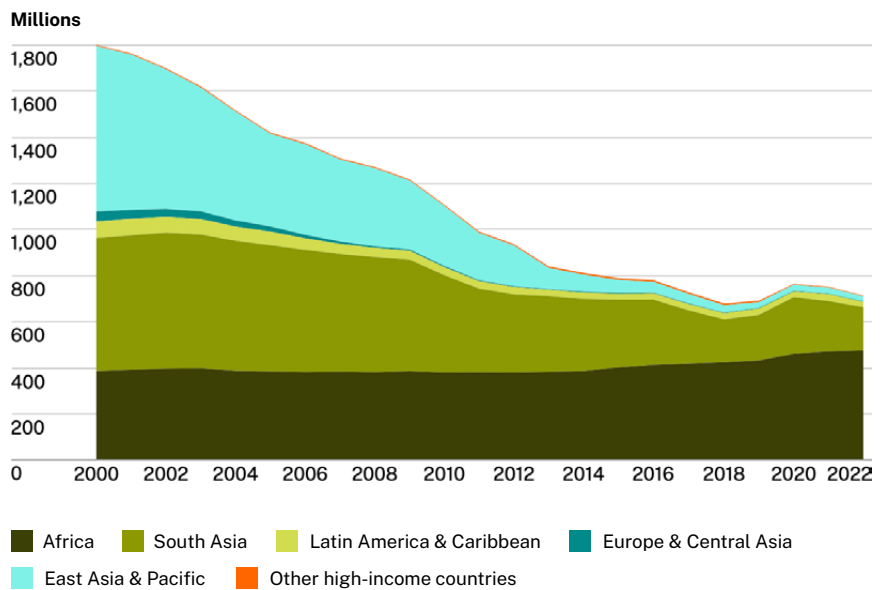
People, Land & Food



A food system under stress

An exceedingly worrisome trend has come into focus in the past few years. The slow, steady progress against hunger that had been a feature of the world economy for decades came to a halt during the pandemic, and it has not resumed.

Figure 38: Living in poverty



This chart shows the number of people in each region living in extreme poverty, currently defined as an income of less than \$2.15 per person per day.

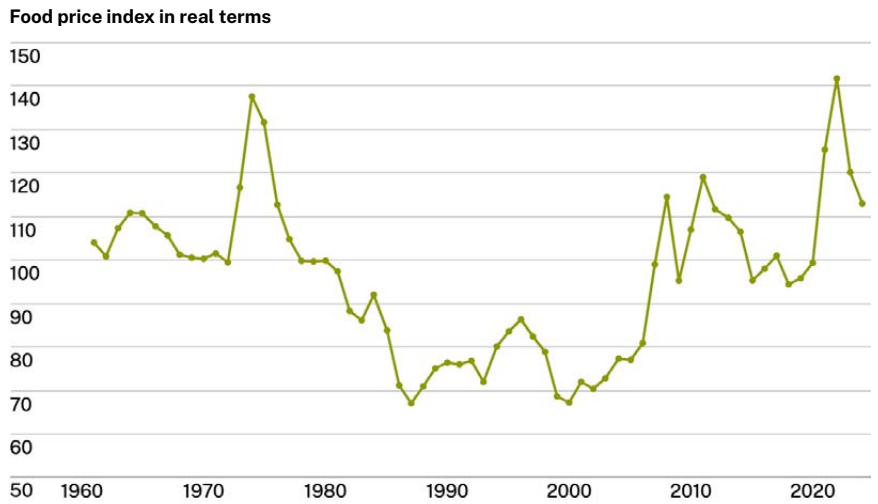
Source: World Bank

Global poverty, in its severe forms, is characterised most starkly by hunger – or in more technical terms, by food insecurity. That phrase is defined as people lacking regular access to enough nutritious food to permit normal human development.

1. This number is of course an estimate, with error bars. The United Nations agencies that monitor world hunger calculate that 713 million to 757 million people faced hunger in 2023. Comparing the midpoint of that range to the midpoint of the 2019 estimate yields the figure of an additional 152 million hungry people since the pandemic. See FAO, IFAD, UNICEF, WFP and WHO, 2024: “The State of Food Security and Nutrition in the World 2024 – Financing to End Hunger, Food Insecurity and Malnutrition in All its Forms.”

In 2019, hunger afflicted about 7.5 percent of the world population. As the pandemic gripped the world in 2020 and 2021, that number jumped above 9 percent and has remained so, driving an estimated 152 million¹ additional people into hunger. Not only did the pandemic disrupt economies, but the Russian invasion of Ukraine followed closely on its heels, shutting off Ukrainian grain exports and sending world food prices to record highs. Ukraine has lately opened a corridor and resumed some exports, but neither prices nor hunger have fallen all the way back to 2019 levels. At this rate, the world community is on track to fail at one of its major development goals: ending malnutrition by 2030.

Figure 39: Food prices are high



This chart shows that world food prices spiked during the pandemic and the invasion of Ukraine, and have not fully returned to their previous level. The global Food Price Index is an average of the prices of 95 commodities tracked by the Food and Agriculture Organisation, weighted by export shares and adjusted for inflation.

Source: FAO

What is the connection between world hunger and the environmental crisis?

2. Zhao, Chuang et al, 2017: "Temperature Increase Reduces Global Yields of Major Crops in Four Independent Estimates." *Proceedings of the National Academy of Sciences*, 114 (35), 9326–9331.

3. This figure is simply the size of the birth cohort, currently estimated at 132 million a year, minus estimated deaths of 62 million a year. See Our World in Data: "Births and Deaths Per Year, World," retrieved August 2024.

4. Kroeger, Carolin, 2023. "Heat is associated with short-term increases in household food insecurity in 150 countries and this is mediated by income." *Nature Human Behaviour* 7, pp. 1777–1786.

A growing body of research suggests that the rise in extreme heat waves around the world may be cutting into crop production, compared to what it would be without the increasing heat.² In other words, while production is still rising — and it has to, with a net increase of 70 million new mouths to feed every year³ — it may not be rising as fast as it could without global overheating. However, there may also be a more acute, near-term linkage between heat and hunger. Recent research shows that severe heat waves can directly cut the income of outdoor workers. For example, construction projects in India often pay their workers — typically women — to carry loads of bricks, and they are paid by the brick. Similar conditions apply for farm workers paid by the basket for the fruits or vegetables they harvest. If heat waves force these workers to slow down or stop work, they lose income immediately, and may then be unable to buy enough food for their families.⁴

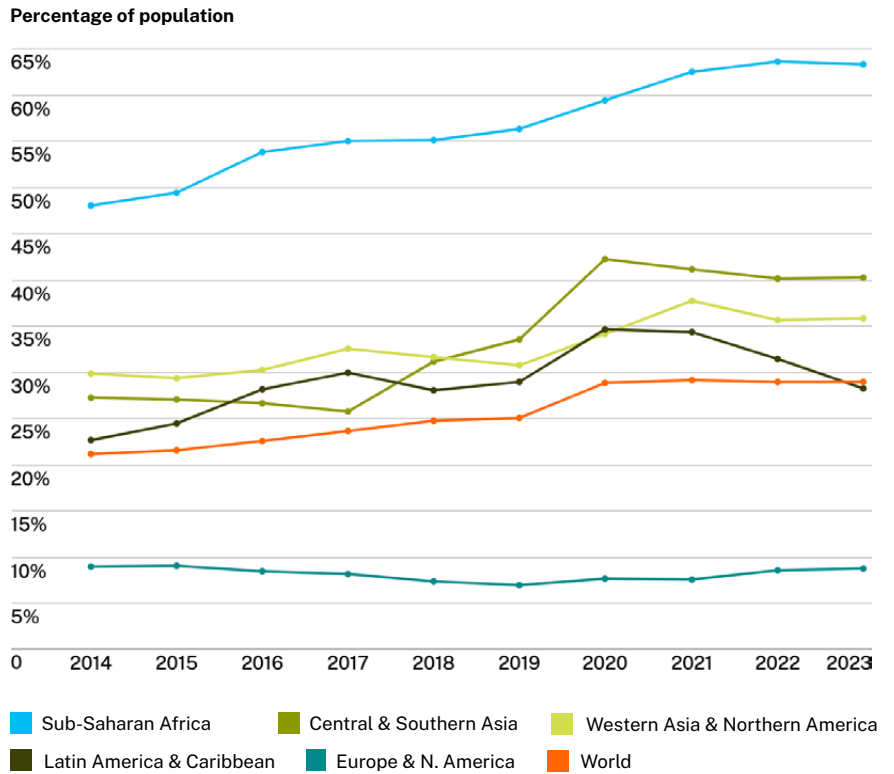
Hunger in Africa



More than any other part of the world, Africa is still stalked by hunger and malnutrition. Here, a feeding program called the Joseph Project serves children in the village of Buli in Malawi.

