

Toothpaste in your tank

Hydrogen goop could be a more convenient fuel than hydrogen gas

At least, the Fraunhofer Institute hopes so

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On paper, hydrogen looks like a dream fuel. Coal, oil and natural gas generate planet-warming carbon dioxide when burned. Hydrogen produces pure water. Hydrogen crams more energy into less space than batteries do (though, admittedly, less than petrol or diesel do). And an empty tank can be refilled with hydrogen much faster than an empty battery can be refilled with electricity.

In practice, things are trickier. Storing meaningful quantities of hydrogen gas requires compressing it several hundred-fold. Liquefying it is another option, but one that requires cooling the stuff to -253°C . Either process requires rugged tanks. Over time, hydrogen gas can infiltrate metals, weakening them and potentially causing cracks. Tanks must be built from special materials designed to resist this breakdown.

There may be a better way. Researchers at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials in Germany, led by Marcus Vogt, think that supplying hydrogen as goop rather than gas offers a way around some of its limitations. They have been experimenting with a chemical compound that can be pumped into a cartridge and then persuaded to give up its hydrogen on demand.

Their invention, which they dub “Powerpaste”, bears a passing resemblance to toothpaste. Its main ingredient is magnesium hydride, a compound that, when introduced to water, reacts with it to form hydrogen and magnesium hydroxide (a substance more familiar as milk of magnesia, a stomach-settling antacid). The escaped hydrogen can then be diverted into a fuel cell, where it reacts with oxygen from the air to generate electric power. The magnesium hydroxide waste is emptied from the reactor automatically.

Dr Vogt’s scheme offers several advantages over batteries, petrol and more conventional ways of handling hydrogen. One is the storage of more energy per litre, and per kilogram, than either batteries or petrol can manage. A second is ease of refilling, which is simply a matter of swapping an empty cartridge of paste for a full one, and topping up the water, which is stored in a separate tank. A third advantage is that, unlike a battery, the paste does not gradually lose its stored energy if it is left on the shelf.

Moreover, the paste itself is non-toxic, as are the reaction’s by-products. But there are plenty of subtleties to work through. Left to its own devices, magnesium hydroxide reacts only slowly with water because the reaction forms a barrier on the material’s surface that inhibits further chemistry. To overcome this, Dr Vogt and his team have found a chemical additive that greatly accelerates the reaction. They have also found a way to ensure that the reaction can be controlled precisely enough to supply only as much hydrogen as is needed at any given moment.

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The paste is unlikely to up-end the clean-car industry, where battery-powered vehicles have already established themselves as the dominant technology. But Dr Vogt nonetheless hopes that his invention may find niches. One early use could be in small vehicles such as scooters, or in flying drones where weight is at a premium. It is hard to scale down the sorts of heavy-duty tanks needed to store elemental hydrogen, he says. Powerpaste could thus enable longer ranges for scooters, and flight times for drones measured in hours rather than minutes. Miniature stoves aimed at campers are another idea.

A pilot plant in Brunswick, a city in Lower Saxony, will be able to produce four tonnes of the stuff per year when it is finished later this year. And heavier-duty uses are certainly possible, if that is what customers would like. Dr Vogt has already built a small demonstration unit for the German army.

This article appeared in the Science & technology section of the print edition under the headline "Toothpaste in your tank"

Decarbonising America

Joe Biden's climate-friendly energy revolution

What it will take to fight rising temperatures

[Briefing Feb 20th 2021 edition](#)

Amid the dust and sagebrush of New Mexico there are 61 rigs at work. The south-eastern part of the state, which sits over the shales of the Permian basin that spans the border with Texas, has over the past decade attracted shale-oil specialists, oil majors like ExxonMobil and innumerable camp followers fixing pumps, selling pipe and hauling the sand used to fracture the underground strata. About 40,000 people in the state now work in the sector; the taxes it generates pay for a third of the state's budget; and it accounts for about 1% of America's greenhouse-gas emissions.

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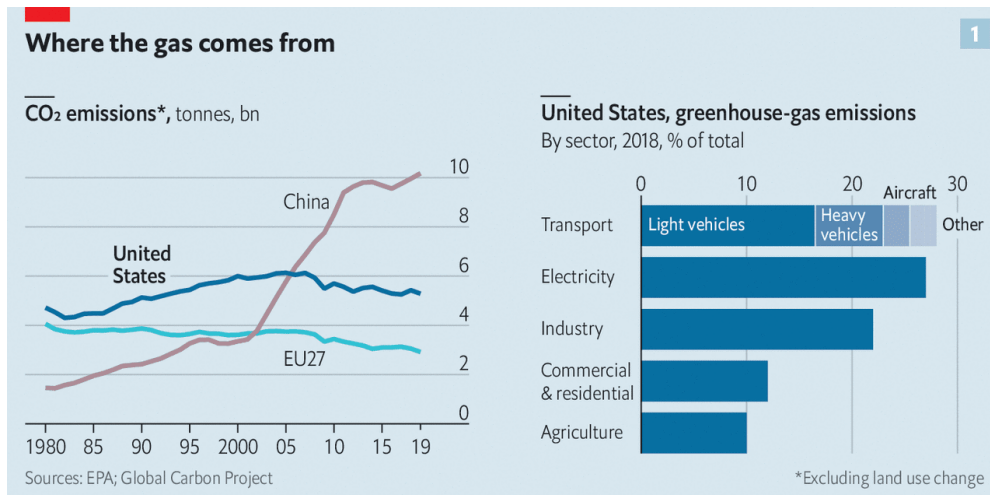
President Joe Biden's announcement in January of a temporary moratorium on new leases allowing drilling on federal land has not gone down well in this bit of the Permian; New Mexico accounts for more than half of such onshore oil production. The American Petroleum Institute (api), the industry's main lobby, contends that the moratorium could cost the state 62,000 jobs. But for all the importance oil has in its economy, even New Mexico is preparing for a new energy era.

The Democratic governor, Michelle Lujan Grisham, wants her state's emissions in 2030 to be at least 45% below their level in 2005, which given the recent oil boom means about 60% less than what they were in 2018. Across the state solar farms are being set up to harness the abundant sunshine and charging points provided for electric cars—just the sort of initiatives Mr Biden is seeking to accelerate as he aims to turn the American economy away from fossil fuels once and for all.

In January the president signed an executive order calling for the country to reduce its net greenhouse-gas emissions to zero by 2050, and to that end he wants the electricity sector to be emissions-free by 2035. Angelica Rubio, a New Mexico state representative who has relatives working on oil and gas projects in the Permian basin, acknowledges local resistance to Mr Biden's decarbonisation goals. "It is drastic," she says. "But this is the road map we need to take." She is sponsoring a bill in the state legislature to ease the transition for oil workers.

Any encouragement from within the shale patch will be welcome to Mr Biden's team, which needs all the help it can get. In Europe, as in China, politicians are using industrial policy, regulations, carbon prices and other tools to lessen the risks associated with climate change and secure their place in a global clean-energy economy; some have got a fair way already

(see [article](#)). But despite having played a key role in the negotiations which produced the Paris agreement in 2015—an agreement that it is rejoining on February 19th—America has to date offered no comprehensive outline of the goals and strategies it will use to tackle greenhouse-gas emissions which, in 2019, were equivalent to 5.3bn tonnes of carbon dioxide (see chart 1). Those emissions declined in 2020 by a staggering 9%, according to estimates from Bloombergnef, a data provider. But as the economy recovers they will bounce back quickly.



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The lack of an ambitious national programme is largely down to the fact that America's Republican Party couples political power with a climate nihilism to an almost unparalleled extent. Donald Trump called climate change a hoax and withdrew from the Paris agreement; his administration put significant effort into trying to roll back the regulations with which his predecessor, Barack Obama, had tried to lower emissions. That they are subject to such reversals is one of the reasons that executive orders and regulatory stances are a poor substitute for thoroughgoing legislation. But Mr Obama had little choice. The vast majority of Republicans elected to federal office reject policies to cut emissions, which is why Congress has not seriously confronted the issue for more than a decade. The power of Republicans in the Senate made it pointless.

The problem is made worse by the fact that some conservative Democrats have their own reservations. Joe Manchin, a Democrat from West Virginia, says that he supports climate action. But he rejects the idea that coal, the dirtiest fossil fuel, might be permanently removed from the world's energy portfolio: "Get into reality," he says. "It's not going to be eliminated." The fact that the Senate is split 50-50 between the parties means that, even with Vice-President Kamala Harris's casting vote, Mr Manchin in effect has a veto over legislation.

Should such obstacles lead to America punting for another decade, it will pay for the privilege. Delaying to 2030 would make the transition to a net-zero emissions economy almost twice as expensive as it would be if started today, with costs soaring to \$750bn a year by 2035 and more than \$900bn a year by the early 2040s, according to Energy Innovation, a policy group. But today's urgency comes from greater concerns than fiscal prudence. America's emissions are not

only a problem for the climate in and of themselves. They are also a check on its opportunities to influence the rest of the world's emissions, which copiously outweigh its own.

A decisive American effort to reduce emissions would be a potent signal of solidarity and a great enabler of change. It is unlikely that poor- and middle-income countries, eager to lift their citizens out of poverty, will try hard to curb their emissions if the world's richest nation declines to limit its own, which are among the world's largest per person. A vibrant American programme would also guarantee levels of innovation devoted to the fight for a stable climate that easily exceed today's. America's wealth, national laboratories, universities, corporate giants and entrepreneurs, if properly harnessed to the task of decarbonisation, will undoubtedly produce novel approaches and technologies that would benefit other nations.

