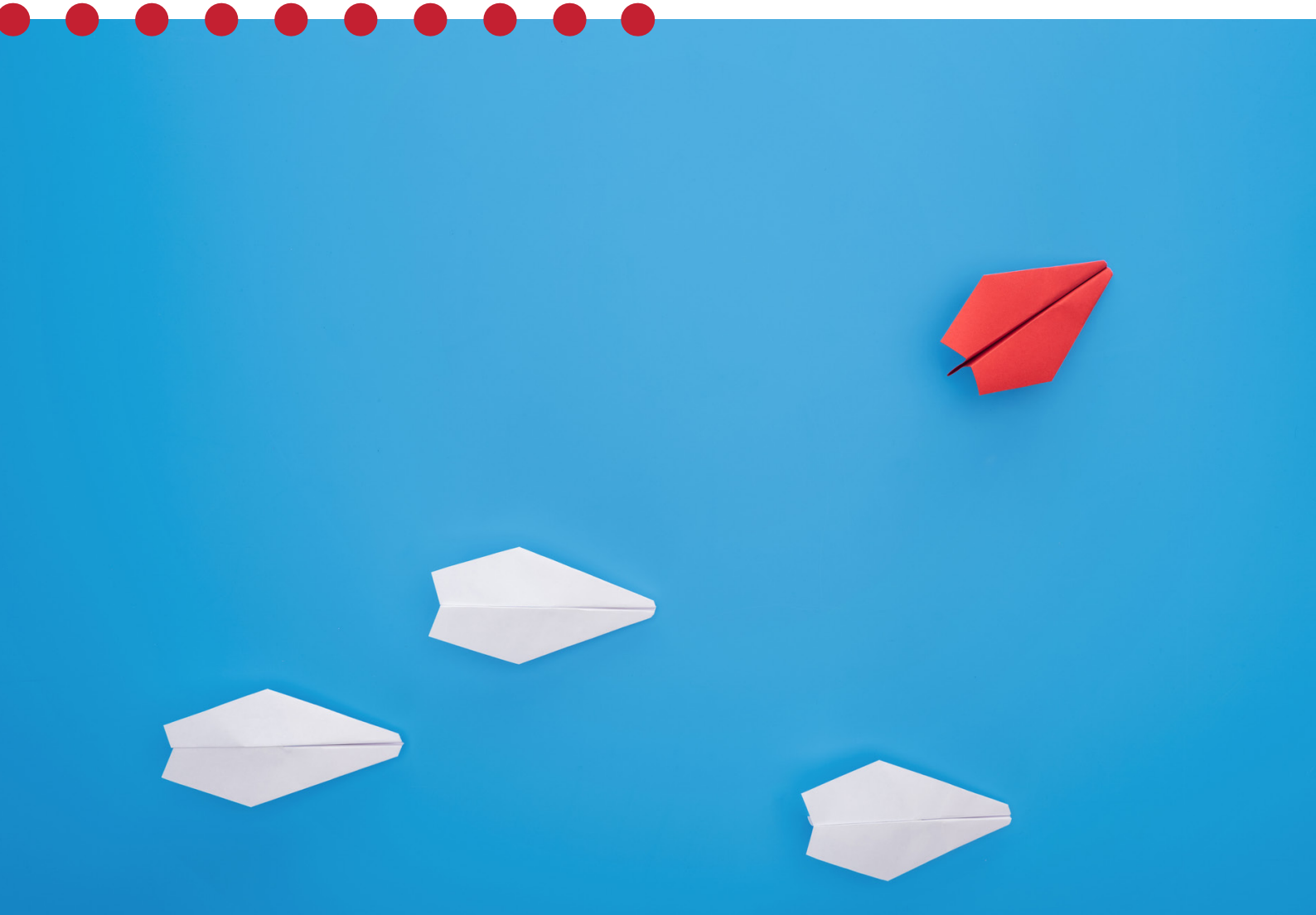
Energy&Climate
INTELLIGENCE UNIT

November 2022

# GLOBAL MOMEMTUM ON CLEAN TRANSITION 2

## THE BIG FOUR

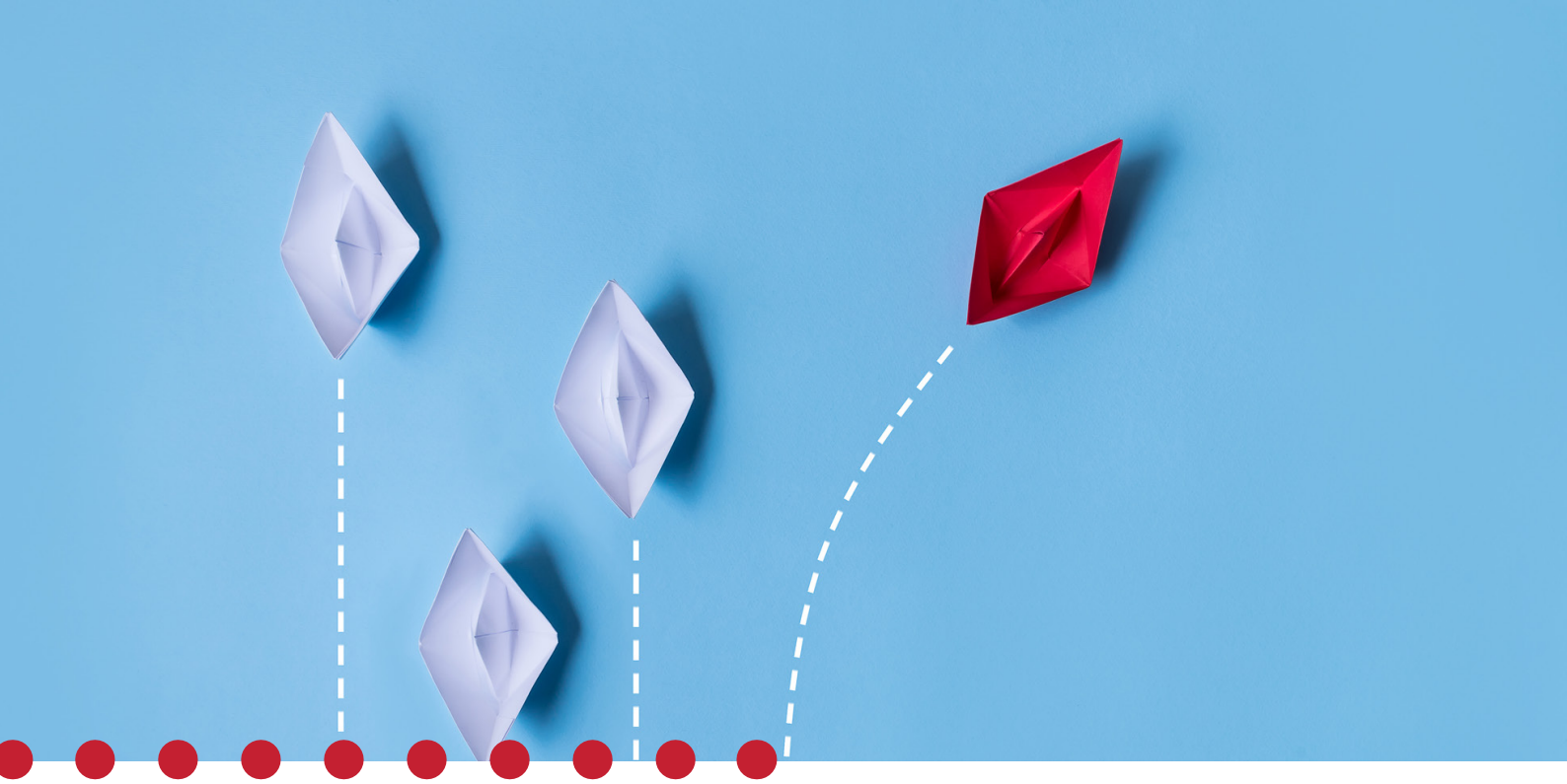
## Are major emitters downplaying their climate and clean energy progress?



# About

**The Energy & Climate Intelligence Unit** (ECIU) is a non-profit organisation supporting informed debate on energy and climate change issues in the UK. Britain faces important choices on energy and on responding to climate change, and we believe it is vital that debates on these issues are underpinned by evidence and set in their proper context.

# Contents



# Executive summary

Top-down and bottom-up: two different ways of looking at the world's progress towards a clean energy future.

From the top down: governments' grand statements; national development policies; energy system scenarios; and formal commitments to the international community via Nationally Determined Contributions (NDCs).

From the bottom up: the realities determined by policy implementation; companies' decisions; local markets; and personal preferences.

Like looking through the different ends of a telescope, the picture these two methods portray can vary widely. And although the global headlines on climate change make depressing viewing, at ground level things are changing rapidly.

In this report, we look from the bottom up at trends in the world's biggest four greenhouse gas emitters – China, the United States, the European Union and India. We ask what these might mean for their greenhouse gas emissions. In particular, we ask whether policy implementation, economic trends, business expansion plans and personal decision-making could mean that they are likely to cut emissions faster than their headline statements indicate.

