China's Climate Transition:
Outlook 2023

CO2 emissions rise
but clean energy surge
brings peak closer

CREA
Centre for Research on Energy and Clean Air

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with
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Nov 27, 2023

About CREA

We are an independent research organisation created in 2019. We use scientific data, research and evidence to support the efforts of governments, companies and campaigning organizations worldwide in their efforts to move towards clean energy and clean air.

Published studies 2020–2023

25 staff in eight countries across Asia and Europe

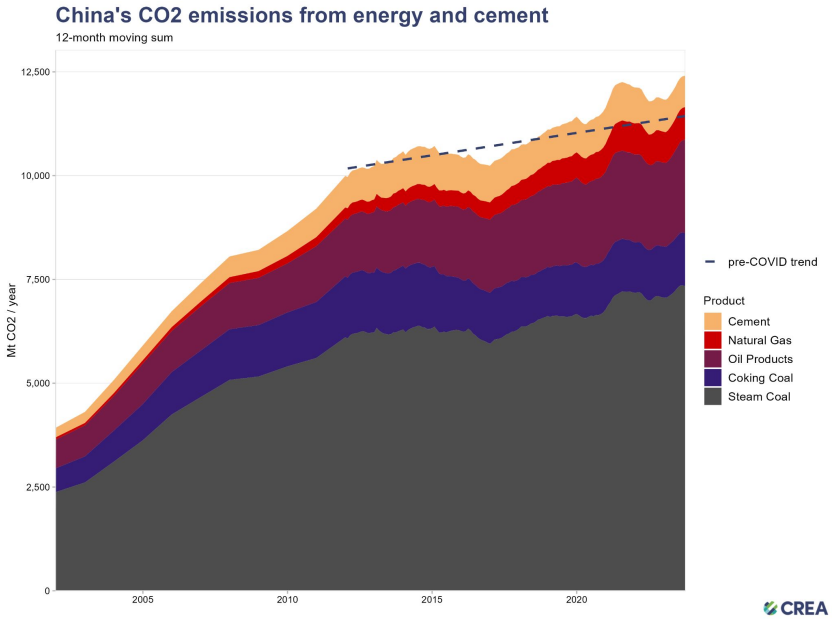
Outline

1. Introduction on China's emissions and climate commitments
2. Research methodology and framework
3. Results: Progress and setbacks in China's transition in 2023
    a. Total CO2 emissions
    b. Total energy supply and demand
    c. Electricity generation and capacity
    d. Industry
    e. Buildings
    f. Transport
4. Policy developments
5. Expert survey and interviews
6. Conclusions

Introduction

China’s emissions and climate commitments

The meteoric rise and leveling-off of China’s emissions



2000

China's accession to the WTO

The increase in China’s emissions in the 2000s was driven by its rapid industrial and economic growth after the export and investment boom started by World Trade Organization (WTO) accession.

2008

The 2008-09 Chinese economic stimulus plan

This boom came to a head with the global financial crisis, and in 2008, leadership responded with an unprecedentedly large infrastructure stimulus programme that drove even faster emissions increases in 2009–2012. Spending was predominantly directed at the most energy-intensive parts of the economy: construction and heavy industry, particularly steel, cement, and other construction-materials industries.

2013

China’s ‘battle for blue skies’ to curb air pollution

This was also the time when Presidents Xi and Obama announced the “climate deal” between the two countries, including China’s CO2 peaking commitment and paving the way for the Paris Agreement, while the air pollution crisis dominated domestic headlines, creating a unique window of opportunity to limit coal consumption at least in the more prosperous coastal areas. A new wave of stimulus was launched in late 2015.