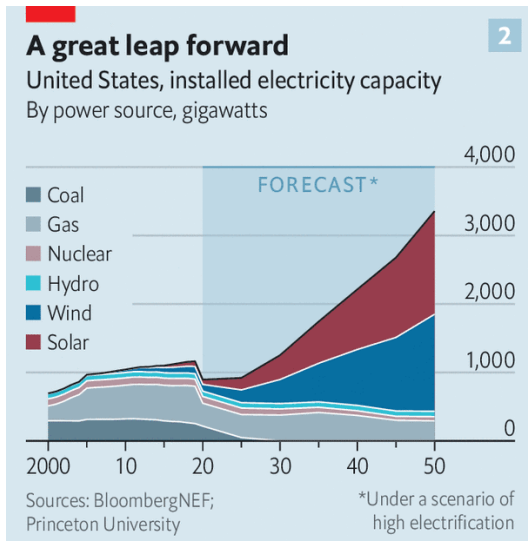
And it would be a licence to persuade, shame and, where appropriate, bully. Mr Biden has charged John Kerry, who when secretary of state was an important player in the Paris negotiations, with leading efforts on climate change abroad (see [Lexington](#)). If he cannot point to progress at home, Mr Kerry's job will be an unprofitable and thankless one.

Running down a dream

But providing Mr Kerry with compelling backup is a tall order. In December researchers at Princeton University published a sweeping report to show how American emissions might by 2050 be reduced to "net zero"—a state where the amount of greenhouse gas still being dumped into the atmosphere is no greater than the amount deliberately being taken out of it and sequestered in some form. Though the study outlined various paths to that goal, all of them shared the basic foundation of an electricity sector rapidly both decarbonised and enlarged.

Over the past decade America's electricity industry has become significantly less carbon-intensive despite meagre federal action. This has mainly been down to the replacement of coal by natural gas; coal, which provided 45% of the electricity generated in 2010, provided just 19% in 2020. But truly clean energy has been on the rise too. Though no new nuclear-power plants have been built and brought online, annual installations of wind and solar have rocketed as states have imposed mandates which require a certain amount of renewable or emissions-free generating capacity—mandates which, with the capital costs of renewables tumbling and interest rates low, have not been irksome to meet. In 2010, according to BloombergNEF, America had 42.6gw of wind and solar capacity. Last year it had 213.2gw, about five times as much, with 33.6gw added in 2020 alone.

But this progress is mere prologue to what must come in the 2020s. “The pace we are talking about is much faster than what has been done historically,” says Eric Larson, who led the Princeton study. In one scenario, wind and solar capacity would need to expand each year through 2025 by about 40gw before hitting 70-75 gw a year in 2026-30—more than double last year’s record rate (see chart 2). If those targets are met, the Princeton researchers reckon, by 2030 wind and solar farms could be providing about half of America’s electricity, up from 9% in 2019.



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and his colleagues estimate that setting America on a path to net zero will require at least \$2.5trn of additional capital investment over the present decade. And that spending requires careful planning, with enough spare power capacity to deal with extreme weather.

One of the reasons for dealing with electricity first is that it opens up possibilities in other sectors. A grid powered by abundant clean energy allows emissions from cars, light vans, trains and buildings to be slashed as they turn to electricity for more and more of their energy needs.

Turbines in America’s endless skyways and panels across her diamond deserts are no use if the power cannot get to the people. Lots of clean power means lots of new transmission lines, too—in one scenario, Princeton estimates that high-voltage transmission capacity would need to jump by 60% over the course of the coming decade. It adds up to a big bill. Mr Larson

The blackouts which hit Texas in this week’s catastrophic cold snap are a case in point (see [article](#)). The problem was not primarily one of renewables failing in the freezing conditions, as some have suggested; many gas-fired plants failed, as did one nuclear reactor. But this does not mean that a grid dominated by renewables would necessarily have done better. Jesse Jenkins, one of the authors of the Princeton study, says the outages show both that America needs interconnections that can transmit large amounts of power over long distances and that “firm” generating capacity—be it in the form of thermal plants powered by biomass, natural-gas plants from which the carbon-dioxide emissions are sequestered, nuclear plants, hydrogen or even geothermal generation—needs to be really reliable.

By 2050 the expansion of transmission and renewables would be truly prodigious (see map). At that point onshore wind and solar farms would span some 600,000 square kilometres, an expanse slightly smaller than two New Mexicos but slightly larger than Minnesota, Wisconsin and Illinois combined. And even that is not, in itself, enough. Research must ramp up, too, to explore the best mix of ways to provide the firm capacity such a grid will need.

E pluribus unum

And even if all electricity were carbon-free and all the country’s cars, light-duty trucks, trains and buildings used nothing else, almost half of America’s emissions would still need to be

tackled. Dealing with aircraft, shipping and farms is much harder. Many firms have committed themselves to reducing or eliminating emissions; but it will be harder to do so in heavy industries such as cement or steel. In those areas change requires either entirely new technology or technologies not yet deployed at a remotely appropriate scale.

This is not the level of change states alone could bring about, even if all of them were trying their hardest. States cannot on their own drive the car industry and its customers away from internal-combustion engines, or deal with the requirement for emissions-free steel, cement, shipping and aircraft. They cannot foot the bill for the \$35bn a year on clean-energy research that Bill Gates, a philanthropist, calls for in a new book (see [Books and arts](#)). As revenues have plunged during the covid-19 pandemic, some states may struggle to supply even basic services; transforming whole swathes of industry is someone else's job.

Enter Mr Biden. His executive order setting the 2050 goal signalled his intentions to push hard on climate; his moratorium on new leases and his revoking of the permit for the Keystone xl pipeline from Canada's oil sands showed he was willing to upset people doing so.

There is a lot he can do simply through forceful leadership and better management of various obscure agencies. The Federal Energy Regulatory Commission, which oversees wholesale power markets, can do a great deal to ease the endlessly fractious construction of transmission lines and support states' efforts to deploy clean electricity. New York's plans to develop a whopping 9gw of wind power off the southern shores of Long Island were held up by Mr Trump's Bureau of Ocean Energy Management. Mr Biden has hired Amanda Lefton, previously New York's assistant energy secretary, to run the bureau, so that will probably change.

Mr Biden can also try and use his powers under the Clean Air Act to accelerate the shift toward low- and zero-emission cars. gm, a giant carmaker, in January announced that it would offer only electric cars by 2035; the prospect for ever stricter regulations on carbon-emitting cars may lead its peers to follow suit. The Securities and Exchange Commission may push companies to disclose climate risks, thus making things easier for the increasing number of investors and asset managers who care about such things. The federal government's nearly \$600bn in annual procurement can be used to create a huge market for new clean technologies.

There are limits, however, to pursuing green policy through the executive branch. Mr Biden risks litigation and review before a conservative Supreme Court that is more sceptical of environmental rules. And even executive orders that avoid legal action remain vulnerable, as first Mr Obama and then Mr Trump have found. These are all strong reasons for Mr Biden to give his programme the buttress of legislation. But in truth, the fact that Congress controls spending is probably enough; a fair amount of the money needed is going to have to come from the public purse.

The most likely vehicle for action is an infrastructure bill which may come later this year. Such a bill might include charging stations for electric cars, support for transmission and investment infrastructure resilient to rising seas. It could also include money not just for basic energy innovation, but for large demonstration projects. Either as part of that bill or separately, Mr Biden would like to create a national clean-electricity standard that could provide zero-emissions

power by 2035, mimicking states' preference for such targets over broader carbon-pricing approaches. Such a clean-electricity standard would force utilities to decarbonise more quickly.

The power to employ

Central to Mr Biden's pitch for such a package is the idea that a green transition will create employment. "Climate change at its heart is not a planetary problem," argues Gina McCarthy, his national climate adviser. "It's a people problem." Building new industries is always appealing to politicians who want voters to have good jobs; updating a great nation's ageing infrastructure could serve the same end. "If we can show that we are growing jobs and that those jobs are good union jobs," argues Ms McCarthy, "then we're going to be able to convince the middle of this country."

The size of any surge in American clean-energy manufacturing should not be overestimated. America is late to the game; industrial policy has already made China the world's dominant producer of solar panels and batteries, and that is unlikely to change. "The United States needs to be clear-eyed about where it will be very hard for us to gain a competitive advantage at this point," says Kelly Sims Gallagher a professor at Tufts University and a former adviser to Mr Obama.

However, she allows that still-nascent, complex technologies such as hydrogen fuel-cells or carbon capture might be possible areas for American differentiation. And the scale of the endeavour matters in itself. If America were to ramp up the deployment of wind and solar as the Princeton team suggests, America's manufacturing jobs for wind would increase by five to tenfold to 2030 and for solar by about tenfold—even if the share of imported components remained the same. Workers would also set about installing wind farms, heat pumps and power lines, to name a few, as well as operating and maintaining them.

Jobs in mining and drilling would decline; those in construction would climb. Princeton estimates that energy's share of employment in 2050 would stay level or rise in most states, with Louisiana, North Dakota and Wyoming notable exceptions. In New Mexico, it would climb from 6% to 10%. In West Virginia, it would inch up from 5% to 6%, as jobs lost in coal were replaced by those in clean power.

Silly games

But that may not be enough to placate Mr Manchin. He is a staunch supporter of his home state's coal miners, who have a symbolic heft that outweighs their economic clout. "We need to innovate our way through this," he asserts, rather than close down industries. He has backed bills to support energy innovation but has so far declined to throw his weight behind a clean-energy standard, noting that renewables are being built quickly already so may not need such support. "Out west, people quit basically raising cows and started raising windmills," he quips.