Already at the global level the year's major reports present a picture of a world tantalisingly poised on a major inflection point. Yes, global greenhouse gas emissions have risen, but by a far smaller amount than the last decade's average. The International Energy Agency is explicit that the exponentially increasing rollout of renewable electricity generation and electric vehicles has reduced the scale of the rise, possibly by two-thirds. Other analyses show that:

- renewables accounted for all the growth in electricity demand seen in the first half of this year
- wind turbines and solar panels now generate 10% of the world's electricity, and the current growth rate would take us to 40% by 2030
- electric vehicles are making vast inroads into the mobility market, accounting for 9% of new car sales and nearly half of bus and two- and three-wheeler sales
- this unforeseen rapid rise in electric transportation is already displacing more than a million barrels of oil per day
- the economics of central elements of the clean energy economy (wind turbines, solar panels, heat pumps, batteries, electric vehicles and hydrogen electrolysers) follow Wright's Law, where increasing deployment leads to cost reductions (and hence faster deployment, further cost reductions, yet more deployment, and so on)
- global investment in clean energy continues to rise, and accounts for almost all new investment in electricity generation.

Logically, one would expect to find these global trends being reflected in the realities of the major economies. And as this report shows, that is indeed the case. It also shows that major global events of the last three years, in particular the Covid-19 pandemic and Russia's invasion of Ukraine with its widespread impact on energy and food prices, are also affecting progress on the ground. The current global oil and gas situation, with Russia using profits to fuel its war machine and OPEC+ withholding production to keep prices high, is spelling out unmistakably the political and economic costs of dependence on commodities whose production is intrinsically cartelised.

Many imponderables remain that will certainly shape the energy transition over this critical decade. And we do not make any firm predictions about how it will unfold.

However, the evidence presented here makes it likely, we suggest, that at least three of these Big Four emitters – China, the EU and India – will see faster progress towards a clean energy economy and thus towards falling emissions than they have set out in national targets and NDCs.

And the progress they make will of course have a global impact – not only via their own greenhouse gas emissions, but also because their faster progress would make clean energy prices fall faster for everyone else.

# National headlines across the big four

## China

- **China is installing 165 GW of renewables this year** – up 25% on the previous year, and with an ever-expanding pipeline, now estimated at 870 GW between 2021 and 2025.
- **Expanded coal use in China is for crisis capacity, not long-term growth**, with renewables coming in cheaper than coal and the People's Bank warning against stranded coal assets.
- **Sales of electric vehicles in China projected to be 6m in 2022**, double sales of non-EV cars in
- 2021; one car manufacturer is ceasing production of new petrol/diesel vehicles.
- **China's emissions fell by a record 8% in the second quarter of 2022** – emissions have fallen in four consecutive quarters, year-on-year, and most recent data in November shows overall 0.9% fall in 2022.

## United States of America

- **US re-entered the Paris Agreement in 2021 and President Biden set out an ambitious NDC**; the domestic target is rated 'almost sufficient' for 1.5˚ by Climate Action Tracker.
- **Biden has secured Congressional approval to some $500 billion** to deliver climate targets at home, spending almost certainly not at risk if Congress changes political hands.
- **US is second only to China for deployment of solar and wind**, and it is forecast they could generate as much as 85% of their power from renewables by 2030.
- **Electric vehicles sales in the US are reaching a market-share tipping point**, with some forecasts suggesting they could be half of all new cars bought in 2030.

## European Union

- **The EU and its member states are setting new climate and energy targets**, and implementing policies to achieve them, in response to Russia's invasion of Ukraine.
- **All areas of energy policy are included** – efficiency, renewables, electric transportation, heating, hydrogen – with decisions of businesses and individuals set to accelerate progress.
- **The cumulative effects will be to increase the EU's ambition** and solidify the policies that will deliver it, even though that is not yet reflected in headline commitments.
- **This could well be translated into a more ambitious EU NDC** in the very near future.

## India

- **Rollout of renewable energy, particularly solar, is accelerating** rapidly and will transform India's electricity sector this decade.
- **Coal generation will become an increasingly unprofitable back-up** for wind and solar, a function that will itself inevitably fall away as storage takes off.
- **Finance is flowing to the clean transition**: 70% of Adani's capital investment this decade; $80bn from Reliance into Gujurat alone; and up to $10.5bn of support in a partnership deal between India and Germany.
- **These trends plus others in transport and homes look like putting India on course** towards its 2070 net zero emissions target.

# China

## CHINA

GHG emissions: **12,055 $MtCO_2e$** | Global emissions %: **24%** | Population: **1.4 billion**

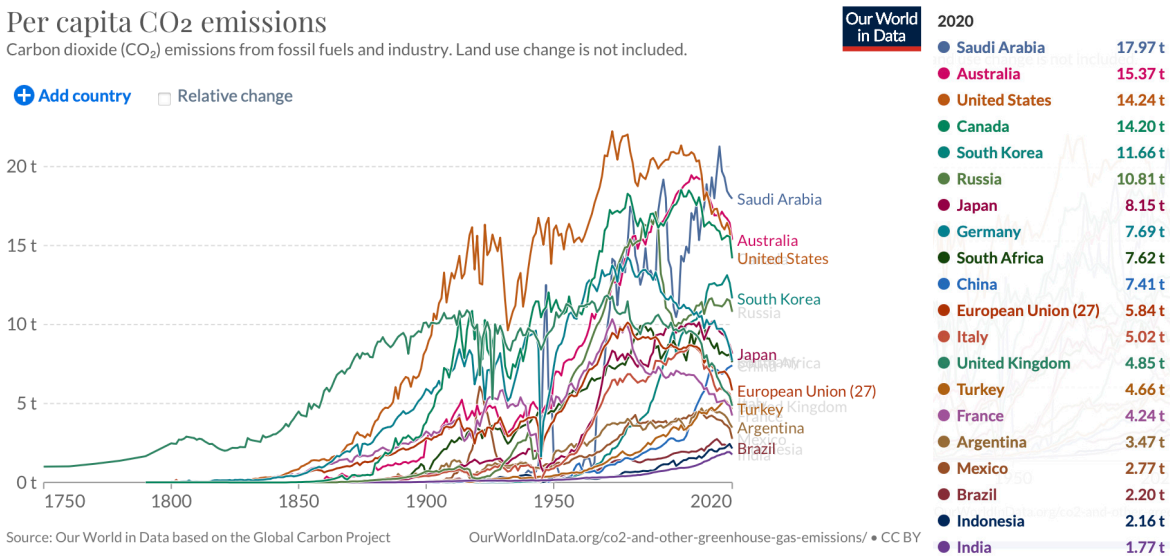
GHG emissions per capita: **7.69$tCO_2e$** | Emissions rank: **1st** | GDP per capita: **$12,500**

NDC: **Lower carbon intensity by over 65% in 2030 from 2005** | Net zero date: **2060**

# Headlines

- **China is installing 165 GW of renewables this year** – up 25% on the previous year, and with an ever-expanding pipeline, now estimated at 870 GW between 2021 and 2025.
- **Expanded coal use in China is for crisis capacity, not long-term growth**, with renewables coming in cheaper than coal and the People's Bank warning against stranded coal assets.
- **Sales of electric vehicles in China projected to be 6m in 2022**, double sales of non-EV cars in 2021; one car manufacturer is ceasing production of new petrol/diesel vehicles..
- **China's emissions fell by a record 8% in the second quarter of 2022** – emissions have fallen in four consecutive quarters, year on year, and most recent data in November shows overall 0.9% fall in 2022.

**Figure 1: Global per capita $CO_2$ emissions**




# Context

At between a quarter and a third of annual global emissions, China is by some way the single biggest emitting country in the world. It is an economic and industrial powerhouse, the second largest economy on the planet. Yet it has been emitting for far less time than the wealthy developed economies of Europe and North America. Given the sheer size of the country and its level of economic development, its per-capita emissions have, until recently, been much lower than other G20 nations; it now sits mid-table.

China submitted its current nationally-determined contribution (NDC) just ahead of COP26 in 2021. It was largely unchanged on commitments which the country had already made outwith the formal UN process.

The NDC pledged that, by 2030, the country will cut the carbon intensity of the economy by more than 65% over 2005 levels. It also committed to peaking emissions before 2030 and to achieving carbon neutrality – net zero emissions – by 2060 at the latest.

Whilst China is on track to deliver its emissions pledge, Climate Action Tracker rate its NDC as highly insufficient and a report in May 2022 calculated that China's target is some 62 percentage points – or nearly 7,000 Mt of carbon dioxide equivalent (excluding LULUCF) – short of ambition necessary to be aligned with 1.5˚C. China's overall energy mix is still heavily reliant on coal – nearly 55% in 2021. That is falling, and there is little doubt that the NDC represents a caution that belongs to a – very recent – time when China was still nervous about its likely continued reliance on coal.

As things currently stand, however, if China delivered solely in line with that target it has

submitted to the UN, then it would still be emitting more than 13 Gt of greenhouse gases annually, where it should be emitting around half that. That level of emission is, say Climate Action tracker, in line with a 3-4˚C world; far from a 1.5˚C one.

# Current situation

Given the sheer scale of China's annual greenhouse gases, as a share of global emissions, the world very much needs China to go further than their current commitments in their NDC. If it does not, then we are unlikely collectively to be on track for net zero by mid-century, as committed to in the Paris Agreement.

It is therefore encouraging that China's current commitments look very likely to be over-delivered by existing policies and measures.