Source: Stephen Dorey ABIPP/Alamy

Figure 40: Where is hunger concentrated?



Hunger levels are highest in parts of Africa and southern Asia. The graphs represent the percentage of the population in each region suffering from moderate or severe food insecurity, a broader measure than the figures cited earlier in this chapter.

Source: UN

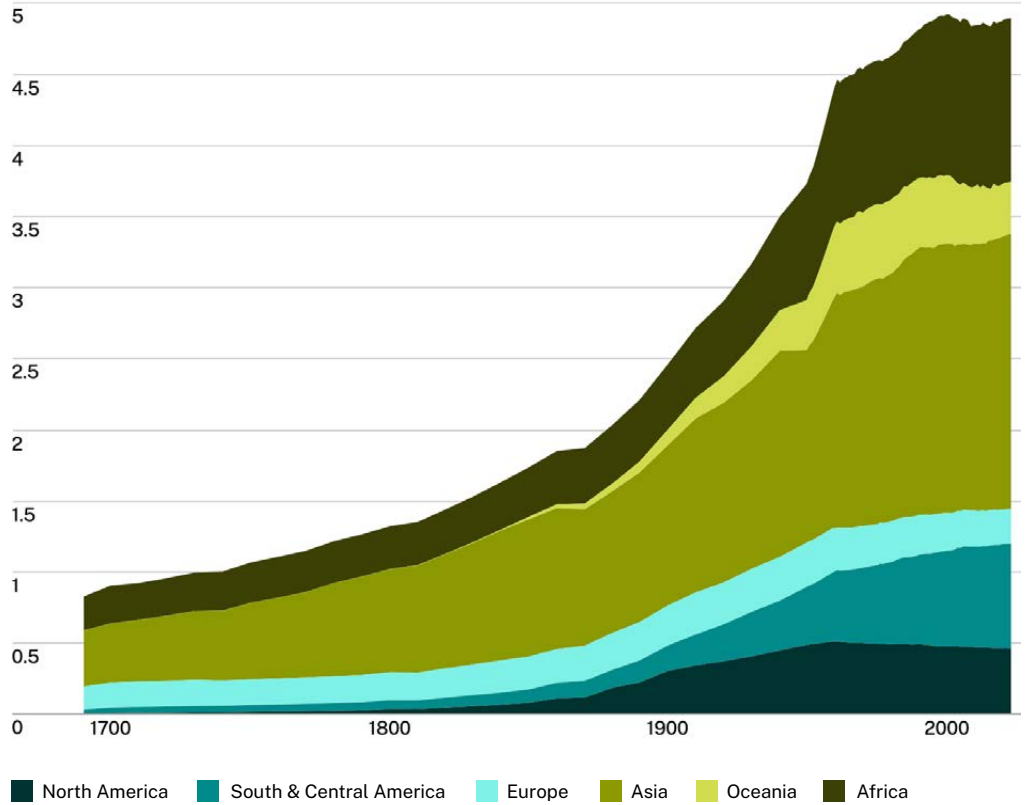
The global food system is a vast subject, and fully critiquing it is beyond the scope of this report. But some aspects of it bear directly on the world’s two major environmental problems — global overheating and the loss of biodiversity — so we will briefly recap some of the main issues.

Humans now use 38 percent of the world’s land surface to produce food.⁵ Immense regions of forest have been cut down and converted to agricultural use. While much of this land conversion occurred in the 19th and early 20th centuries, it continues at a slower pace, with forests in the tropics bearing the brunt of direct human assault these days. That, in turn, is helping to drive the extinction of large numbers of species that can live only in tropical forests, the richest ecological zones on the planet.

5. Food and Agriculture Organisation, 7 May 2020: “Land Use in Agriculture by the Numbers.” Rome.

Figure 41: Plowing the Earth

Hectares covered, in billions

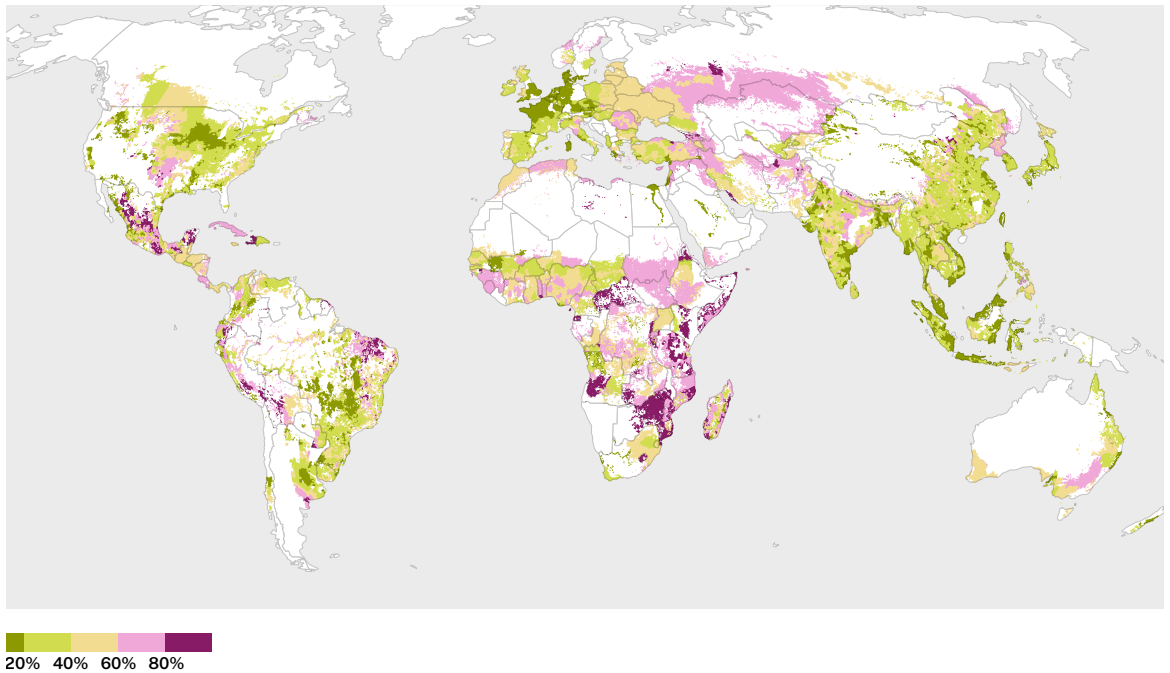


This chart shows the amount of land converted to farming or grazing since 1700. The Asia category includes the European part of Russia, west of the Ural Mountains.

Source: History Database of the Global Environment (HYDE, v 3.3)

The tragedy is that much of the land that has been converted to farms is not very productive — meaning humans are using far more land than we need in order to produce a given amount of food. This ‘yield gap’ is stark, with millions of hectares across Africa, Asia and parts of Eastern Europe producing below their potential. The reasons are no mystery: many poorer farmers lack the basic agricultural inputs, such as fertilisers, pesticides and mechanical irrigation, that are common in the developed world. Conversely, in many middle-income countries that have developed intensive agriculture, including China and the Punjab regions of India and Pakistan, fertilisers are being overused, poisoning streams and creating ‘dead zones’ at the mouths of more than 700 rivers around the world. (Generation has invested in a company, Pivot Bio, that uses micro-organisms to help plants pull nitrogen out of the air, cutting the excessive use of chemical fertilisers.)

Figure 42: 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.

Source: Gerber, James S., Project Drawdown

The entire food system is more tenuous than many people realise. Most of the world’s land is in the Northern Hemisphere, and so most of its food is grown there; heat waves or other weather disasters afflicting broad swaths of that hemisphere can have a serious effect on the food supply. There is no vast global storehouse of extra food tucked away in a mountain somewhere; we live more or less from year to year. Governments have a tendency to lose focus on the food system, which means we are usually not spending enough on agricultural research — but then they rush in with extra aid when a crisis erupts. We are now in the middle of such a cycle, with the Group of 7 wealthy nations promising in June to unleash a new wave of agricultural finance. Italy has led the push, having come to understand that some of the migration straining Europe has been caused by food insecurity in Africa. Details of this new program — and, in particular, the exact amount of new money the rich countries will commit — have yet to be announced.