With Mr Manchin crucial to any attempt to pass a bill purely on the basis of Democratic votes, this might seem to take sweeping legislation off the table. But Sheldon Whitehouse, a

Democratic senator for Rhode Island and perhaps the chamber's most reliable climate advocate, says he is newly hopeful that eight or so Senate Republicans may emerge from their self-imposed exile from the cause. Two-thirds of Americans believe that Washington is doing too little to fight climate change. In January America's Chamber of Commerce—"probably our worst and most implacable adversary", Mr Whitehouse says—voiced support for "durable climate policy" from Congress that supports investment and includes "well designed market mechanisms". Larry Fink of BlackRock, the world's biggest asset manager, is urging businesses to align their strategies with a carbon-neutral economy by 2050. A growing number of companies are tired of climate rules that ping pong from one presidency to the next. "We prefer legislation over regulation," says Ben Fowke, the chief executive of Xcel Energy, a big utility. "It's not as subject to change."

Nodding off

Mr Whitehouse contends that the shift in corporate attitudes may give Republicans cover to support some kinds of climate policy, at least. The fossil-fuel lobby has not gone away. Mike Sommers, who leads api, says he and his colleagues speak with lawmakers daily to explain "what our energy needs are and what they are going to be." That includes a robust future for both American oil and gas, he argues. But Mr Whitehouse says that "there is a very significant chance that the blockade that the fossil-fuel industry perpetrated over the last decade can actually be broken by the rest of corporate America." Indeed in December Congress passed a bill that included an extension of clean-energy tax credits and \$35bn in support for energy research over the next decade—hardly an investment on Mr Gates's preferred scale, but at least a faint glimmer of bipartisanship.

In most 50-50 legislatures the prospect of even a few members of the other side coming over to your point of view would be enough. The Senate is different. Its filibuster rules require 60 votes in order to bring a motion to the floor, meaning that just 41 of the 50 Republicans can block almost any piece of legislation. In principle, the 50 Democratic senators could, with the help of the vice-president's casting vote, end this filibuster rule. But Mr Manchin says it will be eliminated "over my dead body."

The eye of the needle

That leaves Mr Biden with limited options. Bernie Sanders and Alexandria Ocasio-Cortez, Democratic lawmakers who are favourites among the party's left, want to declare climate change a national emergency. That would allow Mr Biden to redirect military funds to boost clean energy; again, though, it would have to pass the Senate.

More likely, Democrats will use their 50 votes in the Senate in a process known as budget reconciliation that allows spending and tax measures to pass with a simple majority. Such a bill could approve investments and tax credits to deal with climate change. Some argue that a clean-energy standard might, if properly designed, squeak through too. Along with a White House that tightens emissions-standards for cars and streamlines permitting for new projects, that would

count as progress. America would connect more clean power to better grids. Additional money could be funnelled towards research. More electric cars would take to the roads.

The question is whether Democrats are able to advance a bill that complies with Senate rules, satisfies both Mr Manchin and Mr Sanders, and is remotely commensurate with the problem at hand. “In the short run we can make a hell of a lot of progress through 2030,” argues Fred Krupp of the Environmental Defence Fund, a non-profit. But emissions neutrality, he says, would eventually require Congress to pass an economy-wide carbon price, too.

Were it not for its politics, America would be as well positioned to decarbonise as any country in the world, argues Stephen Pacala, who led a climate study recently published by America’s National Academies of Sciences, Engineering and Medicine. The country benefits from wide plains and long coasts for wind power, ample sunshine for solar farms across the South, rich forests to act as carbon sinks, expanses of land for producing new energy crops and well-understood reservoirs where emissions might be stored. It has magnificent human resources, too, and a history of rising to challenges, even if it sometimes needs a wake-up call to do so.

For now, Ms Rubio is trying to advance her bill to aid New Mexico’s transition from oil and gas. A port in south Brooklyn awaits transformation into a hub for wind companies. Congress is consumed by debates over covid-19 relief. And still the world’s emissions are set to rise. .

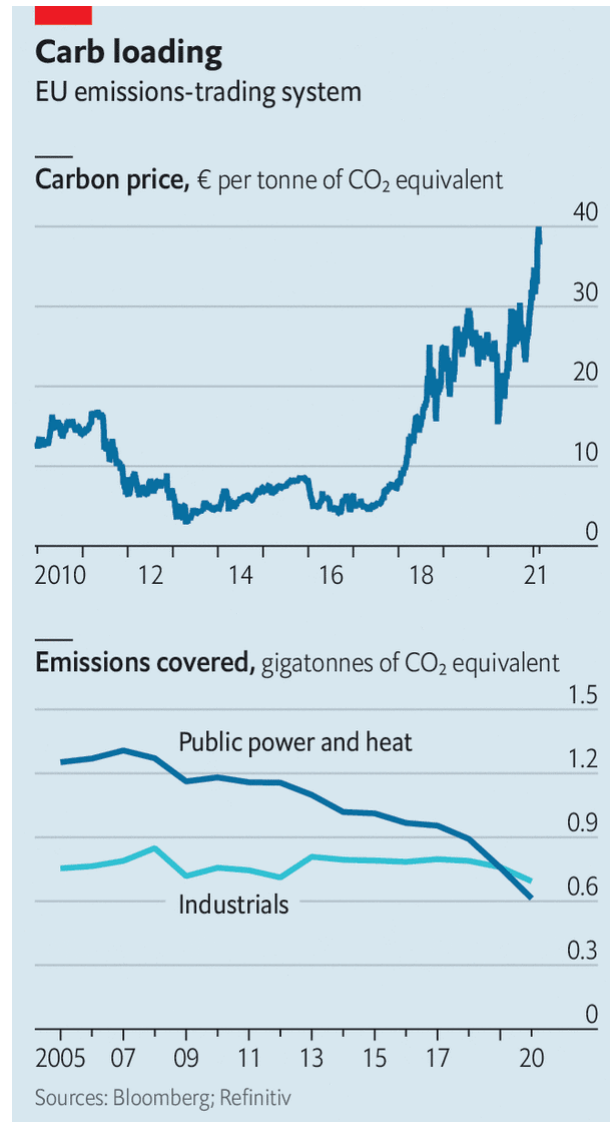
Correction (February 18th): An earlier version of this piece said that America emitted 5.3bn tonnes of carbon dioxide in 2018, rather than 2019. Sorry.

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Europe Carbon Market

AS FINANCIAL MARKETS become cheerier about the pace of vaccinations and the chances of a speedy economic recovery, the prices of stocks, commodities and all manner of assets are rising. So too are carbon prices in Europe, home to the world's largest emissions-trading system. Prices have surged by 60% since November; on February 12th they hit a record high of nearly

€40 per tonne of carbon-dioxide equivalent (see chart).



Last year the value of global carbon markets hit a record €229bn (\$278bn), a five-fold increase from 2017. The European Union's emissions-trading system (ETS) accounts for nearly nine-tenths of both that value and that growth. In 2020 around €1bn-worth of emissions allowances changed hands each day, as well as plenty of options and futures contracts. There are signs that trading is becoming more sophisticated, as investors take an interest.

For a long time after it was launched in 2005, the ETS barely functioned; a glut of allowances (which give the holder the right to emit a certain amount of greenhouse gases) and cheap offsets kept prices close to zero. But after the European Commission sucked excess allowances out of the market in 2019, it began to thrive.

The ETS is an odd market. The commission auctions allowances nearly every day; it caps the overall supply of permits based on the EU's politically determined emissions targets. Demand, meanwhile, comes from three types of participant. The biggest source of demand is the power and heating utilities, such as Germany's RWE and France's Engie. They buy allowances

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to cover the emissions from current projects or to hedge against future price increases. Next come industrial firms, such as ArcelorMittal, a steelmaker. Most of these receive free permits, so that the ETS does not encourage producers to move abroad.

The third, and growing, source of demand is financial firms, including banks, such as Goldman Sachs and Morgan Stanley, and hedge funds, such as Lansdowne Partners and Northlander Advisors. These are not required to hold allowances; instead they hope to profit, either by trading on behalf of utilities or by speculating in the futures or options markets.

The recent spike in prices reflects both supply and demand. Auctions were suspended in January, meaning there were fewer allowances being sold. And on December 11th EU leaders agreed to speed up reduction of emissions, bringing them down by 55% by 2030 compared with 1990 levels, rather than by 40%. That signalled a lower emissions cap, meaning eventually fewer allowances and a higher price.

The expectation of higher carbon prices may have prompted industrial firms to start hedging their emissions early this year. That added to demand for allowances—as did unusually cold weather, which boosted the demand for heating. Speculators may have accelerated the price rise, by buoying futures prices. Around 230 investment funds hold futures linked to the EU’s allowances, up from 140 at the end of 2019. They account for only about 5% of the futures market, but it is a growing, bullish share. Long positions, or bets that the price will rise, have doubled since November. Aje Singh Rihel of Refinitiv, a research firm, notes that this measure closely correlates with recent price changes.

One reason for investors’ enthusiasm is that carbon seems like a one-way bet. Many analysts expect that the EU’s 55% target will require the number of allowances to fall and prices to rise, perhaps towards €80 per tonne. That could be good news for investors. When in 2018 it became clear the commission was going to intervene to limit supply, allowances became the best-performing commodity of the year.

Buy and hold is not the only strategy. Casey Dwyer of Andurand Capital notes that carbon prices are largely uncorrelated with those of other assets, so some investors hold them to diversify their portfolios. They could also be used to hedge against inflation: a higher cost of using fossil fuels is generally accompanied by higher consumer prices.

The presence of financial firms has changed how the market works. Federico Di Credico of ACT Financial Solutions, which specialises in environmental markets, says that the dynamics used to revolve mostly around the commission’s meetings. Now macroeconomic indicators, such as new GDP figures, play a bigger role. Some analysts argue that speculators’ bets cause volatility; others say the consequence has been greater liquidity. Most, though, expect financial flows to grow.