Even ahead of COP26 in 2021, China had made a series of significant commitments on its plans for decarbonisation and tackling climate change:

- China was expected to peak emissions in the second half of the decade on current form – some time before 2030.
- China had signalled its intent to peak coal between 2026-2030; China is heavily reliant on coal still for power generation, and has been
- President Xi Jinping had committed to ending funding of overseas coal developments.

China's climate envoy, Xie Zhenhua confirmed at COP27 that China's carbon neutrality commitment – its net zero pledge – is comprehensive. That is to say that it includes methane and other non-carbon dioxide ($CO_2$) greenhouse gases.

However, its NDC does not. At COP26 in Glasgow, the US and China issued a joint statement on their planned co-operation on climate. In an attempt at a helpful, leadership move, this came late in proceedings at COP, and mirrored the way the two nations had stepped up and shared new commitments just ahead of COP21, to help land the Paris Agreement. In Glasgow, China committed to acting on methane. In Sharm El-Sheikh, Xie confirmed that China has now finished drafting a national methane reduction plan, which is now going through its approval process.

Just before COP27, China also announced a major new initiative to support its decarbonisation efforts. It was focused on deployment of data, biotechnology and artificial intelligence innovations to aid and speed decarbonisation. This 'green technology innovation system' will be used to tackle pollution and climate change, as well as to protect and restore key ecosystems.

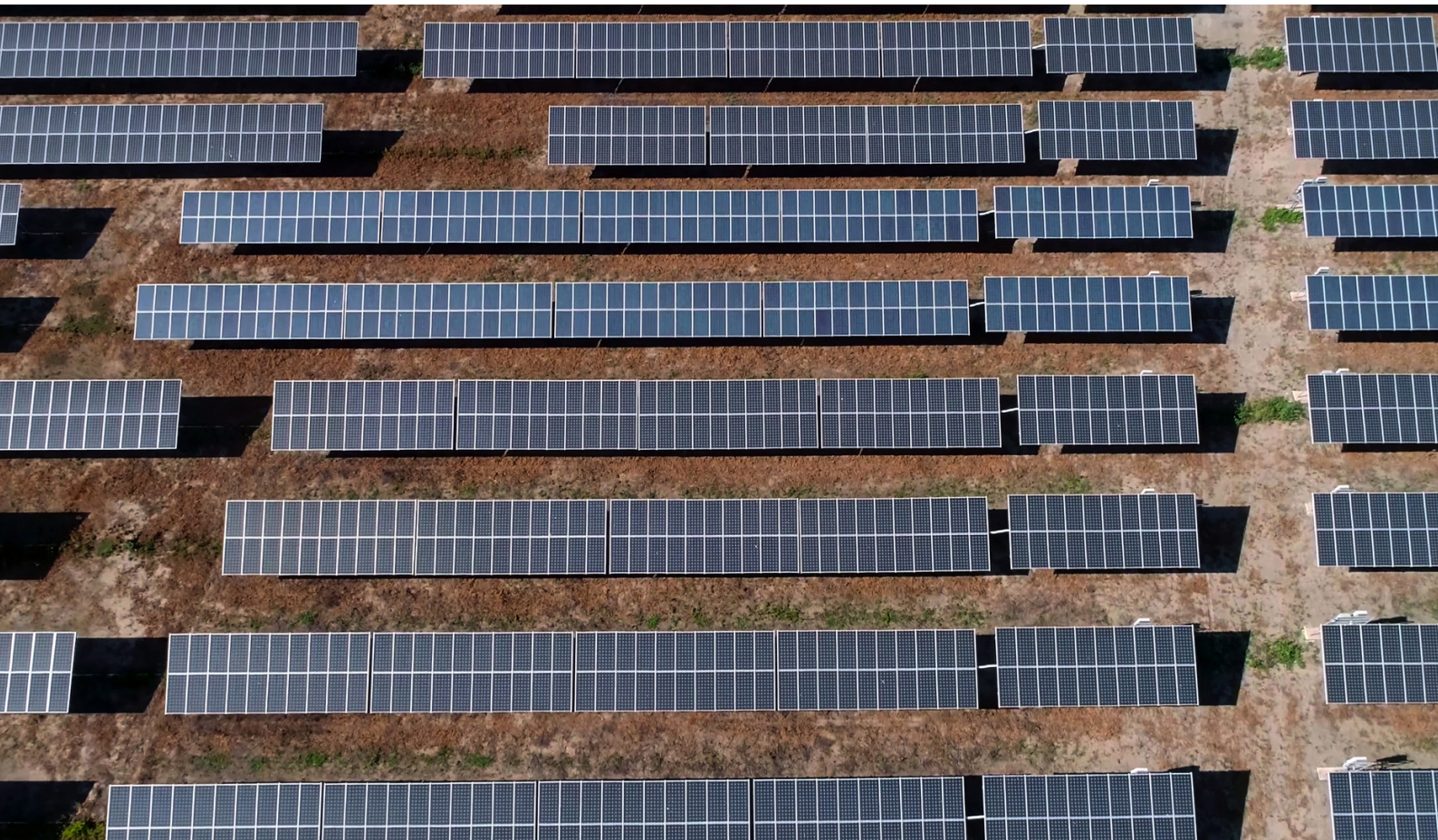
## Renewables

According to the Global Energy Monitor's assessment, China had over 260 GW of installed wind power generating capacity – more than twice the United States of America, which was in second place with just under 130 GW, and more than a quarter of the global total. It also had nearly 100 GW in the development pipeline, second only to Australia and equal to the United States.

Solar generating capacity is a similar story. Again, China has the most installed capacity. At 130 GW, it represents a fifth of the global total capacity, and is three times that of its nearest rival for installation, the US.

China has continued to build renewable generating capacity at a rate which dwarves any other single country, and at times outstrips the capacity being installed in the whole of the rest of the world. In 2021, China installed 26 GW of offshore wind capacity; more than was installed worldwide in the last five years.

Installing 55GW of new renewables in just the first half of 2022 also puts China firmly on track to hit its 2030 target of 1,020GW of installed capacity – early. The China Renewable Energy Engineering Institute forecast this summer that China will install 156 GW of renewable capacity this year – up 25% on the previous year which was, itself, a record.



Tallying up China's plans for solar and wind, analysts earlier this year calculated that they had 600 GW of new renewables capacity in the pipeline for 2021 to 2025. Those same analysts recently revised that up by nearly half as much again – to 870 GW. They set out in their analysis that they believe that China is setting out conditions to ensure that emissions peak before 2025, saying: "solar and wind are currently highly profitable, and provinces are eager for investment".

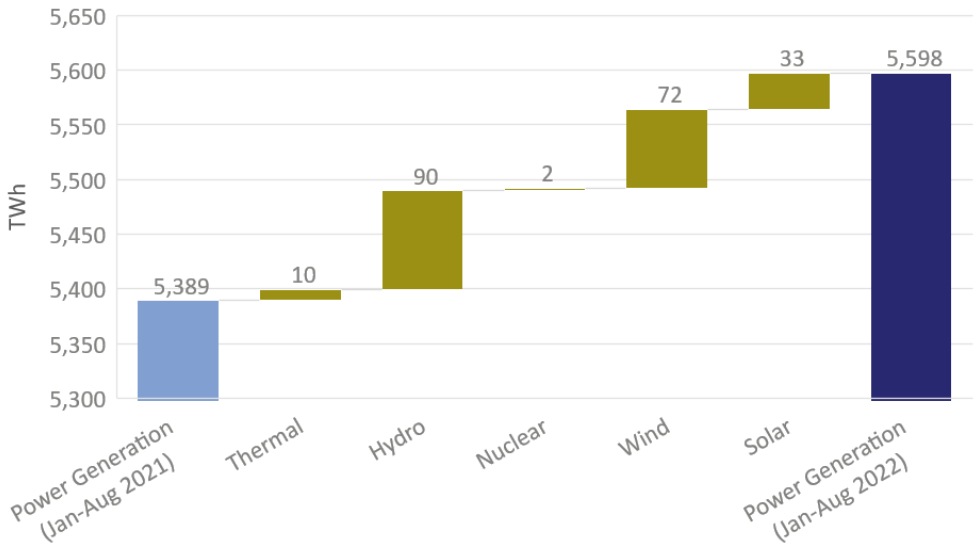
All of which means that, earlier this year, the country's electricity council forecast that non-fossil fuels could generate 50% of the country's power capacity in 2022.

## Coal

Despite this proliferation of renewables, and evident commitment to the benefits of accelerated decarbonisation, still much of the reporting of China's approach to managing its energy needs as demand surged post-Covid has focused on coal generation.

However, the surge that there has been in coal has been in new approved plants – installed capacity. In fact, electricity output from coal-fired power has only increased moderately; just 0.5% between January and September, with August seeing a huge surge in coal power because of extreme heat and droughts.

**Figure 2: Power generation in China, Jan-Aug 2021 and Jan-Aug 2022**




*Source: National Bureau of Statistics*

As experts at E3G explain, the surge is a relatively short-term exercise in crisis management – not a new coal boom. Although coal power generation in China has continued to grow over

recent years, it stagnated in April when new zero-covid lockdowns were imposed in China. Increases in power generation since than have overwhelmingly come from the huge surge in renewables deployment.

The International Energy Agency (IEA) has said that surges in coal use are "not a longterm one in any of our scenarios… coal demand remains near its historical peak for the first half of the decade, but returns to structural decline in the second half of this decade."