The expansion of agriculture onto new lands is a major reason for the world’s biodiversity crisis. If we want to salvage what is left of the natural world, then this expansion needs to stop immediately, worldwide. The priority needs to be on using existing farmlands more efficiently, and eventually withdrawing from many of those lands to return them to the wild.

This imperative puts the wealthy countries in an uncomfortable position: exhorting poor, developing countries not to destroy their forests the way the rich countries did many decades ago. Diplomats have long recognised that justice demands that poor nations be paid to keep their forests standing, but promises that tens of billions of dollars a year would be raised for this purpose have gone unfulfilled. This failure to finance the conservation of nature is one of the world's fundamental injustices.

In terms of greenhouse gases and biodiversity loss, the costliest form of agriculture is the production of meat. Demand for meat keeps rising as incomes go up, ameliorated to some extent by a shift away from inefficient beef to more efficient chicken. Political leaders have been terrified of trying to engineer changes in people's diets, but holding down the growth of meat consumption would go a long way toward easing pressure on the food system and the climate.

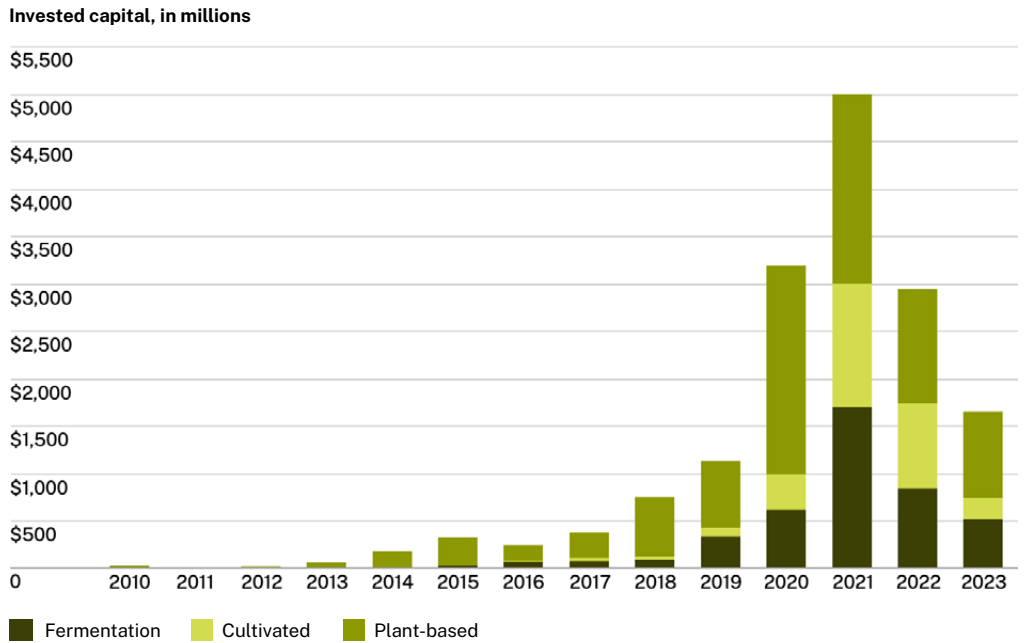
The subsidy schemes that have grown up in Western countries are among the biggest problems: they mainly support commodity agriculture, particularly the meat system, and do almost nothing to encourage the production of healthier foods or a shift to plant-rich diets.

One of the world's most important experiments in agricultural subsidy reform is under way now in Great Britain. It is one of the only benefits we have been able to see from that country's exit from the European Union. Liberated from the complex subsidy system run by the EU, Britain is reorientating its subsidies, paying farmers to adopt sustainable farming methods and to make more judicious use of chemical fertilisers and pesticides. The program is in its early stages, but we are hopeful Britain will pioneer new approaches that can be applied worldwide.⁶

Another possibility for cutting the environmental harm of agriculture is the development of meat alternatives: either plant-based meat lookalikes or, more exotically, actual meat cells grown in bioreactors. This sort of lab-grown meat is already being blended in small quantities into substitute chicken products that have reached the market in Singapore, but the technology is still costly, and broader use of lab-grown meat may still be a long way off. Plant-based meat products like the Impossible Burger and others are already on the market, of course, but public uptake has stalled, and investment in these approaches has been lagging for the last few years. We think some production breakthroughs are needed: the products need to get better, and most importantly, the prices need to come down so that meat substitutes are cheaper than meat itself.

6. For details of the British scheme, see Department for Environment Food and Rural Affairs, 21 June 2023: "Environmental Land Management Update: How Government Will Pay for Land-Based Environment and Climate Goods and Services." This policy paper was published by the Conservative-led government that was voted out of office in July, but the new Labour government seems to want to retain most aspects of the policy.

Figure 43: Lagging investor interest



This chart shows investment in alternative methods of producing meat or meat substitutes. Investor interest has waned as consumer uptake of new products has slowed down.

Source: Good Food Institute

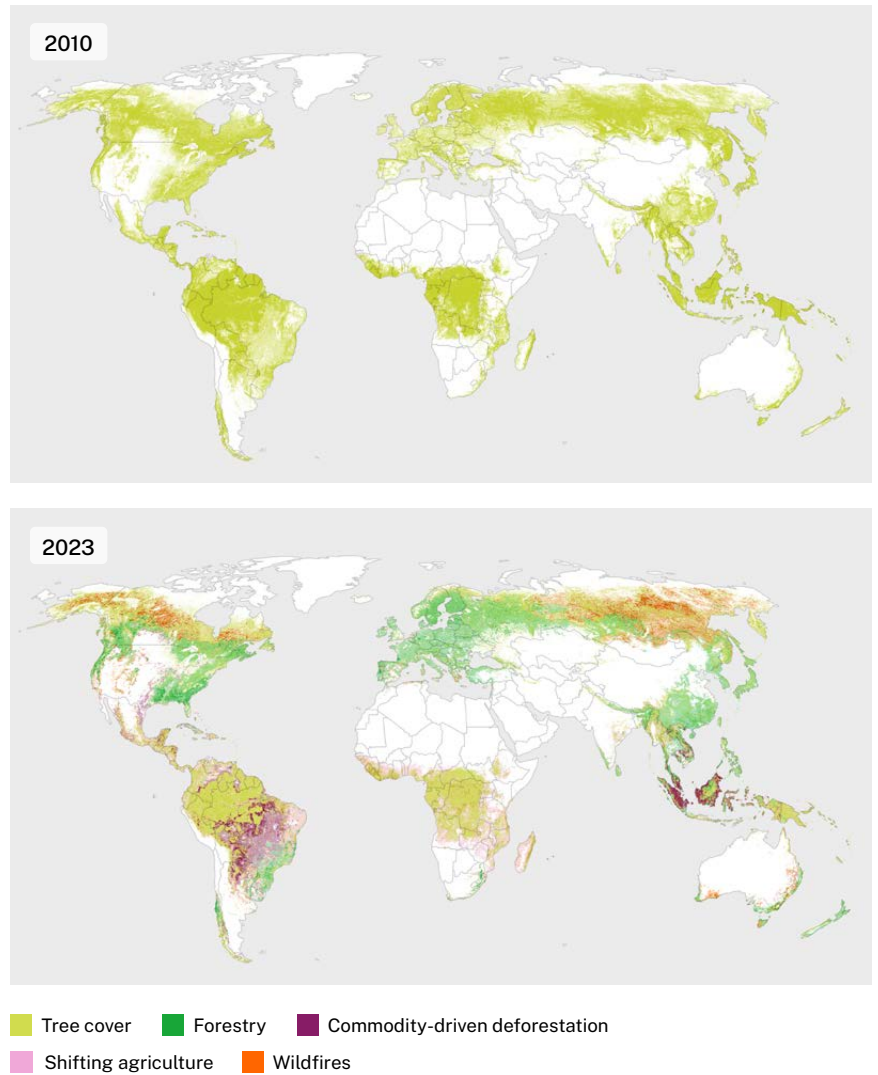
In regard to the world’s land, the single most urgent imperative now is to halt the ongoing destruction of tropical forests. We have fresh evidence of how big a difference political leadership can make on that issue.