“Once investors start to see it as an ESG trade [that takes into account environmental, social and governance factors], funds will allocate more money to the carbon markets,” points out Ulf Ek of Northlander Advisors. And unlike many forms of ESG investing, Europe’s carbon price, where it is applied fully, seems to benefit the environment directly. Emissions from utilities have roughly fallen by half since the launch of the ETS. By contrast, the industrial sector, which is cushioned by free allowances, has seen little improvement.

What next for the ETS? Some elements, including the overall cap, will be reviewed in June. And the commission has expansion in its sights. One ambitious idea is to connect the ETS to other regions through a carbon border tax. In theory, that would protect European industry from carbon-intensive, overseas competitors. And it may link the ETS to other carbon markets, such as Britain's soon-to-be-launched ETS, and California's cap-and-trade system. Complications around design and geopolitics abound, though. Few think the commission's suggested plan for a border tax by 2023 is realistic.

More likely is expansion within Europe. The scheme covers only 45% of the continent's emissions. Shipping is expected to join in the next few years. Road transport and buildings may get separate markets, with higher carbon prices. If done well, that expansion should attract more capital and perhaps lead to higher prices. But as the market's early years show, much depends on implementation. For all its growing sophistication, the ETS is still a political project at heart.

America and climate change

How America can rid itself of both carbon and blackouts

This is the moment for an ambitious attempt to deal with climate change

Leaders Feb 20th 2021 edition

Texas prides itself on being different. Yet it is in the grip of a winter storm that typifies the Snowmageddon-size problems facing energy in America. Although nobody can be sure if this particular freeze is a sign of climate change, the growing frequency of extreme weather across the country is. Texan infrastructure has buckled. The problem is not, as some argue, that Texas has too many renewables. Gas-fired plants and a nuclear reactor were hit, as well as wind turbines. Worse, Texas had too little capacity and its poorly connected grid was unable to import power from elsewhere (see [article](#)). Texas shows that America needs both a cleaner grid and a more reliable one.

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Plans to overhaul American energy will come before Congress in the next few months. President Joe Biden has said that he wants fossil-fuel emissions from power generation to end by 2035 and the economy to be carbon-neutral by 2050. America is not just the world's second-largest emitter, but also a source of climate-related policy, technology and, potentially, leadership. What is about to unfold in Washington will set the course in America for the next decade—and quite possibly beyond.

Time is pressing. Neither Mr Biden nor his successors may get a second chance to recast policy on such a scale. Global emissions from fossil fuels and cement production in 2019 were 16% higher than in 2009. It will be even harder to limit climate change to less than 2°C above the pre-industrial level, the global threshold from which America's target for 2050 comes. To be carbon neutral, the world must curb emissions by 7.6% a year for a decade, a steeper decline than in 2020, when covid-19 cut demand for oil and coal. For America, delaying action to 2030 would nearly double the cost of reaching net zero or, more likely, mean it overshoots its targets.

Yet there are grounds for hope. Although the Republican Party is against almost all action, voters are increasingly alarmed by climate change. Two-thirds of them think the federal government is doing too little about it, and that share includes plenty of younger Republicans. Although the fossil-fuel lobby remains powerful, many Republican business donors want more action—partly because asset managers are urging firms to align their strategies with the net-zero world Mr Biden envisions.

Most encouraging of all, the costs of power from wind and solar have plunged by 70% and 90% over the past decade. Along with cheap gas, this has already helped America decarbonise at an impressive rate, despite Donald Trump's rolling back of fossil-fuel regulations. Price has not been the only factor; more than half of the states have some sort of clean-energy mandate, a device that Mr Biden wants to introduce on a national scale.

This involves a regulatory framework that favours renewable-energy developments and grid connections to hook them up. It will take a lot of extra investment—about \$2.5trn in the coming decade, say researchers at Princeton (see [Briefing](#)). In a new book, Bill Gates, a billionaire philanthropist, argues that research is needed into a host of areas such as energy storage, advanced nuclear reactors to complement renewables and technologies for clean concrete-making and other activities that are hard to decarbonise (see [article](#)). Without these, even if a clean grid is powering electric cars and light trucks, it will displace only around half of emissions.

America is good at innovation, but new ideas need to be deployed at scale, not languish in the lab. One tool is a carbon price which, if it were high enough and if investors believed it would last, would signal what improvements were needed where. But for all its attractions, carbon pricing failed in Congress in 2009. Although many economists and opinion-makers on the right favour it, Republican politicians do not. And even if a carbon price were in place, public-private co-operation would still be needed for America to act as fast as Mr Biden proposes.

For all those reasons, an ambitious climate-oriented infrastructure bill looks like Mr Biden's best chance of getting new policy on climate through the Senate. Unfortunately such a plan will be lucky to attract any Republican votes. Yet, if mustering the 60 needed to see off a Senate filibuster is improbable, a plan could be stripped of some measures, including a clean-energy standard, and passed with a simple majority through the parliamentary manoeuvre known as reconciliation. The bill must still be of a scale and ambition that matches America's challenge.

Failure to act would bring big risks. For a start, it would make America less competitive in the new clean-energy economy. China is the dominant producer of solar panels and batteries; it has also invested in foreign mines to secure minerals needed for them. Europe has its own "green deal" to boost its clean-energy industries. It plans to tax imports from countries that do not pledge to lower their emissions.

America would also be deprived of global influence over climate. It has direct control over only about 10% of the world's greenhouse-gas effluvia. If it wants the benefit of a stabler climate—and with it a stabler world economy, stabler geopolitics and much avoided suffering—it needs to influence the other 90%, too. Mr Biden has appointed John Kerry, a former secretary of state, to spearhead that effort (see [Lexington](#)). America is to rejoin the Paris agreement on February 19th, making it a full participant in the UN conference to be held in Glasgow, in Scotland, in November, when countries will be able to lodge new and more ambitious pledges to cut emissions. If America tables goals and gives evidence that it will back them with domestic policy, it will gain influence. China's two big development banks have doled out \$51bn for foreign coal plants since 2008. America should be part of a push against such subsidies.

Enough drifting

Unfortunately, America brings little credibility to action on climate. Mr Trump took pleasure in subverting it, but his country's poor record precedes him. George W. Bush declined to implement the Kyoto protocol. Congress has not considered serious climate legislation since 2009. Today must be different. There will never be a better chance for Mr Biden to show real ambition. If the blackouts in Texas are any guide, it would not just be the world that would thank him, but Americans, too. .

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This article appeared in the Leaders section of the print edition under the headline "America's better future"

Lexington

How will John Kerry fare as Joe Biden's climate envoy?

The former secretary of state is a good pick for what may prove to be a chastening task

[United States Feb 20th 2021 edition](#)

Feb 20th 2021

When John Kerry ran for president in 2004 he was too green for either party. Having been in the Senate in 1988 to hear Jim Hansen testify that “global warming is changing our climate now”, he had been speaking on the issue ever since. He was a habitué of international climate conferences; he wooed his second wife, the environmental philanthropist Teresa Heinz, at the Earth Summit in Rio de Janeiro in 1992. This made him something of an outlier even among Democrats, which is why he said relatively little about costly emissions-cutting during his presidential campaign. And it naturally made him highly suspect to Republicans, an impression that George W. Bush's campaign manager encouraged by labelling the long-limbed senator from Massachusetts “incredibly environmentally green”.

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Sixteen years later, America still has no national climate policy to speak of, and the Republicans seem even more opposed to having one; but Mr Kerry's party is now as green as he is. This was illustrated by his much-celebrated appointment as Joe Biden's presidential climate envoy, a new position, which comes with cabinet rank, a seat on the National Security Council and ambitions to elevate the issue across the government. Todd Stern, who was Barack Obama's special climate envoy, describes this as a masterstroke: “Kerry's tireless, persuasive and completely committed to the issue.” Even the hard-left seems grudgingly impressed—notwithstanding the plutocratic Mr Kerry's multiple houses and fondness for private jets. Alexandria Ocasio-Cortez, with whom he co-chaired a pre-election climate working-group for Mr Biden, has not singled him out personally, but lavished praise on the climate team of which Mr Kerry is the most prominent member.

He did not win such plaudits as a politician or, for four years under Mr Obama, as secretary of state. A high-minded man with lugubrious features, Mr Kerry has a reputation for being less genial than Mr Biden, but almost as verbose. He has also been associated with some notable failures. He is the only Democrat to have lost the popular vote in recent decades. He hung his tenure at the State Department on a Middle East peace process that even his boss appeared to think doomed. Even so, the praise for his appointment does not seem misplaced.

He is the most senior politician to have been dedicated to climate diplomacy by any country, let alone the superpower. And at 77 he has lost none of his career-long zeal for the issue. “I view this as a critical moment where we either get people on the road to getting the job done or we take part in one of human history’s greatest moments of failures. And I refuse to let that happen,” he told your columnist. “Every day I get up with a great sense of purpose and a conviction that we can do this.” Yet what difference, beyond ginning up his party, can he actually make?

The first test of this is fast approaching; Mr Biden has convened a climate summit, to be held remotely, on April 22nd. The idea is to underline America’s return to the Paris Climate Agreement, which Mr Kerry helped negotiate; and also to encourage those attending to commit to stiffer emissions-reductions targets ahead of a UN climate conference in Glasgow in November. Yet there is a tension between those aims.

America’s inability to pass serious climate policy has long since eroded its effort to provide global leadership on the issue. And its post-Trump standing on climate, signified by its brief exit from the Paris accord, could hardly be worse. While few question Mr Biden’s sincerity to turn things round, America’s ability to keep to its word on climate change looks vulnerable to the next Republican election win.

To address that “credibility gap”, Mr Kerry acknowledges an urgent need to turn promising words into impressive domestic action. “You can’t just come back in and say, OK, we’re here, without a demonstration of good faith regarding the things you’re willing and prepared to do”. To that end the administration aims to unveil a new and more ambitious emissions-mitigation target by the time of the forthcoming summit.