Bloomberg New Energy Finance suggest that the power costs in China make clear which direction the country is heading, commenting that "the source of bulk generation ($/megawatt-hour/MWh, levelised) in … China is onshore wind ($39)." This is in comparison to costs of around $53/MWh for coal (according China's National Energy Administration).

In fact, suggest analysts, Chinese power firms actively do not want new coal generation, as the People's Bank warns of stranded assets if new investment is channelled to coal. Where there is investment, it is taking the form of repurposing coal-fired power stations to enable them to be drafted in to provide occasional peaking demand, rather than – as they were designed – to provide baseload power. This still means loss-making infrastructure, but it avoids adding new capacity that is simply stranded in its entirety.

As well as China's coal construction at home, it has been a major funder of coal power overseas as well. At last years UN General Assembly, however, ahead of COP26, Chinese President Xi Jinping committed to increasing funding for clean power and ending funding for new coal overseas. This was a market-moving commitment which caused other nations to follow suit. And in the year since the commitment, some 15 overseas coal power projects cancelled.

### Electric vehicles

The China Passenger Car Association revised its projections for electric vehicle (EV) sales in 2022 upwards over the summer – from 5.5m, to 6m. Bloomberg reported that as being double the sales of non-petrol/diesel vehicles the previous year. In July 2022, they accounted for nearly 30% of new vehicles sales.

In March 2022, Chinese car manufacturer, BYD, confirmed that it had stopped production of internal combustion engine vehicles altogether, switching entirely to battery and plug-in hybrid vehicles. And to aid this increasingly rapid transition, China's charger installation is leaving the rest of the world in the slow lane. Bloomberg NEF forecast the country will install nearly 400,000 new chargers this year –double the previous year's total, with both years being five to six times the total installed everywhere else.

Not just passenger vehicles: China has seen a surge in electrification of light commercial vehicles as well. Bloomberg reported recently that sales hit a record high of 18,000 in China in August, with their market share this year ten times what it was just two years ago. As the largest commercial vehicle market in the world, that shift has a knock-on effect to markets. Bloomberg's analysis also reports that the uptake is, in part, being supported by innovative experimenting with battery-swap technology. A more than 300% increase in battery-swap stations in China enables vehicles to switch out a drained battery for a fully-charged one, rather than stopping to re-charge the battery.

# Impact on emissions

It is, overall, hard to assess what all this means for emissions without some serious modelling. But in the context of a nation that has a reputation for under-promising and over-delivering on their global targets, the scale of activity in China is encouraging. That is not to say that it would not be immensely helpful to have this transition translated into a stronger NDC from China – not least to help further strengthen market signals to urge the transition further, and faster elsewhere.

However, what we can say is that China's emissions fell by a record 8% in the second quarter of this year – driven at least in part by the very strong growth in renewables that we have discussed here. This fall means that emissions have fallen in four consecutive quarters, year-on-year and, if it continues, would mean China's emissions peaked in spring 2021.

Even if we have not yet seen the peak, close observers of China believe that renewables deployment is at a level to ensure that emissions peak before 2025: "solar and wind are currently highly profitable, and provinces are eager for investment". That investment is, in part, driven by some detailed and tightly target-driven plans for urbanisation and rural development that drill down into decarbonisation of specific sectors. The plans, published this summer, include targets to increase energy efficiency of public buildings by a fifth in key cities, to put solar on the roof of half of all new factories, and ensure that two thirds of buildings' energy consumption is from electricity.

# United States

**US**

GHG emissions: **5,771 $MtCO_2e$** | Global emissions %: **12%** | Population: **332 million**

GHG emissions per capita: **14.04 $tCO_2e$** | Emissions rank: **2nd** | GDP per capita: **$69,300**

NDC: **Reducing emissions by 50–52% below 2005 levels by 2030** | Net zero date: **2050**

## Headlines

- **US re-entered the Paris Agreement in 2021 and President Biden set out an ambitious NDC**; the domestic target is rated 'almost sufficient' for 1.5˚ by Climate Action Tracker.
- **Biden has secured Congressional approval to some $500 billion to deliver climate targets** at home, spending almost certainly not at risk if Congress changes political hands.
- **US is second only to China for deployment of solar and wind**, and it is forecast they could generate as much as 85% of their power from renewables by 2030.
- **Electric vehicles sales in the US are reaching a market-share tipping point**, with some forecasts suggesting they could be half of all new cars bought in 2030.

# Context

After Joe Biden was elected President in 2020 the United States re-entered the Paris Agreement in January 2021, after Donald Trump had pulled the US out. He also immediately appointed former Secretary of State John Kerry as his global climate envoy and, within his first 100 days in office, hosted a climate leaders' summit in April 2021, signalling his intent to return his nation to a leadership position on climate.

Just before that summit, he sent a further strong signal that the US was returning to the climate fold by publishing a new nationally-determined contribution (NDC), committing the US to much more ambitious targets than had existing under his predecessor:

- 50-52% reduction in emissions below 2005, by 2030
- Although a significant improvement on the previous target (26-28% reduction on the same baseline) Climate Action Tracker rate that this is overall insufficient, although almost sufficient solely in terms of their domestic target ; that a 1.5˚C aligned NDC would be 57-63% below 2005 (excluding LULUCF)

**Details**

Despite renewed ambition from 2021, the Biden administration struggled at first to pass the necessarily legislation and budget through the Senate in the face of opposition to climate action from a member of his own party, the senator from coal-state, West Virginia.

At COP26 in Glasgow, the US signed up to two of the sector deals which were agreed there. Those were the pledge to end deforestation this decade, and the statement in support of the clean energy transition.

They also signed up to, and led the charge on recruiting for, the Global Methane Pledge, along with the European Union. The US and EU are revisiting the rigour of the pledge at COP27, as well as announcing new signatories. At home the US has introduced charges for the oil and gas industry for methane leakage, setting them at $900 per metric ton of methane, increasing to $1,500 per ton after two years.

In the case of some of the sector deals to which the US did not sign up, there are nevertheless several states and cities who became signatories: the State of California is an associated member of the Beyond Oil and Gas Alliance, which commits signatories to ending new production and extraction of oil and gas. There are also three states and 10 major cities which

are signed up to the sector deal to speed up transition away from internal combustion vehicles, nd towards low- or zero-emission vehicles

**Funding**

After over a year in which some of the initial scale of ambition, and a lot of the hoped-for budget was pared back, in August 2022, President Biden signed the Inflation Reduction Act into law. After much political wrangling, it contained commitments on health care, tax and climate change worth $750 billion.

An unprecedented $369 billion of that is for climate. This includes funding for:

- Investment in solar, battery and other clean tech manufacturing in the US
- Support for decarbonising low-income homes
- Switching government, school and other public service transport to electric vehicles, along with tax credits for EVs
- Cleaning up port technologies to cut air pollution using zero emissions tech
- Cleaning up air quality, emissions and pollution in low-income communities
- Shifting US agriculture to sustainable farming and investing in new research for further agriculture innovation
- Protections for nature, including mature forests, coastal ecosystems and resilience, recovery of habitats for endangered species
- Imposing penalty fees on the oil and gas industry for methane leakage.

For citizens, it includes tax credits and other incentives for installing low carbon and energy efficiency technology in homes, and supporting the switch to electric vehicles, meaning that large swathes of the investment are in measures that will cut bills and running costs for ordinary people across the country, with one estimate putting the average savings for an American family at $500 a year on energy bills alone.

But the Inflation Reduction Act is not the end of the story in terms of federal funding for climate action in the US.

There is also funding of $54 billion via the CHIPS and Science Act[1] - for solar and battery development – and another $98 billion from the Infrastructure, Investment and Jobs Act. This brings the total committed for climate action by the Biden administration this year to more than $500 billion, calculates a study published this summer.

One of the authors of that report, which estimates that this funding is triple that of recent years, and 15 times that of the 1990s, describes the three pieces of legislation as forming:

> "a coherent green industrial policy, in the sense that they are strategic industries that they focus on, and a set of tools designed to accelerate production up and down the supply chain."

Helpfully, this spending, now committed, is not conditional on who controls Congress, given that, at time of writing, we are still waiting for full results from mid-term elections in the US to indicate who will control each House. This means that this considerable cornerstone to US climate action is secure, even if future attempts to secure further funding from Congress look harder to achieve.

**Renewables**

The US is one of the largest producers of oil and gas in the world, with southern state Texas famous as the centre of the American oil industry. However, what is less well known about the lone-star state is that it is also the country's biggest producer of electricity from wind; it accounted for 26% of US wind energy in 2021.

US wind energy capacity overall, according to Global Energy Monitor, stood at 128 GW in May this year, second only to China (with 261 GW), and more than three times Germany's 40 GW. What is more, they estimate that there is a further 96 GW already in the pipeline.

As for solar, there was 43 GW of capacity operating in the US earlier this year – again, beaten only by China (130 GW) with India in hot pursuit of the US (29 GW).

All of this is only set to grow, as the money and measures from the Inflation Reduction Act kick in. An analysis of the potential impact that spending the new money is likely to have, conducted by Energy Innovation, suggests that a boom is on the way for clean technology industries in the US. The analysts predict that installed renewable capacity by 2030 could be between two and two-and-a-half times the business-as-usual level. That would mean between 800-1000 GW of solar and wind, which may well be generating more than three quarters – even as much as 85% - of America's power.