Under the right-wing populist Jair Bolsonaro, who governed Brazil from 2019 to 2022, the rate of destruction of the Amazon forest soared. His successor, Luiz Inácio Lula da Silva, took office in 2023 vowing to restore law enforcement in the forest and cut the rate of illegal destruction.

The figures for calendar year 2023 show a 50 percent drop in deforestation in the Amazon compared to the previous year.⁷ Indonesia is another case where dramatic progress has been made in cutting deforestation through actions of the central government, an achievement that will stand as a major legacy of outgoing President Joko Widodo. We hope the incoming administration of Prabowo Subianto, who takes office in October, will prove to be as committed to forest protection as its predecessor.

7. MAAP Project, 2023: “Amazon Deforestation and Carbon Emissions.”

Figure 44: What's destroying the world's forests?



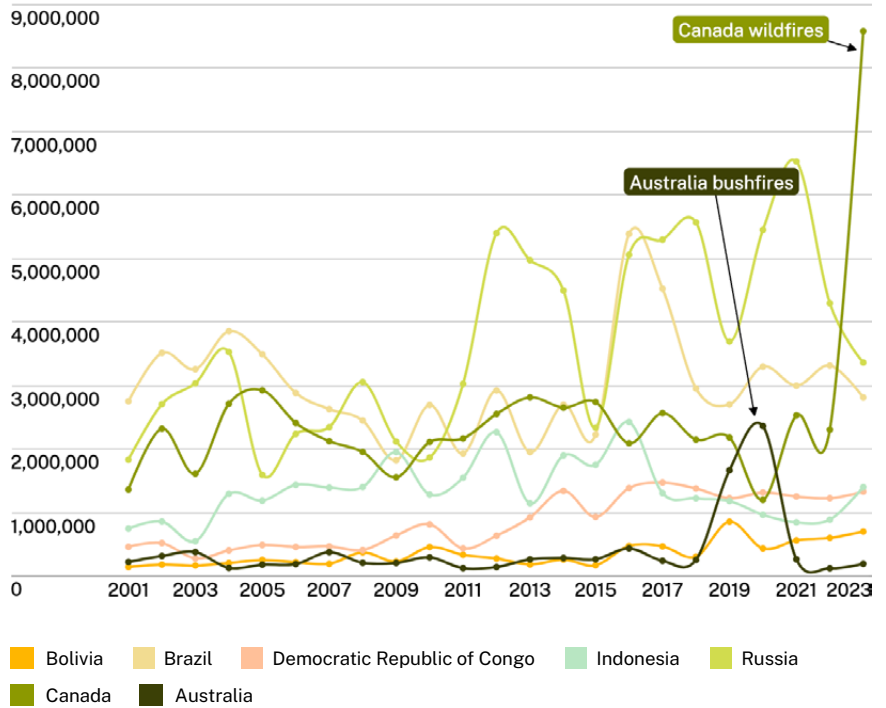
Forests are under stress worldwide, mostly from human activities. The map at top shows the world's forests in 2010, and the one at bottom shows areas where forest has been lost, and the causes of that loss. The expansion of commercial agriculture leads to large-scale, commodity-driven deforestation. Loss from 'shifting agriculture' is generally driven by small-to medium-scale farming and may be temporary. Loss from forestry occurs when natural forests are destroyed for commercial tree plantations. Wildfire losses are often natural and temporary, though human-caused global heating seems to be driving an increased loss of boreal forests in Canada and Siberia.

Source: Global Forest Watch

To be clear, the world is still losing tropical forests at an alarming rate, a profound threat to the long-term survival of the richest and most diverse ecosystems on the planet. A flurry of forest destruction is going on in Bolivia, a small country next to Brazil that shares part of the Amazon with it. Much of the destruction is not even against the law: Bolivia's rapid embrace of industrial agriculture has led the country's central government to authorise extensive forest clearance. A rising hotspot of deforestation is the Congo basin in Africa, where trees are being cut down largely by subsistence farmers. That war-torn region desperately needs better economic opportunities if the forest there is to survive.

Figure 45: When and where trees are dying

Tree cover loss, in hectares



In the Northern Hemisphere, large stretches of boreal forest are being lost to fires made more likely climate change. These trees may ultimately grow back. Fires are also a problem in the tropical forest belt that spans the globe, but the bigger losses there are due to the expansion of agriculture.

Source: Global Forest Watch

The forest situation is yet another example of promises made but not kept. In 2014, 37 governments joined scores of businesses and many other organisations to sign the New York Declaration on Forests, vowing to cut deforestation at the global scale in half by 2020 and to end it by 2030. The first part of that commitment did not happen, and the second part is not on track to happen. Clearing forests and converting the land to agriculture remains profitable. Many of the products of deforestation still end up in the cupboards of Western shoppers.

The European Union is attempting, at last, to put a stop to the trade in such products within its borders. A new regulation went into effect in the middle of 2023, making it illegal to import into the EU products derived from commodities produced on deforested land. The commodities covered by the regulation are cattle, coffee, cocoa, palm oil, soybeans, wood and rubber. That may seem like a short list, but the consumer products potentially derived from those commodities are numerous: paper, books, tyres, soap, cosmetics, leather, furniture and many more. It remains to be seen, of course, how well the EU can enforce this regulation and how much pressure it creates for global corporations to clean up their supply chains, but we are hopeful this pioneering law will help to slow the loss of forests.

Controversy continues to swirl around another approach to helping forests: the sale in a \$2-billion-a-year voluntary market of 'carbon offsets,' with the money often spent on projects meant to limit deforestation on particular plots of land. The credibility of many of these offsets has come into question in recent years, and efforts to clean up the marketplace are under way. A major new aspect to the controversy erupted earlier this year, when the Science Based Targets initiative, which certifies corporate climate plans, announced that it might start allowing the offsetting of certain emissions through the purchase of such certificates. That set off internal turmoil at the organisation, but it now seems poised to allow only limited use of the highest-quality offsets.

07

Financing the Transition

Financing the Transition

Interest rates in the Global South are often 3 times higher than in rich countries

Trillions more needed

For every \$1 invested in pulling fossil fuels from the ground and building fossil-fuelled power plants, about \$2 is now being invested in clean-energy technologies. Only five years ago this ratio was 1-to-1, not 2-to-1: a dramatic sign that we are moving in the right direction on energy investment.¹

But, as with every other aspect of the transition, we are not moving fast enough. The \$1 trillion a year that the fossil-fuel companies are investing is roughly consistent with the level that would be needed in a world where governments broke their promises and failed to deliver the emissions cuts they have signed up for. This is, in effect, what the fossil-fuel executives are betting will happen.

More than that: they are spending tens of millions of dollars on lobbying and advertising campaigns to be sure it happens, seeking to torpedo the energy transition in every way they can. Off the coast of North America, the fossil-fuel companies are now pretending to care about whales, as a way to block offshore wind farms. In many countries, they are financing the campaigns of right-wing populists who dispute the validity of climate science. This is not the only evidence that they don't believe in the transition, though: you only have to look at where they invest their cash. Only about 2.5 percent of it is going to alternative energy sources,² even as the companies run glossy advertising campaigns claiming to be on board with the new era.