Mr Biden is also expected to flesh out, in a speech to Congress next month, a plan to make that commitment seem realistic. He can count on no legislative support from the other side (notwithstanding Mr Kerry’s claim to have received expressions of interest from a few Republican senators). The administration is therefore banking on a combination of regulatory standards—of a kind Mr Obama previously introduced and Mr Trump partly scrapped—and heavy public investment in low-carbon industries and technologies. It is the only available option the president has; albeit, given the tenuousness of the Democrats’ hold on the Senate, by no means a slam-dunk.

And even if that goes according to plan, Mr Kerry may struggle to meet the expectations his appointment has raised. The world has changed since Paris. China’s emissions are now twice America’s. And its growing belligerence and octopine economic reach have made it even more impervious to diplomatic pressures than it was in 2015. Especially, from America’s perspective, considering the deterioration of the two powers’ relations in other areas. Mr Kerry insists that America and China have no alternative but to co-operate on climate, however testy their relations get on trade or security. He is of course right; yet his ability to make progress will depend on China choosing to observe the same distinction.

Kerry on regardless

That is not to deny the hopefulness of the moment. The climate-policy world has been crying out for someone of Mr Kerry's stature and relentlessness. And for his newfound humility. His goal, he says, is not to restore American leadership but to get the job done. "And if in doing that our leadership and our participation earns some respect back, great." Of all the ways in which Mr Biden hopes to restore said American leadership, this may be the hardest. .

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This article appeared in the United States section of the print edition under the headline "John Kerry, eco-warrior"

Green maths

What is the cheapest way to cut carbon?

Bill Gates is the latest to grapple with a thorny question

Finance & economics

Feb 22nd 2021

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IN THE TRENDIER parts of Berlin, cargo bikes are the rage. Locals use the bicycles, which have a wheelbarrow-sized box attached at the front, to do the weekly shop or ferry children around. Because they cut carbon-dioxide emissions, local authorities are subsidising the craze. But the well-intentioned schemes look pricey when you consider how much carbon is abated. One scheme costs the city €370,000 (\$450,000) but is expected to reduce emissions by only seven tonnes a year. That works out at over €50,000 per tonne abated. The equivalent figure for schemes that support the sale of low-carbon heating systems, by contrast, is €200 per tonne.

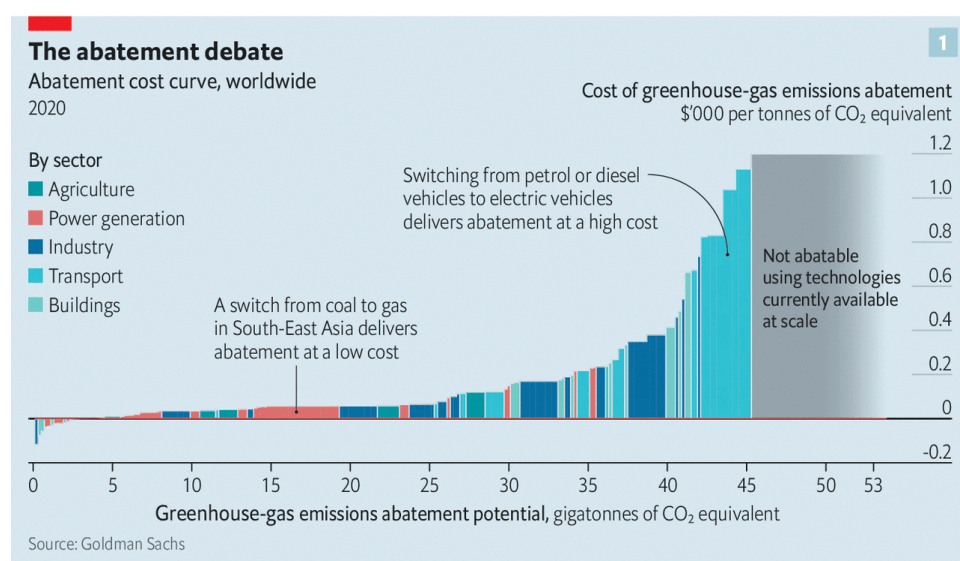
Over 100 countries and 400 cities (including Berlin) have promised to get to net-zero emissions by 2050 or before. Investors and regulators are encouraging companies to do the same. To meet these goals policymakers and bosses will have to pick from a menu of policies, from building wind farms to subsidising low-carbon jet fuel. That raises an important question: what is the cheapest way to abate carbon?

One way to discern the answer is to impose a price on carbon, either as a tax or a cap-and-trade scheme. This would encourage firms and consumers to find the cheapest ways to abate. But setting a price is difficult politically. Only a fifth of the world's emissions are covered by an explicit price. Even in Europe,

the world's biggest liquid carbon market, free credits still allow many industries to continue polluting.

So other tools are needed, too. In his new book, "How to Avoid a Climate Disaster", Bill Gates suggests using a "green premium", or the gap between the price of dirty activities and clean ones, as a guide. Where the premium is low, zero-carbon alternatives exist, and consumers have no reason not to use them. Where the premium is high, more innovation is needed.

A similar approach, popular in climate circles for the past decade or so, is to consider the marginal costs of abatement. Like green premiums, these compute the costs of a climate intervention (including operating costs and upfront spending). But it compares them with the emissions that the policy is expected to abate. When considering whether to regulate car or plane journeys, for instance, it helps to know that cars account for 11% of the world's greenhouse-gas emissions, whereas aviation makes up just 2%. Plotting the costs and emissions abated on a curve shows the policies that provide the most bang for the buck (see chart 1).

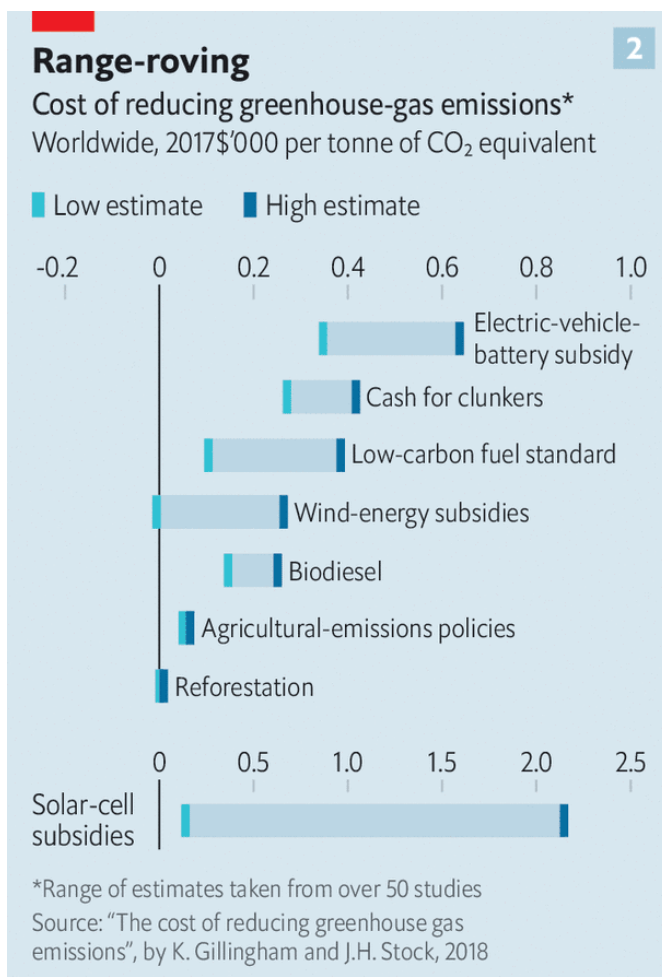


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Such curves have been computed by a number of forecasters over the years, including McKinsey and the Boston Consulting Group, two consultancies; Goldman Sachs, a bank; and Britain's Climate Change Commission, which advises

Parliament. As a rule, most show that the biggest bang comes from making buildings more energy-efficient, say by installing insulation or smart cooling and heating systems. Often these have negative costs—analysts think they will eventually save consumers money through cheaper bills.

The next-best bang for buck tends to be replacing power plants that burn



natural gas or coal with renewable-powered ones. There is less agreement about what the next-best option is after that. But the most expensive areas of the economy to decarbonise tend to be transport (planes and ships), heavy industry (steel and cement) and agriculture (cows belching methane). In these cases clean, cheap, scalable alternatives do not yet exist.

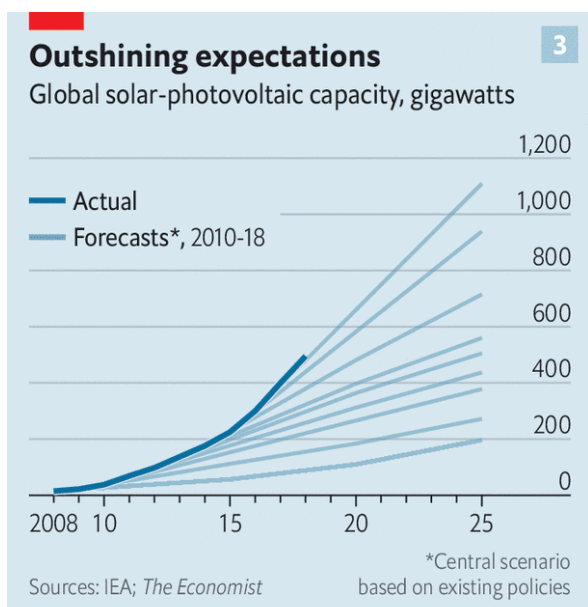
Just as abatement-cost curves provide a rough guide for policymakers, they also show how difficult the maths are. Estimates of costs vary widely, for instance (see chart 2). A paper by Kenneth Gillingham of Yale University and

The Economist

James Stock of Harvard University compares the marginal costs of policies across 50-odd studies. The cost of wind-energy subsidies can range from more than \$260 per tonne of carbon dioxide avoided, to close to zero.