This comes on top of expansion which is already underway, even before the new money was voted by Congress. In summer 2022, the US was on track to install 20GW of new solar and wind generation in the second half of the year, whilst 12GW of coal-powered generation is expected to have been taken off the grid by the end of the year.

Additionally, an auction in February for offshore wind development rights off the coast of New York and New Jersey pulled in $4.37bn in bids, as the Biden administration sought to turbo-charge delivery of its goal of 30GW of offshore wind by 2030. Six more auctions are planned, and there are also two big oil and gas giants working together to build a new offshore wind hub to link planned arrays near New York.

**Electric vehicles (EVs)**

Energy Innovation also calculate that sales of battery EVs could rise by a third on today's levels, to nearly 29% of vehicles sales in 2030. But Bloomberg New Energy Finance go further and project that EVs will be more than half of US sales by then.

In 2022, EV registrations rocketed by 60% in the first quarter, even as sales of cars overall fell by 18%. This, suggest analysts at Bloomberg, in July this year, could well mean that EV sales in the US may have already passed the 5% market share point which, in many other countries, has denoted a tipping point towards mass uptake. If so, and we see uptake of EVs equivalent to the experience of other countries, they project market share reaching 25% by 2025; well on the way to mass uptake by the end of the decade.

# Impact on emissions

Analysis of the climate funding voted by Congress is very promising for delivery of the United States' NDC target.

Rhodium Group calculated that there were policies and funding in place before the Inflation Reduction Act to cut emission by somewhere between 24% and 35%. That is, in other words, potentially not even enough to have delivered the US' previous, weaker emissions cut target. Factoring in the new funding, however, they conclude that it can deliver emissions cuts of between 32% and 42% below 2005 levels.
This, of course, still leaves some way to go to hit the US NDC upper level of 52%, never mind the 63% cuts which Climate Action Tracker suggest align with the Paris Agreement's 1.5˚C warming limit.

However, it is clearly a huge step forwards, including in helping drive market momentum, and in accelerating take-up of critical clean technologies to decarbonise American homes, transport and industry. It also represents what the first year of the Biden Presidency showed to be the highest hurdle to clear – securing Congressional agreement to vote federal funding to decarbonise the US economy.

Beyond this, attention will turn to action at the state and city level.

California, for instance – the fifth largest economy in the world – recently committed $54 billion in new climate spending to achieve its commitment to achieve net zero by 2045 – a record level of spending which was accompanied by regulation to restrict new oil and gas drilling.

Illinois, the fifth largest US state by GDP has committed itself to use 100% renewable energy by 2050, and to phase out coal and gas emissions by 2045. What is more, expected wins in 2022 gubernatorial elections in some states could set the scene for further significant state-level climate action.

The Biden administration will also look to further regulation and legal measures open to them to leverage climate action beyond the parameters of available funding, and with little prospect of securing further major spending from Congress in the short-term.

1 Creating Helpful Incentives to Produce Semiconductors and Science Act, 2022

# European Union

**EU**

GHG emissions: **3,383 $MtCO_2e$**
Global emissions %: **6.8%**
Population: **447 million**
GHG emissions per capita: **6.98 $tCO_2e$**
Emissions rank: **3rd**
GDP per capita: **$35,000**
NDC: **Emission reduction of 55% below 1990 levels by 2030**
Net zero date: **2050**

## Headlines

- **The EU and its member states are setting new climate and energy targets**, and implementing policies to achieve them, in response to Russia's invasion of Ukraine
- **All areas of energy policy are included** – efficiency, renewables, electric transportation, heating, hydrogen – with decisions of businesses and individuals set to accelerate progress
- **The cumulative effects will be to increase the EU's ambition** and solidify the policies that will deliver it, even though that is not yet reflected in headline commitments.
- **This could well be translated into a more ambitious EU NDC** in the very near future.

# Context

Last year the European Commission published its draft 'Fit for 55 package' – a suite of policies and measures aiming to deliver the emissions cut of 55% from 1990 levels by 2030 that is set in European law. The package is big, complex and full of potential points for disagreement between the Commission, European Parliament and EU member states. If enacted in full, it would entail a step change in the pace of decarbonisation. Having reduced emissions by about 25-30% in the last three decades,[1] emissions would then have to fall by around the same amount in a single decade.

Towards the end of 2021, real-world events began to impact energy policy discussions. The price of fossil fuels, particularly gas, began to soar across Europe as Russia withheld supply, exacerbating the pre-existing scarcity caused by the Covid-19 pandemic and higher demand in Asia. The European electricity system was also feeling the pinch from two unrelated issues – safety concerns in ageing nuclear reactors that led to long-term shutdowns of half the French fleet, and hot and dry weather that compromised both thermal power plants[2] and hydropower dams.

In February 2022, Vladimir Putin sent tanks rolling across the Ukrainian border. The EU and other European countries imposed sanctions; Putin put more pressure on gas supplies; the EU implemented a range of measures to reduce dependence on Russian supplies; Russia tightened the tap still further, with prices soaring still higher; and finally came the (presumed Russian) bombing of the NordStream pipelines.

At times it has seemed likely that some countries would face a real supply shortfall and have to resort to measures such as interrupting the supply of gas or electricity to households or businesses. Indeed that could still become a reality, even though Europe has drastically reduced consumption of Russian fossil fuels. The explosive destruction of the NordStream pipelines, if Russia was indeed behind the incident, shows that sabotage of energy infrastructure is by no means off Mr Putin's tactics table, including, potentially, infrastructure that has nothing to do with Russia.

One consequence is that governments are spending billions of euros offsetting the cripplingly high energy bills faced by domestic and business consumers. And there is no clarity when this might end, with some forecasts indicating high gas prices will endure for several more years. The situation has shown European leaders in the starkest possible terms that continuing to rely on fossil fuels means import dependence, energy insecurity, high energy bills, and high state support for citizens and businesses struggling to afford it. It also shows that fossil fuel

dependence compromises foreign policy, because it creates a situation where oil and gas are used as weapons of blackmail.

For Europeans, the swiftest possible switch to clean energy now provides answers to all objectives of energy policy. It fulfils all three elements of the 'trilemma' of energy security, decarbonisation and low cost. And it delivers on three more as well – jobs, development of important industries, and foreign policy independence.

Although the EU and several member states have secured new fossil fuel supplies, through building infrastructure such as floating LNG terminals, making deals with new suppliers and granting coal-fired power stations a stay of execution, it is also clear that such measures can only be temporary fixes. There is clearly far less to be gained through switching import dependence from one petrostate to another (including to the US, where a future presidency might decide to restrict gas exports) than by securing true independence through clean energy.

Hence the short-term interest in new fossil fuel sources has been complemented by a suite of measures to accelerate uptake of renewables, energy efficiency, EVs, heat pumps and other elements of the non-fossil-fuelled energy system, whose impact will last well beyond those of short-term gas deals. German finance minister Christian Lindner was the first to use the phrase 'freedom energy' to describe renewables in the context of the Putin invasion. But the notion has gained wider currency.

There is some evidence that action at government level has been supplemented by decisions of businesses and individuals – reducing energy demand, buying electric cars, installing heat pumps. Whether stimulated by the rapidly evolving economics of energy bills, energy security, concern over climate change or the desire to do something to help Ukraine, faster voluntary adoption of all these measures will speed decarbonisation. By big margins, Europeans after the start of the Russian invasion approved of both continuing support for Ukraine (80% support vs 16% oppose) and moving faster to clean energy in response to the crisis (84% vs 11%).

Through his attempt to invade Ukraine, Vladimir Putin may have contributed more to European decarbonisation than any individual in history.

# Current situation

In the immediate aftermath of the invasion of Ukraine, the EU and most of its member states (as well as non-EU members such as the UK and Switzerland) embarked on a wide range of measures falling broadly into three categories: financial support for people and companies hard-hit by energy costs, short-term measures for energy security, and medium-to-long-term measures to reduce gas demand and accelerate the clean energy switch.

In the short-term, one approach was to attempt to secure replacement supplies of gas. Germany, hitherto the biggest importer and political backer of Russian gas, led the charge to commission new import terminals for LNG. The UK government, at least rhetorically, attempted to speed the opening of new North Sea oil and gas fields. A second response was to replace gas-burning in electricity generation with whatever else was available – which meant delaying the closure of nuclear reactors in Belgium, Germany and Hungary, and in several countries, increasing the availability of coal-fired power stations that had been little used in recent years. The EU and member governments have also introduced measures to curb gas consumption, aiming in particular to replace Russian imports as quickly as possible.

All governments and the EU itself implemented measures to support hard-pressed bill-payers, at a collective cost to date of €674bn, according to the Bruegel thinktank.[3]

Meanwhile, climate impacts and an increasingly vocal civil society have continued to keep climate change on the political table. The German coalition government that took power in late 2021 with the Greens as the second biggest party had to begin planning immediately a path to climate neutrality by 2045, a legal legacy left by its immediate predecessor. The EU's 2050 net zero law and the Fit for 55 package were already a major issue for discussions between the European Commission, Parliament and Council well before Putin's war began.