Major banks have been promising for years to wind down their financing of fossil fuels, but their pledges are wearing thin. A coalition of environmental groups that tracks the issue reported earlier this year that since the Paris Agreement was adopted, banks have poured \$6.9 trillion into financing

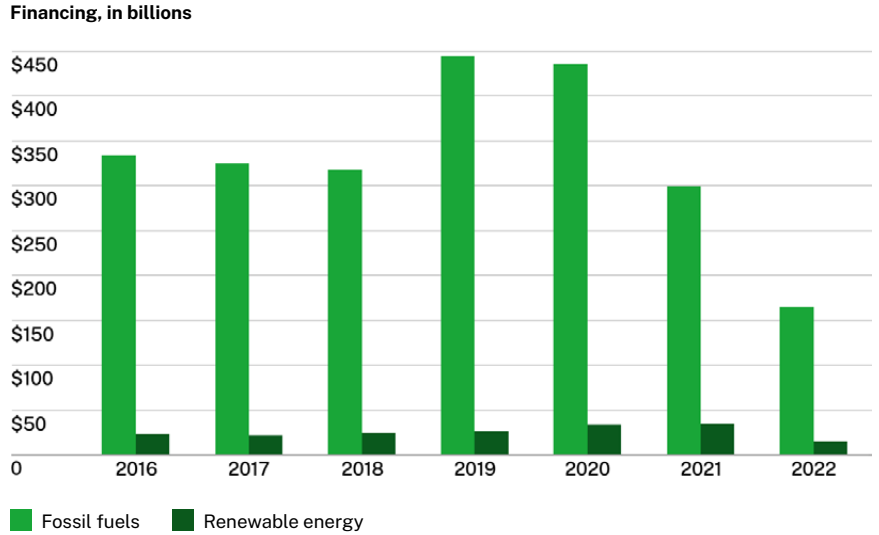
1. International Energy Agency, 2024: "World Energy Investment 2024." Paris.

2. International Energy Agency, 2023: "The Oil and Gas Industry in Net-Zero Transitions: Executive Summary." Paris.

3. Rainforest Action Network, et al, July 2024: "Banking on Climate Chaos 2024."

fossil fuels.³ Without doubt, the world still depends on these fuels and some financing is necessary to keep them flowing for the time being, but we are not seeing the wind-down in fossil finance that the International Energy Agency says is necessary.

Figure 46: Banking on fossils



This chart examines the lending and bond underwriting of 60 major banks, comparing the level of finance for fossil fuels vs. renewable energy. The investment figures mentioned in the text are higher than those in this chart because fossil-fuel companies have access to much broader sources of finance than just lending from these 60 banks.

Source: Sierra Club, Fair Finance International, BankTrack and Rainforest Action Network

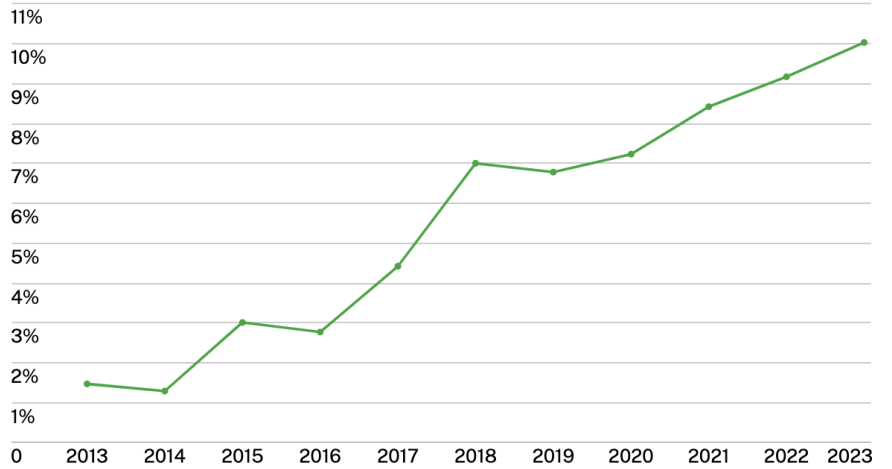
4. International Energy Agency, June 2024: "World Energy Investment 2024." Paris.

If governments do intend to live up to their promises, then the level of fossil-fuel investment is far too high. The IEA calculates that if the world is to get on track for the Paris goals, investment in coal, oil and gas production needs to be falling by almost \$80 billion a year; instead it is rising by close to \$50 billion a year.⁴

As heartening as it is to see clean energy beating fossil fuels to secure investment capital, the numbers are ominous in certain ways. The clean investment is overwhelmingly going into just three economies: China, Europe and the United States. This highlights, yet again, the risk that developing countries are going to be left behind, or worse, that they will be forced to embrace fossil fuels due to a lack of financing for clean energy.

Figure 47: Searching for solutions

Climate tech investment as a % of venture capital and private equity investment



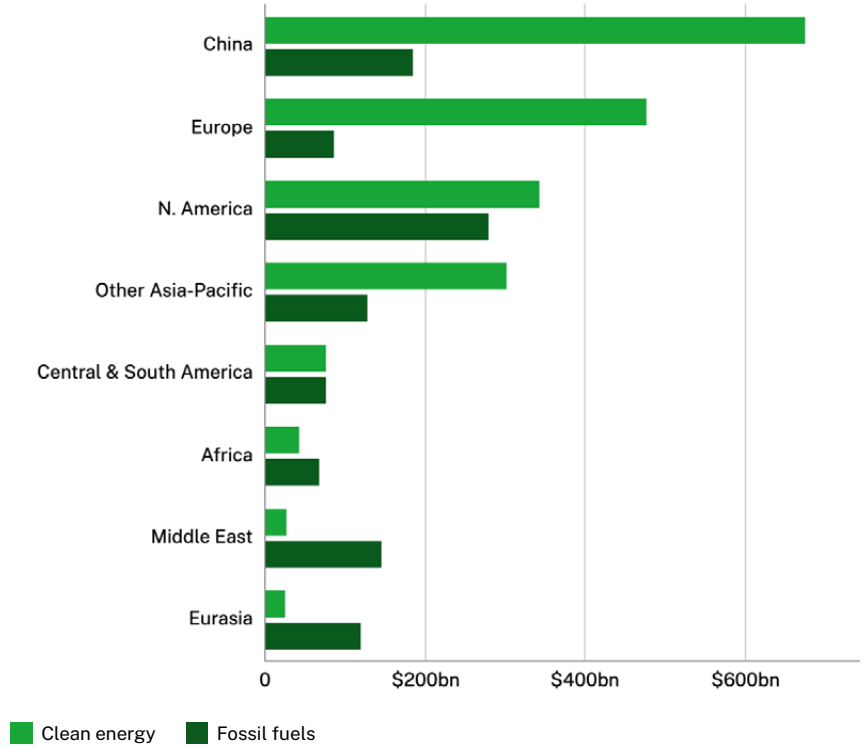
Investment in climate technology is rising as a proportion of all startup investment.

Source: PWC

The basic problem is that investment of all kinds, and clean power plants in particular, is seen as risky in these economies, and the interest rates demanded by investors can easily be two to three times those in the West. This effectively makes renewable energy unaffordable. Fossil-fuel projects are easier to finance, often because the bulk of the product will go to export markets in exchange for hard currency. Many fossil-fuel projects are also financed by state-owned enterprises at low, government interest rates, while renewable energy is the province of private developers who invariably have to pay higher rates.

Figure 48: Priorities

Investment in energy by country or region in 2024



China is by far the world's biggest investor in clean energy. North America is the biggest investor in fossil fuels, but is nonetheless investing more in clean energy than fossil energy. The Middle East is investing five times more in fossil than clean.

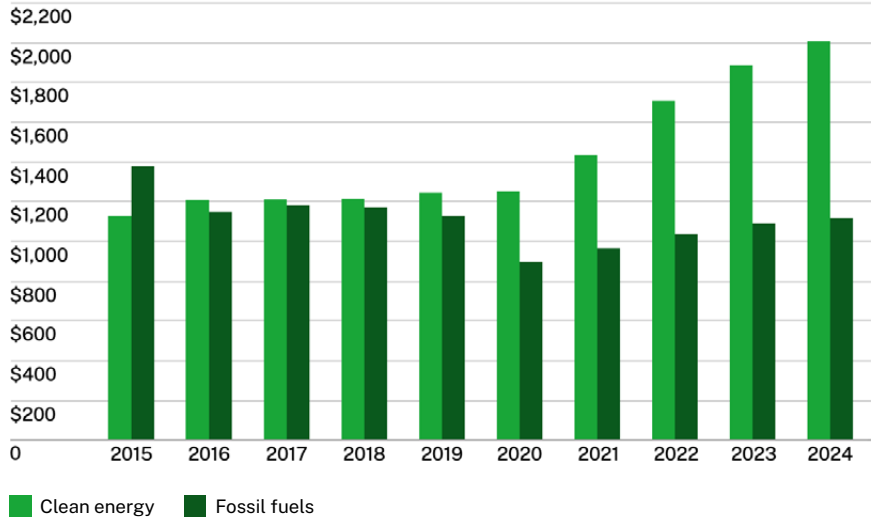
Source: IEA

Efforts to solve this problem at a global scale have been unimpressive so far. Rich countries have struck a series of partnerships with countries like South Africa and Indonesia, promising to help buy down the interest rates on projects to equitable levels, but misunderstandings and conflict have plagued the effort, and little has been achieved so far. The World Bank, which helps to finance projects in developing countries, is working on its own plan, but it is still unclear how ambitious it will be.