This is partly because a technology's abatement potential can vary from place to place. Some countries, such as Britain, are blessed with high winds and shallow

seas that are ideal for offshore wind farms. In other places, wind energy will provide scant abatement.



The Economist

Working out costs is tricky, too. The International Energy Agency (IEA), for instance, has routinely underestimated the pace of deployment of renewables (see chart 3). And because economies of scale drive down prices, that means it has overestimated the costs of switching, too. In 2010 the lowest the IEA expected solar prices to drop to over the next decade was about \$195 per megawatt hour. Today the price in America and Europe is \$30-60.

Nor do abatement-cost curves show how technologies interact. Hydrogen is rarely produced without emissions. But if it were, the Hydrogen Council reckons, it could be used in 35 different green applications, from storing energy to heating buildings. Ignoring this could lead to underinvestment in hydrogen power today.

Interactions also affect how much interventions reduce emissions. Consider two things needed to decarbonise the economy: converting the grid to low-carbon power, and electrifying transport. The order in which you do these matters. According to a model developed by the Massachusetts Institute of Technology and others, if transport were electrified, there would be less demand for oil to fill tanks with petrol. Yet, as the demand for dirty power for electricity would

surge, overall emissions would drop by only 2% by 2050 (compared with a business-as-usual baseline). If the grid were cleaned up first, though, then emissions would fall by about 30%.

Faced with all these difficulties, forecasters are taking a more sophisticated approach, rather than simply working their way along the marginal-cost curve. Goldman Sachs is incorporating different scenarios and a wider range of costs into its analysis. Others are turning to “energy-systems” modelling, which estimates models over and over again with different assumptions. That lets technologies interact, and means that forecasts rely less on one set of assumptions for, say, prices.

This type of analysis lets you sort climate actions into three categories, says Jesse Jenkins of Princeton University, all of which require funding. First are what he calls “robust” interventions, such as improving energy efficiency, which are valuable across lots of scenarios. Next comes “shaping” interventions, such as investing in hydrogen and batteries, which improve the likelihood of arriving at a low-carbon future. Then come “hedging” strategies: long-shot options to develop, just in case, such as direct-air-capture, which sucks carbon dioxide from the atmosphere. The result is a more complex framework better suited to deal with the complex, ever more urgent task of decarbonisation.

How Britain decarbonised faster than any other rich country

That was the easy bit. Now the hard stuff starts

[Britain Feb 20th 2021 edition](#)

Feb 15th 2021

Over the summer of 2020, as coronavirus cases fell and life in Britain felt briefly normal, something very abnormal was happening to the country's electricity supply. No coal was burned to generate any portion of it for a period of more than two months, something that had not happened since 1882. Britain's four remaining coal-burning power plants are zombies, all but dead. Within a couple of years they will be closed and Britain will probably never burn coal for electricity again.

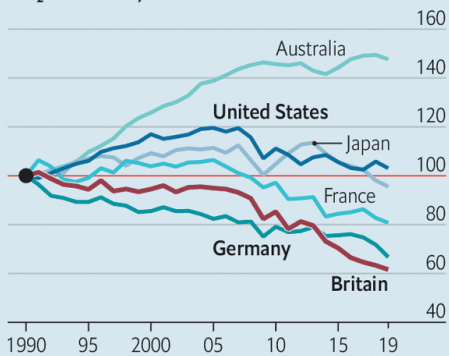
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The elimination of power stations that burn coal has helped Britain cut its carbon emissions faster than any other rich country since 1990 (see charts). They are down by 44%, according to data collected by the Department for Business, Energy and Industrial Strategy (beis) during a period when the economy grew by two-thirds. Germany's emissions, in contrast, are down by 29%; coal is still burned to generate some 24% of its electricity. Britain has made cuts to its emissions 1.8 times larger than the eu average since 1990. In America, emissions over the same period are up slightly.

Cleaning up

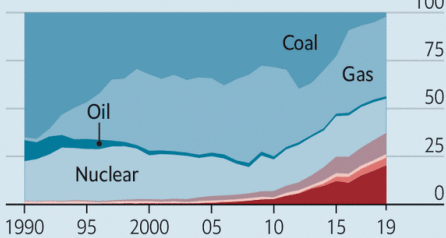
CO₂ emissions, 1990=100



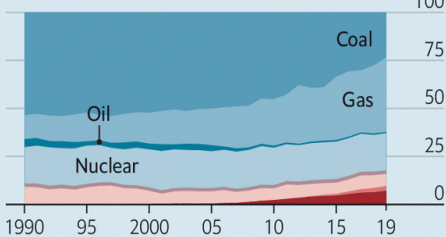
Electricity production by source, %

Wind Solar Hydroelectric
Other renewables

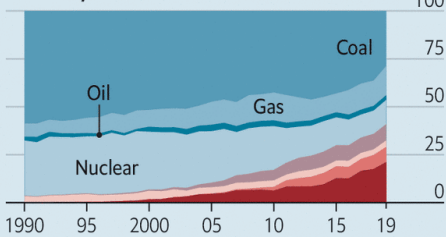
Britain



United States



Germany



Source: Our World in Data

The Economist

into [the act] very early," says Mr MacDonald.

Britain's success has given it prominence in the global debate on climate change. This year it will co-host cop26 in Glasgow, the world's largest and most important climate gathering. Boris Johnson, the prime minister, is attracted to the futuristic whizbangery of clean energy and is deploying "climate diplomacy" to help define post-Brexit Britain's place in the world. In November he presented a "ten-point plan for a green industrial revolution" that included spending £12bn (\$17bn) on clean-energy gubbins. But examining Britain's decarbonisation shows that much of its success was circumstantial, and that the country's hardest problems are ahead of it. After a decade of meeting its own legally binding decarbonisation targets, Britain is now veering off course.

Unusually for a right-wing politician, Margaret Thatcher was an early believer in the dangers of global warming. But the impetus she gave to decarbonisation was a by-product of policies with other aims. In crushing the coalminers' unions in the 1980s, she neutered a powerful industry dedicated to the emission of carbon. Privatising Britain's energy markets and opening up the North Sea for oil and gas exploitation weakened the coal industry further. Emissions declined gently after Thatcher left office, long before climate change was on the national agenda, simply because a growing proportion of Britain's electricity and heat was being generated by burning gas, which emits about half as much carbon dioxide as coal when burned.

But this century, decarbonisation has been the deliberate consequence of political choices. In passing the Climate Change Act in 2008, Britain became the first country in the world to commit to legally binding carbon-emission reduction. Labour was in power at the time, but there was a remarkable political consensus in its favour. Only three mps voted against it. According to Phil MacDonald of Ember, a think-tank, David Cameron's Conservative Party was casting around for policies that might detoxify its image, and settled on climate change. "Cameron bought

The weak, dirty coal industry was an obvious target for a country newly united against the emission of carbon. In 2013 a Conservative-Lib Dem coalition government introduced a power-sector carbon tax which hit coal twice as hard as gas, making it uncompetitive. Coal plants which had been running continuously started being used only when electricity was in high demand. In 2015 coal produced about a quarter of Britain's electricity. Now it accounts for less than 2%.

As the cost of wind farms plummeted, gas started feeling the squeeze too. In its latest carbon budget, the Climate Change Committee (ccc), the independent body created by the Climate Change Act to steer Britain towards net zero, said that Britain should commit itself to phasing out gas power plants by 2035. This has changed the economics of new gas power stations. Drax, a power company which had been planning to build Europe's largest gas power station in Yorkshire, is now reconsidering. "The risk for investors in those utilities is that they are only going to get a decade out of it," says Mr MacDonald.

The grid is not yet even halfway to complete decarbonisation, but seems bound to get there as the price of electricity from renewable sources continues to fall. "The economics have just shifted so that wind is the default," says Mr MacDonald. Solar power has grown too, but a cloudy, crowded island is ill-suited to the technology. In 2020 solar provided just 4% of electricity. Wind provided almost a quarter. Old nuclear power stations must be replaced with new ones, Hinkley Point c and Sizewell c, or Britain's plans for a decarbonised grid will be in disarray.

Consumers have barely felt the costs of the transformation to date. Paying for low-carbon electricity accounted for about 9% of bills in 2016, but increases in the efficiency of light bulbs and appliances offset the rise in power costs. The ccc estimates that required efficiency increases will more than cover the increased cost of electricity in future.

The tricky bit

Zero-carbon electricity is an end in itself, but also a necessary first step to decarbonising other parts of the economy, such as heating and transport. Heat pumps must replace gas boilers; electric motors must replace internal combustion engines. But Britain's success in decarbonising its grid has not yet translated into progress in these areas. Where emissions related to electricity generation plunged by 66% between 1990 and 2019, the equivalent reduction for transport, which is now the largest source of emissions in Britain, was just 5%. Buildings generate the second-largest block of emissions, largely thanks to the burning of gas to heat water in radiators.

It is harder to decarbonise heat and transport than electricity. The only change consumers notice when dirty power sources are replaced with renewable ones is a slow price rise. But to clean up heat and transport, either policy or market mechanisms must reach right into people's homes and driveways. Incentivising them to rip out their combi boilers and switch to electric cars will be expensive at best, impossible at worst.

Heat is a particularly tricky issue in Britain, for its houses are higgledy-piggledy and badly insulated, and its people fond of them. Keeping them warm is easier with gas, which has a high energy density, than with electricity, which tends to generate lower temperatures. Heat pumps and bigger radiators or underfloor heating are needed. That will cost tens of thousands of pounds

per home. Similarly, installing charging points for electric cars in old, winding city streets will be tricky. Mr Johnson's commitment, as part of his ten-point plan, to end sales of petrol and diesel cars in Britain by 2030 will help a lot.