Europe's general solidarity (with the exception of Hungary) in support of Ukraine also cast a new light on decarbonisation. Wind turbines, solar panels, electric vehicles and rolls of insulation could now be seen as economic weapons to be wielded against the Putin regime. Every move towards 'freedom energy' not only brought the end of energy blackmail closer, it also struck a blow for Ukraine by helping to undercut Russia's fossil fuel earnings. It is an argument that may have struck a chord with European citizens contemplating whether to invest in an EV or insulate their apartment.

The equation before European leaders as they contemplate the years ahead to 2030 is simple. Reducing reliance on gas and other fossil fuels down to zero as soon as possible will:

- reduce energy bills for voters
- remove the need for expensive (and eventually unaffordable) financial support packages
- eliminate fossil fuel purchases from Russia
- guarantee energy independence
- assure European companies of a place in the clean energy world against increasingly fierce Asian competition
- deliver climate change targets.

By contrast, continuing to rely on fossil fuels will:

- keep energy bills high, probably for years
- potentially create a reliance on ongoing state financial support
- entrench energy insecurity (because Europe can never be self-sufficient in fossil fuel production)
- perpetuate the threat of energy blackmail
- obstruct the climate change progress that the majority of European voters desire.

One additional issue concentrating minds came from OPEC+, the cartel of major oil- and gas-producing countries (including Russia) informally headed by Saudi Arabia. Early in 2022 the cartel declined to increase oil output in the face of a globally tight supply. Then in October it cut production, the direct opposite of the request lodged earlier by its long-term ally the US. The interpretation has to be that Saudi Arabia and its allies intend to keep oil and gas prices high for the foreseeable future; and they have the resources to do that. Whether this is for straightforwardly commercial or more political reasons is unclear, but in either case the economic threat to Europe is clear: if you depend on fossil fuels, you can depend on having to pay a huge bill every year.

For European governments, then, the Fit by 55 programme quickly became seen as the minimum feasible ambition rather than stretching maximum. The obvious questions were: how far would the EU and its member states want to go beyond the targets, and what measures

would they put in place to start getting on track?

These are not questions to which simple, neat answers all emerged at the same time. Instead, elements have been decided and revealed at various times over the intervening months. Adding to the complexity, many member states have begun implementing decarbonisation policies appropriate to their national situation. In countries with a federal structure, such as Germany, some individual states have also made commitments. Decision-making at EU level is complicated by the fact that some decisions have to be hammered out between the Council of Ministers, European Parliament and European Commission, in a process that in normal times can take years.

At EU level, the Commission proposed some major changes in response to Putin's war in May under the REPowerEU banner – a plan to 'rapidly reduce dependence on Russian fossil fuels and fast forward the green transition.' With Russian coal banned soon after the invasion and a virtual end to oil and petroleum products in sight before the end of this year, the key fuel left was gas. The Commission suggested that REPowerEU would end Russian gas imports 'well before the end of the decade' with two-thirds of that reduction achieved before the end of 2022. Overall, by 2030, the plan would:

- increase the binding energy efficiency improvement target for 2030 from 9% to 13%
- increase the renewable energy target (across power, industry, buildings and transport) from 40% to 45%
- for solar power specifically, to double capacity by 2025 and have 600GW installed by 2030
- double the rate of heat pump installation
- increase production of green hydrogen and biomethane.

The Commission estimates that the original Fit for 55 proposals would cut gas use by about 30% by 2030, and that the additional REPowerEU measures would add around 15% to that. Which means gas use across the bloc would virtually halve this decade. EU member states also agreed two important measures to restrain gas use immediately. One set a voluntary target to reduce gas consumption by 15% this winter. The other set targets of cutting overall electricity consumption voluntarily by 10%, and mandatorily by 5% during peak hours.[4]

Coal is already on its way out across Europe. In 2020, use was projected to fall by about 70% across the decade. But that figure already looks out of date, not least because under its current government, Germany (the EU's biggest coal burner by far) intends advancing its phase-out date from 2038 to 2030. And for oil, the prospects do not look much brighter. In October the European Council and Parliament agreed to phase out petrol and diesel car and van sales by 2035.

However: as noted earlier, action at EU level is only part of the picture. Each individual member state has responded to the energy crisis with its own set of measures – some to be implemented right now, others setting more stringent targets for 2030 and/or other dates.

One of the most important, because of its sheer scale, was Germany's announcement in July of plans to invest €177.5bn on 'economic modernisation and climate protection' between 2023-26. Most of the money will support energy efficiency and low-carbon heat in buildings, especially in fuel-poor households, while the package will also advance renewable energy rollout, decarbonising industry and EV charging infrastructure.

Across the bloc there have been too many developments of too many different kinds to list them all here. The Bruegel thinktank maintains an authoritative list – this is just a selection:

- the Belgian government launched the 'J'ai un impact / ik heb impact' campaign to persuade people to reduce energy use, while Italy's Operation Thermostat changed heating and cooling standards for public buildings, again to cut overall energy use. Several other countries followed suit
- the French government banned shops from leaving doors open while heating or cooling systems are active (a measure also mandated in Portugal and Spain), and mandated the switch-off of neon signs at night. Germany banned heating of swimming pools
- the Hungarian government is targeting a gas saving of 25% over the winter in publicly-owned facilities
- the Lithuanian government established a programme of financial support for people upgrading the energy performance of flats
- Portugal increased the size of its first auction for offshore wind power
- Belgium, Denmark, the Netherlands and Germany signed a cooperation agreement aimed at increasing their collective installation of offshore wind power in the North Sea
- Czechia simplified the permitting process for small renewable energy projects
- the Netherlands launched a programme to upgrade the energy performance of almost one-third of the country's housing stock, and will also support heat pump installation
- the Polish government increased subsidies for people replacing coal boilers with less polluting forms of home heating. This is expected to accelerate still further the impressive uptake of heat pumps
- Greece strengthened a national programme assisting people to replace household appliances with more energy efficient models

What matters most for the climate is of course the burning of fossil fuels. So in addition to the EU-wide goals mentioned earlier, member states' targets for limiting fossil fuel use are obviously crucial.

The Ember thinktank maintains a tracker of such targets, and it shows that since 2019 (and not only because of Russian warmongering) the majority of member states have upped their game. The following countries have increased since 2019 their ambition for cutting fossil fuel burning by 2030: Austria, Belgium, Bulgaria, Czechia, Denmark, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Portugal and Romania. Fossil fuels should by 2030 be generating less than 20% of electricity across the bloc, down from around 42% now. Further analysis by Ember shows the current emergency increase in active coal power capacity will have a tiny impact: the plants newly placed on standby would at most generate enough electricity to power the EU for a single week, hiking carbon emissions by 1.3%.

Governments are not of course the only actors in a clean energy transition. The decisions of businesses and individuals play a role too. Most cars and most home heating system purchasing decisions are taken by individuals, and businesses will also make decisions on energy and technology use based on a range of rational (and sometimes emotive) criteria – including, but not limited to, policies set by governments.

Whether businesses and individuals are changing their decisions because of Putin's war is a moot point. All we have at the moment is a few statistics without understanding the drivers behind them.

In 2021, sales of heat pumps rose across the EU by 34% with the Polish market boasting the biggest growth, at 66%. And the trend continues. In Germany, sales of heat pumps were 25% up in the first half of 2022 compared with the equivalent period in 2021; in Finland, the figure was 80%. By one analysis, sales across the EU will increase by a further 34% this year.

Whether people are making these purchase decisions because of concern over climate change, or fears over fossil fuel supplies, or a desire to 'do their bit' for Ukraine, or to save money, or to leave yesterday's fossil technology behind, is not at all clear. Nor is the balance of what is driving them, between government policy and personal preference. But whatever the reasons, these trends will inevitably have a real impact on emissions – and grow supply chains, bring down prices, and increase social acceptance.

The EU, meanwhile, has also turned its attention to the supply of critical minerals needed to underpin a rapid expansion in clean energy technology. As is often reported, currently China dominates both the mining and processing of rare earth metals, for example. But reserves are found in other places, and as the global market growth accelerates, companies are of course responding. The EU wants to secure a certain amount of both raw minerals and processing capacity. As well as fostering mining within Europe, the European Commission has just signed deals with Kazakhstan, Egypt and Namibia aimed at guaranteeing access.

# Impact on emissions

Already there is some evidence that the transition to clean energy is helping fulfil all aims of Europe's energy policy mix. The summer[5] saw record solar generation across the bloc, jumping from 9% to 12% of the total – in the process saving €29bn in gas that would otherwise have had to be imported. Interestingly Poland, in past times the EU's energy contrarian-in-chief, saw the biggest jump, with solar generation increasing 26-fold since 2018. High prices and concern over gas shortages are also kicking in, at least in Germany where gas consumption in September 2022 was down 19% in industry and 36% for households. Responding to the Russian invasion of Ukraine, coal imports have almost entirely ended, oil and petroleum products will be virtually gone by the end of the year, and gas imports are likely to be a fraction of their former size.

But major questions about the impact of all this on Europe's emissions and energy transition remain unanswered; in some cases, they are as yet unanswerable. How will gas availability and prices change next year, and how will governments and people respond? How many of the planned LNG import terminals will get built on time, and how much will they actually import – and at what price? Will energy saving habits stick? Will all governments follow through on their

new commitments on energy efficiency and renewables – will they allow planning regulations to stymie the build-out of wind and solar farms? As governments internalise the fact that they are facing years of heavy subsidies for fossil energy bills, will they steer a greater proportion of their spending towards permanent solutions based on clean energy and energy efficiency? Will supply chains for EVs hold up as demand soars? Will Europeans' support for Ukraine remain solid? Another key question is whether the measures announced and implemented by member states will add up to more or less ambition than those announced by the EU.