Not only is clean investment inadequate in developing countries; many of them are spending heavily to subsidise fossil fuels. In other words, instead of spending money to make the problem better, they are putting up immense amounts of public cash to make it worse. On first blush the numbers are astonishing, and the subsidies look like a huge pot of money that could be tapped for the energy transition.

Figure 49: Clean vs. dirty

Global investment, in billions



Investments in clean energy compared to investments in discovery and production of fossil fuels.

Source: IEA

5. Figures quoted are for explicit subsidies, namely undercharging for supply costs. Implicit subsidies, or undercharging for environmental damages like global warming and local air pollution, are many times higher. Simon Black, Antung A. Liu, Ian Parry, and Nate Vernon, 2023: "IMF Fossil Fuel Subsidies Data: 2023 Update." International Monetary Fund, Washington.

India, for example, spends \$32 billion a year, or 1 percent of its total economic output, subsidising fossil fuels. This is 10 times what the United States spends for the purpose. Saudi Arabia spends \$129 billion a year, or nearly 14 percent of its economic output; petrol in Saudi Arabia is sold for about 50 US cents per litre, or about \$2 per US gallon. No country can outdo China, though, which underprices fossil fuels throughout its economy to the tune of \$270 billion a year.⁵

6. Ibid.

Grabbing this huge pot of cash and putting it to better use is not nearly so simple as you might imagine. The subsidies going directly to producers of fossil fuels are actually modest in most countries. The United States spends only \$3 billion a year for that purpose — a pittance, though it has spent more in the past. The big subsidies are in middle-income countries like China and India, and they are consumer subsidies, designed to lower the cost of fuel for poor people.⁶

Politicians in these countries mess with such subsidies at their peril, and they know it. Sudden attempts to jack up fuel prices can provoke protests, riots and even *coups d'état*. Yet history shows that it can be done, and ought to be done. It just has to be done carefully.

No subsidies, no peace

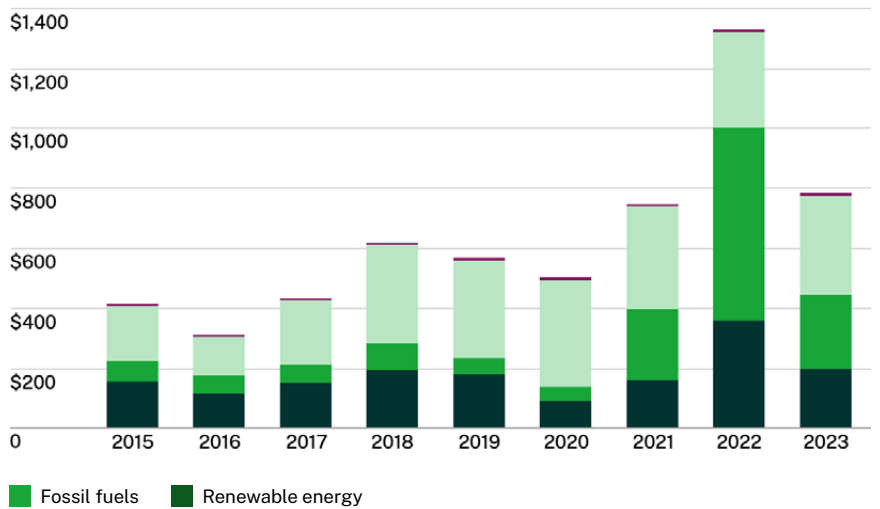


Protesters in Nigeria demand the retention of fuel subsidies, along with other measures to fight high inflation, in 2024.

Source: NurPhoto

The subsidies in India are actually a good bit lower than they used to be, because the Indian government phased in cuts over time. Helping poor people with the cost of living is of course a worthy social goal, but the smarter way to achieve it is to help them directly, with cash benefits, instead of underpricing fossil fuels across an entire economy.

Figure 50: Still high



This chart shows the worldwide level of cash subsidies to producers and consumers of fossil fuels. 2023 figures are estimates.

Source: IMF

Getting governments to see this has been a long struggle. Yet we were making progress, with subsidies falling year by year, up until the Russian invasion of Ukraine. The huge spike in fossil-fuel prices caused governments across the world to panic and institute new subsidies, and we now face a long period of trying to unwind those and get back on track.

In part because the world of finance has embraced fossil fuels for too long, it is about to face a reckoning. For decades, money managers and other investment professionals have got away with voluntary disclosures about their environmental records. That allowed many of them to paint themselves in a positive light — a practice known as greenwashing.

But new, mandatory rules are coming into force. Companies face new provisions requiring accurate reporting of their environmental footprint, and potential penalties if they do not comply. In the United States, the Securities and Exchange Commission has adopted a mandatory measure, though it is weaker than many people had hoped. The rules in Europe are strong, however, and California has adopted stronger measures than the S.E.C. Many of the big American corporations will be subject to those rules.

The era is dawning when lying about a corporation's environmental record can get its executives thrown in jail.

08

Looking Ahead

Caught in the crossfire

The mood in Paris was jubilant. As the gavel fell and cheers rang out in a plywood meeting hall in a Paris suburb, a new international agreement to limit climate change came into existence. Champagne corks popped. That night, floodlights bathed the Eiffel Tower and the Arc de Triomphe in green.

A moment of hope



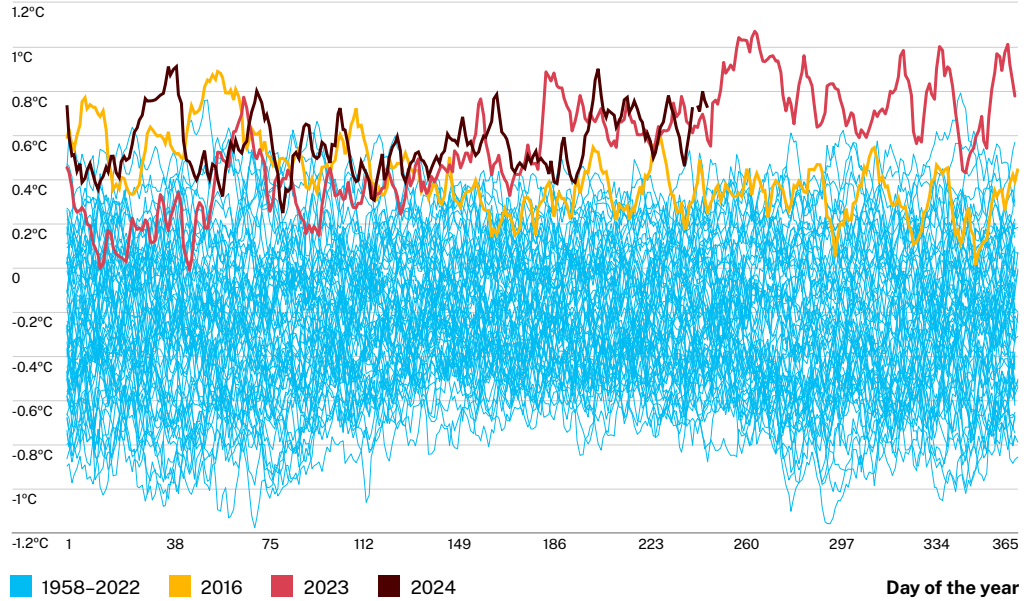
The Arc de Triomphe was bathed in green on the evening that the Paris Agreement on Climate Change was adopted in 2015. “The Paris Agreement is done!” the slogan reads.

Source: Chesnot/Getty Images

The startling thing to realise is that the Paris Agreement on Climate Change will soon be a decade old. As its 10th birthday approaches in 2025, we confront stark realities, far removed from the hopes of that joyous day in Paris. The goals of the agreement — to limit global warming to 2 degrees Celsius above the pre-industrial temperature, and to “pursue efforts” to limit warming to 1.5°C — are hanging by a thread. The global temperature continues to increase relentlessly. As we recounted elsewhere in this report, emissions have not even started to fall; they rose in 2023 and are forecast to do so again in 2024. The devastating effects of the climate crisis — more powerful storms, more intense heat waves, greater stress on water supplies, melting ice and rising seas — are coming faster than scientists had forecast.