And although gas helped decarbonise Britain's grid, it is a hindrance when it comes to heating and transport. That is because Britain has one of the world's most robust and extensive infrastructures for moving gas around; 85% of its 29m homes are heated with gas boilers. In Germany 47% are. Decades of investment in the gas grid mean that Britain's electricity grid is not as robust as it needs to be in order to carry the extra power required to replace gas in the heating of Britain's homes. If it is to charge all the cars and run all the heat pumps, the grid will need to be upgraded at a cost of tens of billions of pounds.

The political consensus is fraying, too. In 2015 the Tory government scrapped a plan to make all new homes carbon-neutral, meaning that most houses built since then have gas boilers and low-quality insulation, so will need retrofitting. Fuel duty, which would incentivise car electrification, has been frozen since 2010. Rishi Sunak, the chancellor, plans to raise it in his forthcoming budget, but faces opposition from his party. And in early February, 24 hours after the right-wing *Daily Mail* called a proposed carbon tax that would have raised the price of consumer goods a "tax raid on your lifestyle!", the government dropped it like a hot potato.

The challenges of heat and transport are already showing up on Britain's carbon budget. The country is no longer on track to meet its own legally mandated targets for reducing emissions. In 2017 it was projected that Britain was set to miss its 2030 target by 8%. A year later that gap rose to 10%. The problems posed by transport and heating are largely responsible.

Mr Johnson's ten-point plan therefore reads more as an ode to successes past than as a sensible recipe for the future. But Britain's moment on the world stage of climate policy approaches, so its recent performance and future plans will be in the spotlight. The prime minister cannot rest on his predecessors' laurels. ■

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The race to zero

Bill Gates has a plan to save the world

Tackling climate change, he says, requires governments and business to work together

[Books & arts Feb 20th 2021 edition](#)

Feb 15th 2021

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How to Avoid a Climate Disaster· By Bill Gates· Knopf; 272 pages; \$26.95· Allen Lane; £20

“How many planets?” That question was posed by Mahatma Gandhi as he contemplated the environmental implications of India’s following the resource-intensive path of development pioneered by Britain. The inquiry still resonates. As the World Economic Forum, a think-tank, has put it, the global “food-energy-water nexus” is in trouble. Global warming is the most alarming crisis of all. How many planets would be needed if everyone in China lived in McMansions and drove gas-guzzlers, as many Americans do?

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For some tycoons, the solution is to find more planets. Fifteen years ago Elon Musk was so worried about climate change making Earth uninhabitable, he earnestly told this reviewer, that he intended to turn humanity into a multi-planetary species. He has since been funnelling the fortune he is making at Tesla, his electric-car company, into building ever-better rockets at SpaceX. This month Jeff Bezos stepped back from running Amazon, an e-commerce goliath, to spend more time on Blue Origin, his rocket venture, which he calls his most important

work. The coming energy crisis, he has declared, means that “we have to go to space to save Earth.”

By contrast, Bill Gates, the co-founder of Microsoft, has his feet firmly planted on the ground. He is just as concerned about global warming as are those trillionaires, but in his view there is only one planet that matters. His new book, “How to Avoid a Climate Disaster”, is devoted to reconciling the legitimate aspirations of billions of people for economic advancement with the environmental harm that results. If humanity is to win the great race between development and degradation, he writes, green innovation must accelerate.

Previous energy transitions—for instance, from coal to oil—took many decades. But given the pressing need to decarbonise the global economy, says Mr Gates, “we have to force an unnaturally speedy transition”. He wants governments to increase funding for climate research fivefold in a decade; disclosing his own investments, he urges them to bet on such promising but risky fields as advanced nuclear power. There should be more green procurement (a path China has followed with solar panels and electric cars) and greener regulation. But the linchpin of his argument is the introduction of a meaningful carbon price, to account for the externalities involved in using dirty energy.

Mr Gates is hardly the first to advance these proposals. Besides his status as one of the world’s richest people and most generous philanthropists, two things make his endorsement of them compelling. First, he is not a reflexive environmentalist. His long-standing commitment to public health and the alleviation of poverty led him to oppose flaky green causes like Europe’s unscientific bans on genetically modified organisms. In a moving chapter, he notes that Africa’s poor have yet to enjoy the benefits of the first “green revolution” in agricultural science, which from the 1960s boosted farming yields and saved a billion people in Asia from starvation; they desperately need more such innovations in crop science and fertilisers. He awakened to the climate crisis as it became clear that the world’s indigent, who have contributed least to the problem, are likely to suffer most from famines, droughts, rising seas and other effects of global warming.

Second, Mr Gates has long been allergic to top-down regulation. “It might seem ironic that I’m calling for more government intervention,” he concedes. “When I was building Microsoft, I kept my distance from policymakers in Washington.” Because he instinctively favours markets over mandarins, his policy recommendations carry more weight than the common calls heard today in America and Europe for blank-cheque spending on Green New Deals. A carefully calibrated push from the top, he insists, will set off a tsunami of private-sector investment and invention.

Much of his book is devoted to a delightfully wonkish assessment of contenders in the race to solve the climate problem. In Mr Gates’s view, decarbonising electricity is the “single most important thing we must do to avoid a climate disaster”. This is not only because electricity accounts for over a quarter of the direct greenhouse gas (ghg) emissions caused by human activity today, but because clean power can enable a shift to zero-carbon transport (think electric cars). Greening industry is harder, he acknowledges, but he points to advances even in such unsexy areas as low-carbon cement and steel.

Mission possible

Mr Gates takes on some green shibboleths, which he clearly considers courageous, though others will detect an outmoded mindset. He is an unabashed defender of carbon-free nuclear power, despite the industry’s failure to solve serious problems surrounding waste and proliferation. He chastises those who make a fetish out of wind and solar technologies, emphasising the constraints of the intermittent generation they involve.

Many environmentalists are clamouring for cuts in emissions of ghgs by 2030. Mr Gates rejects that: what matters most, he counters, is getting to a “net zero” carbon footing by 2050, which means any man-made ghg emissions are offset by absorption and sequestration. Provocatively, he claims that “making reductions by 2030 the wrong way might actually prevent us from ever getting to zero”. For example, a breathless dash from carbon-loaded coal to natural gas sounds climate-friendly, as it would lead to a decline in energy-sector emissions within a

decade. However, it would lock gas technology—which is not carbon-free—into the grid for decades, perhaps blocking the adoption of better alternatives. “The things we’d do to get small reductions by 2030 are radically different from the things we’d do to get to zero by 2050,” he insists.

The most refreshing aspect of this book is its bracing mix of cold-eyed realism and number-crunched optimism. Mr Gates reveals that when he attended the UN’s landmark Paris summit on climate change in 2015, he had serious doubts about mankind’s willingness to take on this Herculean task: “Can we really do this?” Even now, after making the case for why the world must do so, and urgently, he wonders if the climate challenge will be harder than putting “a computer on every desk and in every home”.

That is a useful analogy, for the techno-Utopian vision of a global internet seemed as impossible to achieve a few decades ago as solving the climate crisis does now. Ken Olsen, founder of Digital Equipment Corporation, a pioneering computer firm, once stated flatly: “There is no reason anyone would want a computer in their home.” Yet before long the digital revolution succeeded—because of a happy convergence of top-down forces and disruptions from below.

Mr Gates wants the same combination to take on climate change. He acknowledges the power of the state and a need for intergovernmental co-operation, something not often heard from techno-libertarians; but he also calls for more green ambition and risk-taking by short-termist investors and company bosses. Ultimately his book is a primer on how to reorganise the global economy so that innovation focuses on the world’s gravest problems. It is a powerful reminder that if mankind is to get serious about tackling them, it must do more to harness the one natural resource available in infinite quantity—human ingenuity.

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CHINA

China and America talk of co-operating on climate. It will be hard

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Charlemagne

The rise of dirty politics in Europe

A coming backlash to the green wave

Europe Feb 20th 2021 edition

Feb 20th 2021

The bois de la cambre is the most handsome park in Brussels. Its 123 hectares offer mature forest and potential peace for the residents of the Belgian capital's well-to-do southern suburbs. Naturally, the Belgians—among Europe's biggest petrolheads—built a motorway through it. During the lockdown, the park was closed to traffic. Pedestrians were delighted. Drivers were furious, court cases came and a new front in the culture war was born.

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Grumpy motorists are easy to find in Europe today. Head north to the Netherlands and they moan about speed limits. There, motorway traffic now crawls along at 100kph (62mph) after the government cut the daytime speed limit from 130kph to stop the country busting through its pollution limits. Mark Rutte, the country's ever-flexible prime minister, declared the measure he had just introduced "rotten". Over the border in Germany, the days of screaming down the autobahn at 200kph could be over, if the Greens end up in government and introduce a speed limit. Green politicians know it will cause a fight. "The speed limit is second amendment stuff," says Daniel Freund, a Green mep.

Car wars belie Europe's reputation for eco-friendliness. Green parties are riding high in the polls and could return to power in Germany this year. Climate-denier cranks have been routed. Those who believe man has nothing to do with global

warming are bracketed with folk who think the Moon landing was fake and Elvis is alive. Ambitious targets are set, and then made more stringent, as the eu positions itself as the class swot of environmentalism. A few years ago, reducing emissions to 40% below 1990 levels by 2030 was deemed enough. Now the demand is 55%. All eu countries have signed up to it, after persuasion and copious bribes via eu funding.