Nevertheless: the EU has set precise new targets for energy saving and renewables in its REPowerEU package.[6] It has not yet turned these targets into a new Nationally Determined Contribution (NDC) target for the UN climate process, but has indicated that it plans to do so in the months after COP27. What number might it come up with to supplant its current headline target of a 55% cut by 2030?

Based only on the enhanced REPowerEU targets for energy efficiency and renewables, Climate Analytics calculates the target would rise by a few percent. But might the EU go further?

There are several factors that suggest it could and perhaps will:

- short-term actions are already being taken that are, apparently, already reducing emissions; whereas in the absence of Putin's war, it might have taken several years and lots of arguing before member states actually started accelerating clean energy rollout
- with evidence indicating the high price of oil and gas is here to stay, where is the advantage in not moving as quickly as possible?
- the same rationale applies to safeguarding energy security, given that staying with fossil fuels opens the door to further energy blackmail by hostile petrostates
- technologies such as wind turbines, solar panels, batteries and heat pumps get cheaper as more of them are made; so demanding more of them will, all other things being equal, result in prices coming down faster. Europe's acceleration could prove particularly influential with heat pumps
- with clean energy being seen as 'freedom from Putin and energy blackmail' energy, citizens and businesses that were previously ambivalent may be happier to see a quick transition and might relish contributing to it, helping their bills, Ukraine and climate change simultaneously.

While the size of the new target remains unknown, three things are clear:

- Vladimir Putin's aggression has fundamentally changed the clean energy equation in Europe
- governments, businesses and individuals are responding with both new targets and immediate action
- the crisis is not going away any time soon.

Taken together, these suggest that the EU is currently low-balling its ambition for 2030. It is entirely sensible to expect the bloc soon to calculate the impact of everything put in place so far and present a new, more ambitious NDC target early next year, and continue the implementation that serves so many different policy aims in one go.

[1] Emissions data for the last two years has been markedly affected by the Covid-19 pandemic so cannot be a good guide to trends. The EU's emissions in 2019, the last pre-pandemic year, were 28% below the 1990 level

[2] By reducing the water available for cooling

[3] The total includes non-EU countries

[4] This will mainly affect gas-fired generation, as it is the form with both the most flexibility and the highest price

[5] Defined as May to August

[6] With the caveat that not all elements of REPowerEU have yet been finalised between the European Commission, Council and Parliament

# India

## India

GHG emissions: **3,364 $MtCO_2e$** | Global emissions %: **7%** | Population: **1.4 billion**

GHG emissions per capita: **1.75 $tCO_2e$** | Emissions rank: **3rd** | GDP per capita: **$2,277**

NDC: **Reduce emissions intensity by 45% below 2005 levels by 2030** | Net zero date: **2070**

# Headlines

- **Rollout of renewable energy, particularly solar, is accelerating** rapidly and will transform India's electricity sector this decade.
- **Coal generation will become an increasingly unprofitable back-up for wind and solar**, a function that will itself inevitably fall away as storage takes off.
- **Finance is flowing to the clean transition**: 70% of Adani's capital investment this decade; $80bn from Reliance into Gujurat alone; and up to $10.5bn of support in a partnership deal between India and Germany.
- **These trends plus others in transport and homes look like putting India on course** towards its 2070 net zero emissions target.

# Context

Prime Minister Narendra Modi's pledge to put India on course for net zero emissions by 2070 was perhaps the most dramatic announcement of any at the 2021 UN climate summit (COP26). And it is crucially important: already the world's third-biggest emitting country, India's projected rapid economic growth would make it an even bigger driver of climate change in the near future unless emissions are constrained. But although Mr Modi also announced more stringent clean energy targets for 2030 at COP26, there has been scepticism about policies to put India on track.

Looking at the Indian economy more generally, one important factor was the Covid-19 pandemic, which hit hard in 2020. Unemployment tripled within a month of the first lockdown, exports plummeted, and nearly half of households experienced a drop in income.

By contrast, India has weathered the impacts of Russia's invasion of Ukraine rather better than most countries. Low use of fossil gas has protected its energy system from severe disruption, and it has procured oil and coal from a variety of sources including Russia during 2022. Inflation has remained around 7% – high, but avoiding the huge spikes seen in some other regions of the world. A recent Brookings-Financial Times analysis of near-term global economic prospects found India to be the only 'bright spot' among major nations, projecting major growth next year.

In recent years India has made major progress in electrification, with nearly 100% of the population now connected to the grid (up from 75% a decade ago). The next priority for government and the Central Electricity Authority is to improve the reliability of supply, which has been uneven this year.

Largely but not exclusively because of Covid-19, far less conventional electricity generation capacity (30GW) was built in the last five years than the government had envisaged (50GW). [1] However this does not appear to have been a factor affecting security of supply; far more important have been problems supplying coal to power stations. As in other parts of Asia, droughts linked to climate change are affecting hydro output in some years.

In overall energy security terms, as much as 40% of the population remains dependent on traditional biomass for cooking. Domestic production of oil and gas is dwindling despite government attempts to revive it. But consumption is rising: gas use in buildings and transport almost doubled over the last decade and has risen in industry too, while oil demand has more than doubled since 2000, with import dependency now 75% and rising.

Like its major regional rival China, the Indian government is keen to grow manufacturing capacity for clean energy alongside its use, to turn potential import dependence into export opportunities. One important decision implemented this year was to set import tariffs on solar modules, 25% for cells and 40% for panels – one of several incentives aiming to promote domestic manufacture. A parallel aim is to grow the domestic electric vehicle industry, and by extension – given that EVs are all about batteries – the energy storage industry too.

# Current situation

At COP26, Prime Minister Modi accompanied his 2070 net zero pledge with a pair of striking announcements on clean energy. India would source half of its energy from renewable sources by 2030; and by the same date, would have 500GW of non-fossil energy capacity in operation.[2]

Some confusion reigned at the time on whether the Prime Minister really meant 'electricity' or 'overall energy.' The influential think-tank the Council on Energy, Environment and Water quickly clarified that the capacity announcement referred to electricity only.[3] But it is still unclear which the 'half of energy from renewables' pledge referred to. In either case it would represent a huge lift, given that fossil fuels currently account for over 60% of primary energy use and nearly 80% of electricity generation.

In any case, the targets have subsequently moved on. In August of this year, the government updated its Nationally Determined Contribution (NDC), its official submission to the UN climate convention. Here, the 'half of energy from renewable sources' pledge is absent, and so is the 500GW non-fossil-electricity target: instead, the pledge is to have 'about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030.'[4]

Whatever is happening with targets, implementation is heading in a positive direction. It is happening very quickly; and renewables build, in particular solar, is set to be by far the dominant engine of India's energy future.

The recently published draft National Electricity Plan shows the scale of the transformation taking place:

- In the period 2007-2017, the total generating capacity of India's coal-fired power plants doubled
- By contrast, over the next decade, the Central Electricity Authority (CEA) sees coal-fired capacity increasing by less than 20%
- Over the same period, the capacity of renewable generation is set to soar by 250%.

As we will see shortly, there are reasons to think even the modest level of coal capacity

growth envisaged by the CEA may not come to pass. And increasing the coal fleet does not necessarily mean increasing emissions.

The transition from coal-heavy capacity growth to renewables is mainly down to cost. Indian solar electricity is among the cheapest in the world, level with the UEA and on average even cheaper than in Chile, China, Australia and Brazil. It is so cheap that the cost of building and operating new solar + battery storage facilities can undercut even existing coal-fired power stations.[5]

The government sees other advantages in solar. It can be built at various scales, can be erected in ways that do not take up useable space (for example, on railway station roofs), can create side-benefits (such as reducing water evaporation when built over canals and reservoirs) and can be largely financed by private capital. Stimulating domestic solar panel production is likely to create a supply chain to rival China's, potentially cutting prices further.

The last two years have been challenging due to the Covid-19 pandemic, which affected investment, labour, supply chains and other factors. It seems likely that the country will miss its target of building 175GW of renewable capacity by the end of 2022. With the total solar installation early in the year standing at 54GW, the 2022 target of 100GW (set in 2015 under the National Solar Mission) will almost certainly be missed too. The pandemic is one reason; another is the hike in customs duty on solar modules; and other factors such as planning regulations and grid connections have had an effect too. In addition, India's federal structure means that state governments can either accelerate or obstruct: so much so that whereas four states have already surpassed their 2022 targets, others are way off. Differences in population density, insolation, land prices, and the importance of coal mining are among the various factors cited.

Nevertheless, 55GW of renewable generating capacity has been built in India over the last five years, comfortably outstripping the 31GW figure for non-renewables. In the first eight months of 2022, 17% more renewable capacity was built than in the first eight months of 2021.

The government has recently introduced a number of other policies aimed at easing the growth of renewables. For example, generators can combine renewable, non-renewable and storage in a single 'firm power' offering; with solar undercutting coal on cost, such a 'package' would use solar power when it is available, use storage second, and switch in coal generation when needed. Renewables can be introduced alongside coal, on a similar basis, in existing power purchase agreements. Interstate transmission of renewable electricity is tariff-free; so, newly, is transmission of electricity from pumped and battery storage when that storage is filled primarily by renewable generation. Each state will boast at least one Solar City, powered

entirely by the sun. India is investing diplomatic effort in making the technology stick, via the International Solar Alliance, which now numbers 121 member countries, and more recently through the One Sun, One World, One Grid initiative which envisages long-distance high-voltage cables linking country to country, allowing solar electricity to be distributed around the world.