Figure 51: Global overheating

Temperature anomaly



Last year was the warmest on record, and scientists now believe 2024 is likely to set another record.

Source: Analysis of JRA-55 data

Only a radical increase in global ambition can save the Paris goals from failure. Soon, countries will get their chance to deliver such ambition.

New national climate plans are due to be made public in early 2025 and adopted late in the year. This means the critical decisions about what they will contain are being made now. The main conference in 2025 will take place in Belém, the gateway to the Brazilian Amazon; it will be both the 30th global negotiating session under the United Nations climate treaty and the ninth since the Paris Agreement was adopted.

An intensive focus on saving the world's tropical forests and savannahs is expected at the Belém conference, but equally important will be the ratification of the national climate plans. They are voluntary, but countries have agreed that collectively, they should add up to a credible effort to keep the Paris goals alive. It remains to be seen how ambitious the plans will really be, as well as how generous the rich countries will be in aiding poor countries that cannot do enough on their own.

In other words: a decade on, is the spirit of Paris still alive?

The need for countries to come together to ramp up their climate goals coincides, unfortunately, with rising global tensions. The entire international system that has prevailed since the end of World War II is under strain. The trading framework that opened borders to the flow of goods, and created rising prosperity for billions in the last half of the 20th century, is verging on

collapse. Under the pressure of populist politics, countries are thumbing their noses at institutions they helped to create, like the World Trade Organisation. They are imposing steep tariffs on each other's goods in an ominous echo of the trade wars that broke out during the Great Depression, helping to prolong it and setting the stage for war.

Tensions over trade have large implications for the energy transition. The international trade in low-emissions technologies is critical to rapid progress, and the destabilisation of the trading system is thus a major risk. China is the world's most important manufacturer of advanced batteries; it is the only country able to refine some critical minerals; and it is by far the largest producer of solar panels, electric cars, electric buses and electric scooters. It is installing more renewable power than the rest of the world combined, and as a result, may reach peak emissions years earlier than expected, possibly within the next year or two. The brightest spot of the energy transition — the tremendous fall in the cost of solar panels — can be laid at China's feet, with a big boost from Germany, which created the first large market for the panels.

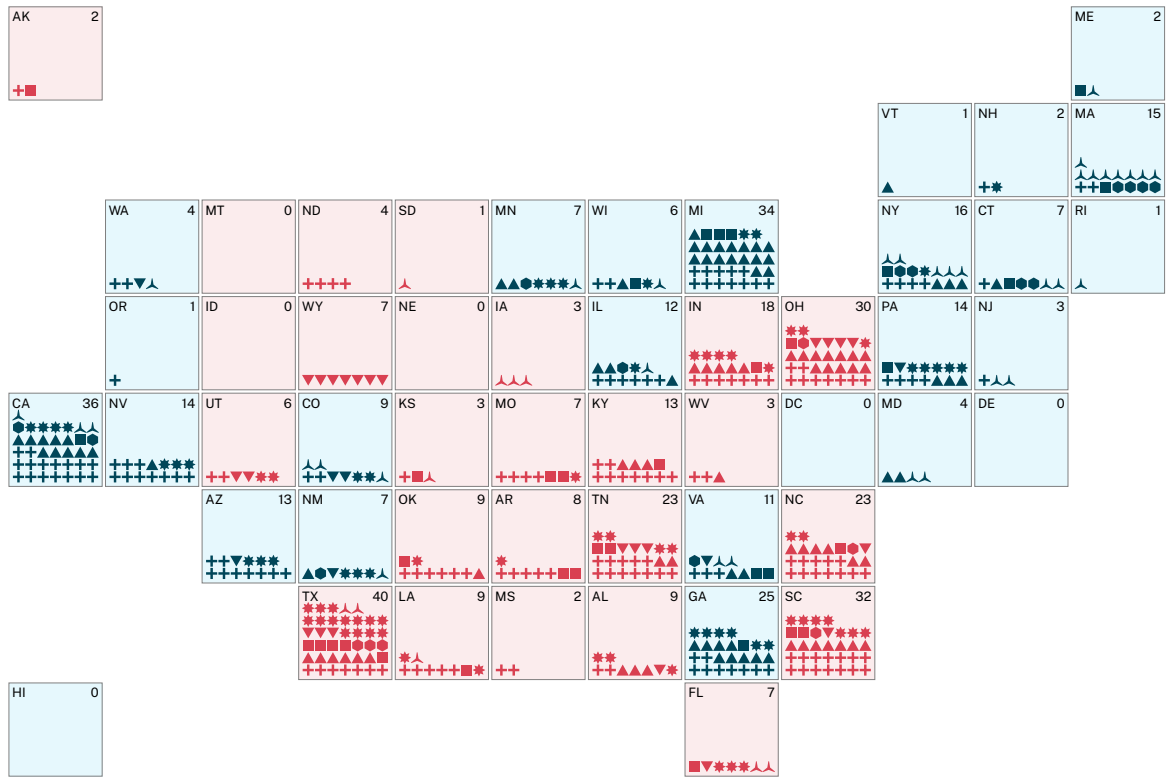
Yet China's return to an aggressive form of authoritarianism under Xi Jinping has put it at loggerheads with many of its trading partners. China's military adventurism, its threats to invade Taiwan, its support for Russia in the Ukraine war, its theft of technology from other countries, its repression of the Uyghur ethnic group and other factors are leading to something like a new Cold War between China and the West.

We very much fear that elements of the energy transition could get caught in the crossfire. To some degree it has already happened. The American government, which claims on the one hand to want speed in cutting emissions, has imposed 100 percent tariffs on Chinese-made electric cars, essentially keeping these highly affordable models off the American market. In late August, the Canadian government followed suit with its own 100 percent tariffs. European countries have imposed tariffs as high as 36 percent on electric cars from China, up from their previous tariffs of 10 percent. Both the United States and Europe have put heavy tariffs on Chinese solar panels, even though their domestic manufacturers cannot make them at anywhere near the cost that Chinese factories can.

We understand the political imperatives behind many of these actions. The great trade liberalisation of the 20th century was carried out with insufficient attention to the plight of workers whose factories and jobs were being displaced — one of the factors that helped create a political opening for right-wing populists across the democratic world. Mainstream politicians are fending off the populist threat in part by abandoning their commitment to open trade.

They are also using public money to try to conjure new, domestic industries into existence. To a degree we could not have imagined just a few years ago, it seems to be working. Many thousands of jobs are being created in new American battery and car factories, for example.

Figure 52: New industries, new jobs



■ Republican ■ Democrat
+ Batteries ▲ EVs ■ Heat pumps ● Hydrogen electrolyzers ▼ Nuclear 人 Wind * Solar panels

Countries are racing each other to develop the industries of the future. In the United States, much of the benefit is going to Republican-leaning states. The chart shows announced factories since the big American clean-energy law passed, with the colours reflecting how the state voted in the 2020 presidential election.

Source: US Department of Energy

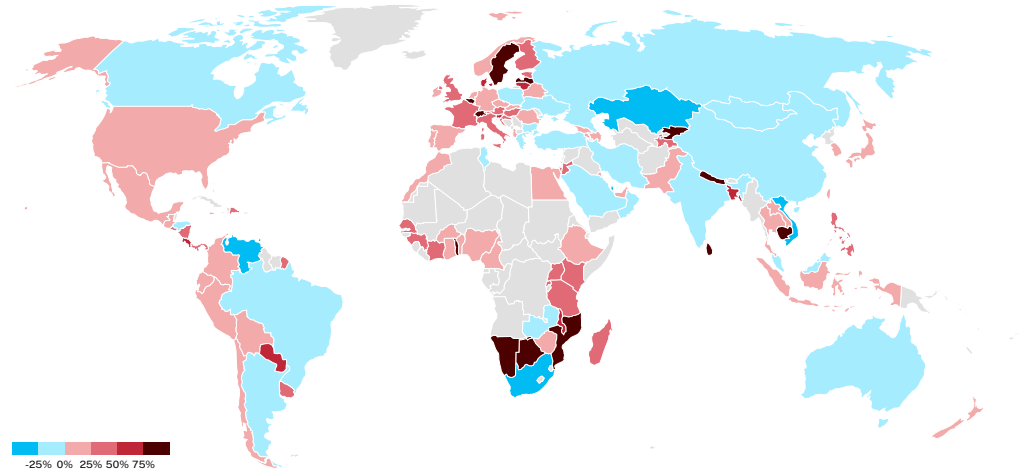
Plans are far advanced to manufacture advanced microchips in the United States, clawing some elements of that critical industry back from Asia. New mines and metal refineries are under development in both Europe and the United States.