What must be done has been agreed on. The fight over how to do it is just beginning. Support for climate measures is broad but shallow, says Heather Grabbe of the Open Society European Policy Institute in Brussels, which polled eight European countries. Nearly all voters are happy to buy less plastic, though far fewer are keen to pay more for fuel or flights. And good intentions mask complacency. In each country a majority of voters expect life to continue broadly as normal, even if nothing is done by 2035. The size of the likely shift over the coming decades has not sunk in. Hard choices are yet to be made or a political price paid.

Already certain politicians of the right are jostling to provide voters with an easy way out. Policy platforms promising frequent flights, cheap petrol and a guilt-free carnivorous diet are appearing across fringe parties. Ahead of Dutch elections in March, the far-right Party for Freedom (pvv) promises to raise speed limits to 140kph. Populists have found their previous bread-and-butter issue, immigration, sinking from public consciousness as borders have been more or less closed. So now the likes of the Sweden Democrats, an anti-immigration party, and the similar Alternative for Germany are increasingly focusing on the environment. Most stop short of outright global-warming denial. Instead, they argue that too much is being done, too quickly, at too high a cost. "Nobody is against a green environment," declares the pvv in its manifesto. Instead it opposes "pointless, unaffordable climate policy". The pvv and its ilk are unlikely to get anywhere near office. Such parties achieve their aims, however, not by winning power but by dragging mainstream parties towards their positions. That is what happened with migration.

*This makes it politically more dangerous for politicians to go green than at first glance. Get it wrong and punishment is swift. France provided an example of what not to do when, in 2018, it cut speed limits on country roads and raised taxes on fuel. The result was the *gilets jaunes* movement, which snowballed from a crowd of grumpy drivers into protesters waving mock guillotines in Paris. In Germany the Greens learned in 2013 that proposing to ban some things and charge more for others was not popular. In the land of sausage-munching drivers of gas-guzzling cars, the party proposed higher taxes on fuel and meat-free days in the cafeteria. Support plunged and the Greens are still trying to shrug off a reputation for being the party of prohibition.*

Foot-dragging is already a problem, even before a proper backlash has begun. Germany agreed to phase out coal only by 2038, after dawdling from both the centre-left Social Democrats and the Christian Democratic Union, their centre-right coalition partners. The new cdu leader, Armin Laschet, is among the coal industry's strongest supporters. The temptation to go even slower may grow as parties on the extremes offer voters an easy alternative. Pushing through environmental reforms in the wake of a catastrophic slump makes life even harder. Suppose the recovery is botched. Even if the real cause is miserly fiscal policy, voters may blame greenery for their woes. That could make reform harder to sustain.

Avoiding a car crash

When it comes to the environment, there will be losers. This is by design. Some behaviour—whether taking a third flight in a year, or zipping through a park in a Mercedes—must become inconvenient or expensive compared with greener options, because technology will not solve the problem fast enough. Some jobs will go. Politicians argue hopefully that if carbon taxes go up, then other taxes can go down; dirty jobs can be replaced by clean ones. But voters may feel they have heard all this before. A similar argument was put forward about globalisation. For years, voters were assured that it did not matter if jobs went abroad as new ones would replace them at home. The proceeds of extra growth

would be shared. But the hoped-for redistribution disappointed. Some jobs were not replaced; some areas were left to rot. Politics went to pot. Voters are expected to accept this logic a second time and trust that governments will not betray them. If Europe's leaders flunk it again, the consequences could be ugly.

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Emission days

How today's reviled airlines could become greener

The pandemic has drawn attention to the environmental damage caused by air travel

Special report [Feb 13th 2021 edition](#)

Feb 11th 2021

Skies cleared of much commercial aviation gave plenty of ammunition to those who see air-travel emissions as one of the gravest threats to the environment. Travel by commercial jet attracts more criticism than its 2-3% share of global carbon emissions seems to justify. Yet despite this seemingly modest contribution it is (or was, until covid-19 struck) one of the fastest-growing sources, the worst contributor of all emissions per kilometre travelled of transport and is likely to continue on its upward path. The growing ease and falling cost of travel, plus a lack of any regulations to curb emissions, means that unchecked a rise to as much as 9% of total carbon emissions by 2050 has looked plausible.

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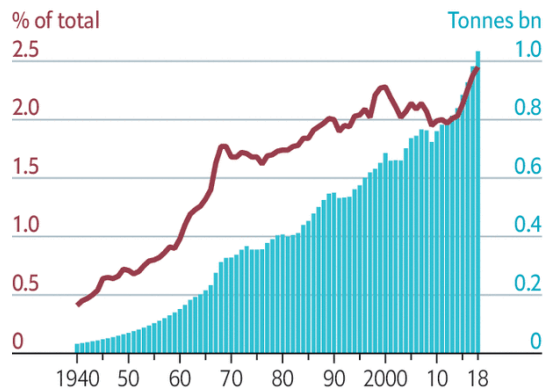
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As far back as 2009 the airline industry pledged to cut emissions from flying by half from levels in 2005 by 2050. More recently *flygskam* (flight shame), a Swedish word that sums up a growing worry about the environmental impact of flying, protest groups such as Extinction Rebellion, whose followers have blockaded airports, and other anti-flying movements have all reminded the airline industry that for too long it has got away with failing to tackle the growth in carbon emissions.

The industry has adeptly managed to sidestep regulation. Aviation fuel is exempt from taxes on international flights, thanks to the Chicago convention, still the main rulebook for the industry even though it was agreed in 1944. In 2013 the eu tried to add international flights to its emissions-trading system, but the industry successfully resisted. As a compromise the International Civil Aviation Organisation, a un agency, came up with corsia, a global scheme to offset emissions. Although criticised for its toothlessness—it is voluntary until 2027 and does not include domestic flights—corsia starts its pilot phase this year.

Hot airlines

Global aviation, CO₂ emissions*



*Includes land-use change

Sources: "The contribution of global aviation to anthropogenic climate forcing for 2000 to 2018", D.S. Lee et al., *Atmospheric Environment*; Global Carbon Project

The Economist

Yet carbon emissions per passenger have fallen by over 50% since 1990. New technology serving the commercial interests of airlines (fuel typically accounts for 15-20% of airlines' operating costs) has had the side-effect of lowering emissions. Every generation of aircraft, such as the newest short-haul planes from Airbus and Boeing, is typically 15-20% more fuel-efficient than the one it replaces, mostly because of improvements in engines. Other bits of kit have helped. Airbus's "sharklets" or Boeing's "winglets", the specialised wingtip additions on new planes, have improved fuel efficiency by 3-4%. Better business models, such as low-cost carriers that pack in more passengers, have ensured that aircraft are flying around with more people on board. Average load factors have improved by some ten percentage points over the past 15 years to 83% in 2019—though that was pre-covid.

Emissions per passenger will fall further in the next few years, if only because flying is unlikely to return to levels of 2019 for three or four years. Cleaner skies will result from the early retirement of older, less efficient planes as airlines cut capacity. The oldest, most inefficient models such as the Boeing 747 jumbo jet and the Airbus a340 may stay on the ground for good. Other older planes will be retired earlier and replaced with more efficient models.

Rail v air

The pandemic might even see some shift to rail, especially in Europe where trains and planes compete on international routes and an established high-speed network can be expanded. China's domestic market could see similar competition between rail and jet engine. UBS, a bank, reckons that the use of high-speed trains could lead to zero growth in air traffic between European destinations from 2018 to 2028. Governments should be keen to invest in high-speed rail in Europe given their commitments to net-zero-carbon emissions by 2050. Further liberalisation across the EU will expose state-run incumbents to more competition.

Yet rail can never compete with airlines on long-haul routes that traverse large stretches of water. So a bigger leap to net-zero emissions from aviation has come to the fore. Airbus and Boeing, the duopoly atop the aircraft supply chain, have been clobbered by big losses, production cuts and fears for the financial health of their suppliers and their customers. Boeing's woes have been compounded by the damage from the grounding of the 737max for almost two years after two fatal crashes. The plane was eventually recertified for a return to service by American regulators in November. Yet the pair will continue to sell planes and these will largely replace older ones rather than expand fleets. So the share of newer, cleaner planes in the world's fleets will grow.

Airbus and Boeing have gone further, with plans for aviation to clean up its act more comprehensively. The European firm hopes to have net-zero-emission planes that can ply short-haul routes in commercial service by 2035. The three concept aircraft it has unveiled, including a futuristic "blended wing" design, use hydrogen as a fuel. In January Boeing said that by 2030 it will start delivering commercial planes powered entirely by biofuels, another way to cut emissions. These are already in use in limited quantities by several airlines, blended with regular fuel, but are still prohibitively expensive—perhaps twice the price of kerosene.

Scale should bring prices down. And turning plant matter and waste into fuel has a carbon footprint of its own. Rolls-Royce, a jet-engine maker, nevertheless reckons a 75% reduction of carbon emissions is possible, with more to come. Other zero-emissions technologies are in development. Startups have been testing small battery-powered planes. Eviation, an Israeli firm, hopes that Alice, capable of flying nine passengers up to 800km, will fly for the first time next year. Others, such as ZeroAvia, are trying out fuel cells that use hydrogen to generate electricity to power engines.

Airbus expects its new plane to be powered by hydrogen directly as a fuel in new turbofans of the sort now found in large passenger jets. Big investments will be needed, starting with engine makers that must work out how hydrogen, which burns at a far higher temperature than kerosene, can be used safely. Boeing's plans require some adaptation of existing engines. Given that new planes can take seven or eight years to get from drawing-board to commercial service, that gives Boeing what Robert Spingarn of Credit Suisse, another bank, calls "breathing room". Airbus is likely to launch its hydrogen programme formally in 2027.

So gradually, after 2030 if the timetable holds, new planes will have far lower emissions and after 2035 short-haul jets should have net-zero emissions. The hydrogen technology could be extended to twin-aisle planes, all of which should be using more biofuels. No switch will be flicked but in around a decade the journey to clean up travel will start in earnest.

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