Although going from about 165GW of renewables installed now[6] to 570GW in 2032, as envisaged in the government's draft National Electricity Plan, might seem like a big stretch at first, it does not seem quite so hard when broken down. Installation would need to average out at 3.8GW per month. In March this year, Indian companies installed 3.5GW: so this is not a high rate, especially when you consider that some states have yet to really get on board.

So, where does this leave coal?

New coal-fired power stations are still being built, coal mines are still being opened. Under the surface, however, coal is quickly becoming fragile. With renewables set to dominate generating capacity, particularly wind and solar which generate variably, the case for baseload power is progressively being undermined. And here are some numbers that should give any would-be coal investor and indeed any depressed climate change campaigner food for thought:

- In the national electricity plan's forecast, peak demand will reach 363GW in 2032
- Non-fossil generation capacity, meanwhile, will be 590GW – far bigger
- This shows that for increasingly large chunks of the time in the next decade and possibly even this decade, India's grid is likely to operate without any fossil generation at all – certainly far less than now – provided that the national grid has enough capacity to channel power seamlessly between different regions.

This is changing the economic realities for coal markedly. Coal-fired power stations are designed to be operated as baseload power: turning them on and off repeatedly, and leaving them off for long periods of time, means they operate inefficiently and unprofitably. In general they need to be operating at least 60% of the time to break even. Already they are hovering around this mark, averaging 55-65% over the last few years (down from 75% a decade ago). Once the utilisation rate falls much lower and obviously will not come back up, the plant is condemned to make a loss for the rest of its life. Backing up solar and wind by generating for a few hours on some days and nothing on others is not what they were designed for, technically or economically. Either the government pays subsidies adequate to make up the shortfall, or it closes.

What this really does is to throw coal-fired power stations into an economic battle with storage

– batteries, pumped hydro and other more nascent technologies. With auctions already resulting in contracts for solar+storage facilities that undercut the price of coal generation, and with the government having already identified 96GW of pumped hydro potential across the country, this is a battle that coal cannot win. From here on in, the speed at which coal burning falls and coal-fired power stations close hinges on how quickly storage, interconnection and demand management can provide regional and national flexibility for wind and solar.

Already this reality is so obvious to investors that they will not put their own money into new coal-fired power stations. A recent analysis from the Centre for Financial Accountability and Climate Trends came up with three compelling findings:

- In 2020, about three-quarters of all investment in generation went to renewables
- Investment in coal generation was 85% lower than in 2017…
- All of the coal investment came from state banks, whereas more than half of the funding for renewables came from the private sector.

By contrast, BNEF's annual Climatescope report last year ranked India first among 107 emerging market countries for attractiveness in renewables investment, citing 'transparent market mechanisms, supportive policies and ambitious government targets.'

This picture is reinforced by the plans of some leading companies. The giant Adani conglomerate plans to put 70% of its capital investment this decade into the energy transition, including renewables and green hydrogen – a total of $50-70bn. Reliance Industries will invest $80bn in renewable energy projects in the state of Gujurat alone. Adding up the plans of renewable energy investors, BNEF calculates that the 10 biggest will have built 430GW of clean energy capacity by the end of this decade – 86% of the 500GW target announced at the Glasgow summit.

Financing India's decarbonisation transition is also helped by a significant partnership with Germany, signed earlier in 2022, that could unlock up to $10.5bn in assistance through to 2030 to boost clean energy resources.

While these numbers collectively signal the inevitable demise of coal, they also make things very challenging for gas generation. Currently accounting for around 6% of generating capacity, gas has been a side-show in the electricity mix despite its growing importance in other arenas. The current draft National Electricity Plan shows only a single planned gas-fired power station, and the CEA did not consider further expansion in its scenarios due to 'unavailability of natural gas and high price of imported Regasified Liquid Natural Gas (RLNG). How quickly things have turned around since 2013, when the Vision 2030 – Natural Gas

Infrastructure in India report envisaged gas-fired generation growing four-fold by 2030. By contrast green hydrogen is increasingly part of the strategy, with the IEA observing that India has more potential to reduce the global price than most other countries owing to its extremely cheap solar electricity.

While renewables are the cornerstone of India's clean energy transformation, government and business have big plans for electric transportation.

Whereas the biggest focus in developed nations is on cars, in India the first segment to go electric is two-wheelers. By some accounts India is both the biggest producer and biggest market for two-wheelers in the world – other analysts have it in second place behind China – but in any event it is a big player in both manufacture and use. More than 20 million two-wheelers were sold in 2019. Only a small fraction are currently electric – about 1.3% of total vehicle sales – but growth is predicted to be huge. The Indian government projects annual growth of 49% compounded through this decade; analysts RBSA Advisors are more bullish and foresee 90% annual compound growth, taking the value of the market to $150bn in 2030.

As with renewables, some companies are buying in heavily, with more than $3bn of private capital invested in the first half of 2021 across all elements of the supply chain. Indian and non-Indian companies are both represented. Ola Electric Mobility is building what it says will be the world's biggest e-scooter factory in Bengaluru, aiming to pump out 10 million units per year. Skoda is among the western companies taking an interest. Particularly in the car sector, Chinese companies headed by BYD, the world's fourth biggest EV manufacturer, are making a move. The space is developing in a highly competitive way, with potential global benefits in terms of price and diversity of suppliers.

The Indian government has enacted several policies aiming to ensure that Indian companies are in the vanguard of the global EV and battery storage revolution. Its Production Linked Incentive scheme has awarded a total of more than $3bn to electric vehicle and component manufacturers, which leverage private capital worth three times as much. A slightly smaller pot has gone to stimulating battery storage investment. Other policies include requiring no licence for installation of EV charging points.

More generally, the government has instituted a number of measures aimed at curbing the growth of energy consumption and steering consumption towards electricity. The 'Go Electric' campaign instituted in 2021 showcases the virtues of EVs, electric induction hobs and pressure cookers, helping reduce reliance on imported coal and gas. Mainline rail routes will all be electrified by 2024. More than 10,000 public buildings have been retrofitted with energy efficient lights, fans and air conditioning. Air conditioners have a mandatory default cooling temperature of 24˚C rather than 20-21˚C. Publicly listed companies will be required to disclose climate-related risks from next year.

# Impact on emissions

It is impossible to be specific about what this means for India's greenhouse gas emissions, because the government has not set targets for emissions that are in anyway quantified apart from the 2070 net zero pledge.

However, if action on the ground is considered more important than promises, there are clearly many reasons to be optimistic. Falling costs, government policies and the plans of significant corporate players suggest the projected build-out of renewables, particularly solar, is likely to happen, especially when cheaper Indian-made solar panels come off the production lines in greater bulk. That will make successive dents in coal-fired generation, inducing government to cut its rising bill for subsidies. That will further spur the economic case for storage, interconnection and demand flexibility. Falling electricity costs will accelerate the rollout of electric mobility and cooking – and in time, of industrial processes that rely on electrification and/or hydrogen rather than direct burning of fossil fuels.

However, if the transition is inevitable, as it appears to be, the speed is uncertain – hinging most obviously on the rate of energy demand growth, increasing access to cheap storage, and retrogressive pressure from coal-rich states. One factor potentially hastening the end of coal is that the government may be over-estimating the growth in electricity demand, as it has regularly done in the past. The National Electricity Plan suggests an average growth of 6% per year over the decade, whereas so far it has never exceeded an average of 5% per year. If growth is lower than estimated, we should expect the need for coal to disappear faster than estimated.

Climate change will not be the only winner from India's accelerating clean energy transition. Its city air – among the world's most polluted – will be cleaner, reducing the burden of respiratory health. So will air inside many million homes where biomass is currently burned for cooking. India's overall economy will be larger than it would be under fossil fuels, thanks to rupees invested and jobs created in key industries of the immediate future, cheaper energy, and a concomitant reduction in import dependency.

[1] Mainly coal, but also including large hydro and nuclear
[2] Other pledges included cutting carbon intensity by 45% by 2030, and reduce total projected emissions over the decade by 1bn tonnes
[3] It would in any case be hard to know what 'capacity' meant in the context of overall energy
[4] The rationale for dropping the 500GW figure seems to be that the government wants to keep its option open in case additional coal-fired capacity is needed – a decision taken, presumably, in the light of disruption to global clean energy supply chains caused by Russia's invasion of Ukraine and China's extended Covid lockdowns. It is worth noting that the '500GW of non-fossil-fuelled capacity' was itself a downgrading of the target in place in 2019, of having 500GW of renewable capacity in place – because adding nuclear to that figure would have taken non-fossil capacity above 500GW. Meanwhile the government has also spoken of a renewables-only target of 450GW by 2030
[5] The high price of coal-fired generation compared with renewables is adversely affecting some of India's state-owned electricity distribution companies ('discoms'), which are tied into long-term contracts to purchase power from coal-fired power stations
[6] Figure for August 2022. This includes large hydro – the figure for all other renewables is 118GW, half of which is solar