If the Chinese, offended by these muscular industrial policies, were to declare an embargo on all shipments of battery technology to the United States and Europe, the manufacture of electric cars in those regions would all but shut down. The Chinese dominance in other technologies, like solar panels and electrolyzers for hydrogen production, will be difficult to dislodge. Embargoes on such products would be costly for China itself, throwing millions of people out of work, but if war were to break out between China and the West, trade would be the first casualty.

We need international cooperation, not hostility, for another big reason. Some of the emissions declines that have occurred in rich countries are an illusion – in effect, they have outsourced some of their emissions to China, Vietnam

or a handful of other rising manufacturing powers. The map below shows how the ‘embedded emissions’ from manufactured goods would change the emissions picture if they were fully taken into account. All countries, both importers and exporters, have a shared interest in finding ways to cut the emissions from manufacturing. That seems likely to happen only in a world characterised by international cooperation, not open hostility and trade wars.

Figure 53: Trading carbon



When countries import goods, they are also importing the ‘embedded carbon’ that was used to produce them. This map shows how much higher the emissions of rich countries would be if this embedded carbon were added to their national totals. Positive values, in red, represent CO₂ importers, while negative values, in blue, represent CO₂ exporters.

Source: Global Carbon Budget

So far, the leaders of the world’s democracies have managed to hold right-wing populists at bay, more or less. But if the climate crisis is allowed to continue getting worse — with food shortages, unbearable heat waves, and outbreaks of disease sending millions of new refugees streaming across the borders of wealthier countries — what then? We have learned in recent years that demagogues exist in every country, and they are eager to gain power by scapegoating refugees. This is one reason, among many, that the effort to ramp up global ambition and limit climate damage has become so important.

As climate delegates battle over clauses and phrases and numbers in the next 18 months, much more will be at stake than words on a page.

Credits

01 Year in Focus

Fig. 1 Still rising



[The Global Carbon Budget, Friedlingstein et al. 2023](#)

Fig.2 On the drawing board



[Global Energy Monitor](#)

Fig.3 A daunting program



[International Energy Agency: Net Zero by 2050 Scenario](#)

International Energy Agency

Fig.4 What we need now



[International Energy Agency: COP28 Tripling Renewable Capacity Pledge](#)

Fig.5 Phasing out fossil fuel use



[Net Zero Tracker](#)

02 Power

Fig. 6 Not falling yet



[Ember: Electricity Data Explorer](#)

Fig. 7 The coal behemoth



[Energy Institute: Statistical Review of World Energy, 2024](#)

Data from the 2024 Statistical Review of World Energy with additional data analysis by Generation

Fig. 8 Hail the sun



[Energy Institute: Statistical Review of World Energy, 2024](#)

Fig. 9 Making the shift



[Ember: Electricity Data Explorer](#)

Fig. 10 A changing mix



[Ember: Electricity Data Explorer](#)

Fig. 11 Get in the queue



[Lawrence Berkeley National Laboratory: Queued Up, 2024 Edition](#)

Fig. 12 Reforms pay off



[Ember: Electricity Data Explorer](#)

Fig. 13 Hail the wind



[German Special Agency for Onshore Wind Energy](#)

Fig. 14 Still off the grid



[International Energy Agency, 15 September 2023: Commentary, "Access to electricity improves slightly in 2023, but still far from the pace needed to meet SDG7."](#)

Fig. 15 Choking



[Health Effects Institute and Institute for Health Metrics and Evaluation, 2024: "State of Global Air 2024."](#)

03 Transportation

Fig. 16 Out of the exhaust pipe



[BloombergNEF: New Energy Outlook 2024](#)

Fig. 17 Up and away



[International Energy Agency: Global EV Outlook 2024](#)

Fig. 18 Getting closer



[International Energy Agency: Global EV Outlook 2024](#)

Fig. 19 Lithium gets cheaper



[Bloomberg](#)

Fig. 20 Batteries get cheaper too



[BloombergNEF](#)

Fig. 21 Plugging in



[International Energy Agency: Global EV Outlook 2024](#)

Fig. 22 Stuck in traffic



[INRIX 2023 Global Traffic Scorecard](#)

Fig. 23 Can you take the train?



[Center for International Earth Science Information Network, Columbia University, 2023: SDG Indicator 11.2.1: Urban Access to Public Transport, 2023 Release, Palisades, New York.](#)

Fig. 24 All aboard



[Organisation for Economic Co-operation and Development](#)

Fig. 25 Searching for an alternative



[Generation analysis of airline disclosures](#)

Generation has converted disclosures into metric tonnes where other units were used in airline disclosures

Fig. 26 A thirst for crude



[Energy Institute: Statistical Review of World Energy 2024](#)

04 Buildings

Fig. 27 Holding steady



[International Energy Agency: Generation analysis](#)

Fig. 28 Action needed



[International Energy Agency, 2023: "Annual investment in energy efficiency in the buildings sector in the Net Zero Scenario, 2017-2030."](#)

Fig. 29 Follow the rules



[World Bank Global Indicators Group: Building Green global dataset](#)

Fig. 30 Moving to town



[World Bank](#)

Fig. 31 Out with the old



[Germany Federal Statistical Office](#)

Fig. 32 Making the switch



[International Energy Agency, March 2024: Clean Energy Market Monitor](#)

Fig. 33 Cleaner and greener



[International Energy Agency, March 2024: Clean Energy Market Monitor](#)

Fig. 34 Embedded emissions



[Inventory of Carbon and Energy Database Version 3.0](#)

05 Industry

Fig. 35 From the smokestack



[BloombergNEF: New Energy Outlook 2024](#)

Fig. 36 Split those molecules



[International Energy Agency: Hydrogen Production and Infrastructure Projects Database](#)

Fig. 37 Cement emissions



[The Global Carbon Budget, Friedlingstein et al. 2023](#)

06 People, Land & Food

Fig. 38 Living in poverty



[World Bank: Poverty and Inequality Platform](#)

Fig. 39 Food prices are high



[Food and Agriculture Organisation: World Food Price Index](#)

Fig. 40 Where is hunger concentrated?



[United Nations: Sustainable Development Goals Indicators Database](#)

Fig. 41 Plowing the Earth



[History Database of the Global Environment v 3.3, Klein Goldewijk, C.G.M, Utrecht University, 2023](#)

Fig. 42 The yield gap



Gerber, James S., Project Drawdown

Fig. 43 Lagging investor interest



[Good Food Institute](#)

2010 – 2022 data sourced from 'State of the industry report 2022 – plant based meat, seafood eggs and dairy' and 2023 data source from GFI investing in alternative proteins website.

Fig. 44 What's destroying the world's forests?



[Global Forest Watch](#)

Fig. 45 When and where trees are dying



[Global Forest Watch](#)

07 Financing the Transition

Fig. 46 Banking on fossils



[Sierra Club, Fair Finance International, BankTrack and Rainforest Action Network: Banking on Climate Chaos / Fossil Fuel Finance Report 2024](#)

Fig. 47 Searching for solutions



[PwC State of Climate Tech 2023](#)

Fig. 48 Priorities



[International Energy Agency: World Energy Investment 2024](#)

Fig. 49 Clean vs. dirty



[International Energy Agency: World Energy Investment 2024](#)

Fig. 50 Still high



[International Monetary Fund: Fossil Fuel Subsidies Data, 2023 Update](#)

08 Looking Ahead

Fig. 51 Global overheating



[Generation analysis of JRA-55 data](#)

Fig. 52 New industries, new jobs



[US Department of Energy](#)

Fig. 53 Trading carbon



[Global Carbon Budget, Updated from Peters, GP, Minx, JC, Weber, CL and Edenhofer, O 2011. Growth in emission transfers via international trade from 1990 to 2008. Proceedings of the National Academy of Sciences 108, 8903–8908.](#)

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