2020

COVID-19 pandemic, 2030&2060 climate commitment

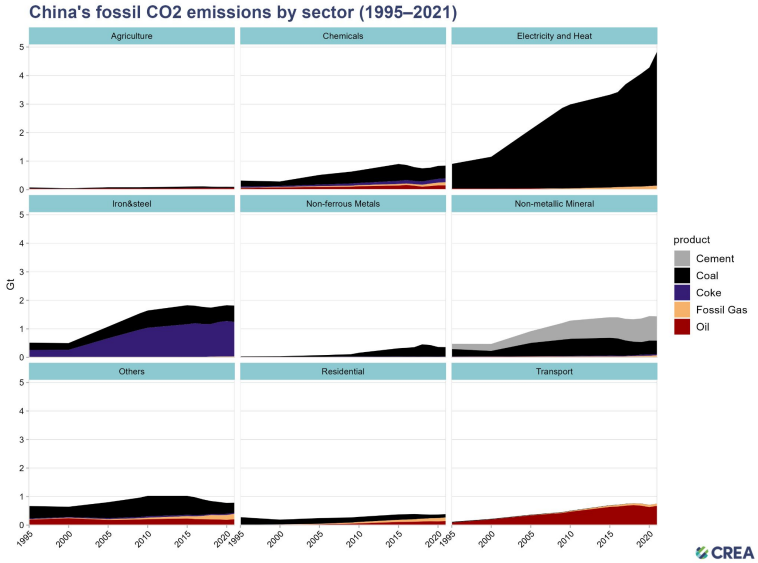
China’s emissions surged in late 2020 and early 2021, due to economic recovery policies aimed at stimulating construction and industrial output, including export industries. The surge in industrial output reversed in mid-2021, due to economic policies aimed at tamping down real estate speculation and low-value construction projects, strict COVID-19 control policies, and clean energy expansion.

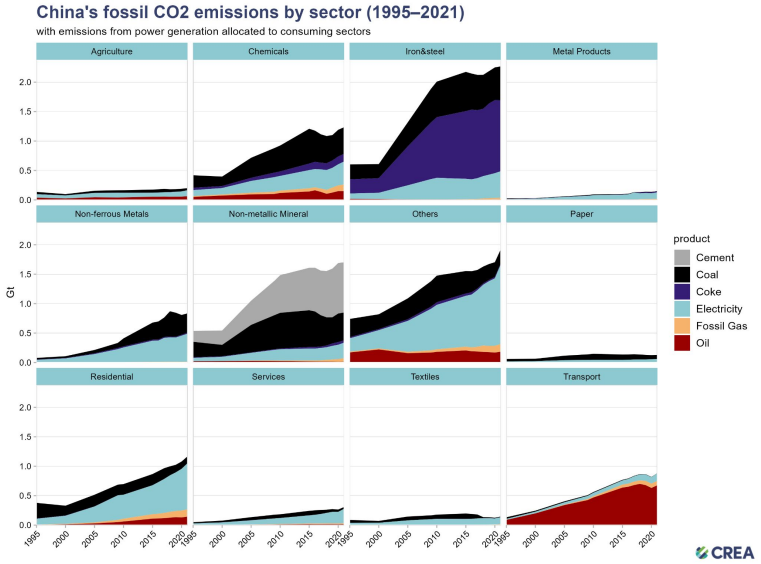
2022

Power crisis and reforming the growth model

A record heatwave and drought caused emissions to increase again in late 2022 and in 2023, as hydropower generation plummeted and was substituted by coal in the short term. In addition, oil consumption rebounded after the removal of zero-COVID-19 policies. China’s clampdown on financial risks and speculation in the real estate sector has put an end to growth in steel and cement output, which were the key drivers of China’s emissions growth for most of the past two decades.

China’s CO2 emissions are heavily dominated by power generation and heavy industry sectors





China’s CO_2 emissions are heavily dominated by power generation and heavy industry sectors, with iron and steel, non-metallic minerals (cement and glass) and chemicals being the largest industrial emitters.

When emissions from power generation are allocated to the sectors consuming the power, the non-ferrous metals industry (e.g. aluminium, copper and nickel) stands out as a major emitter due to the sector’s high electricity demand.

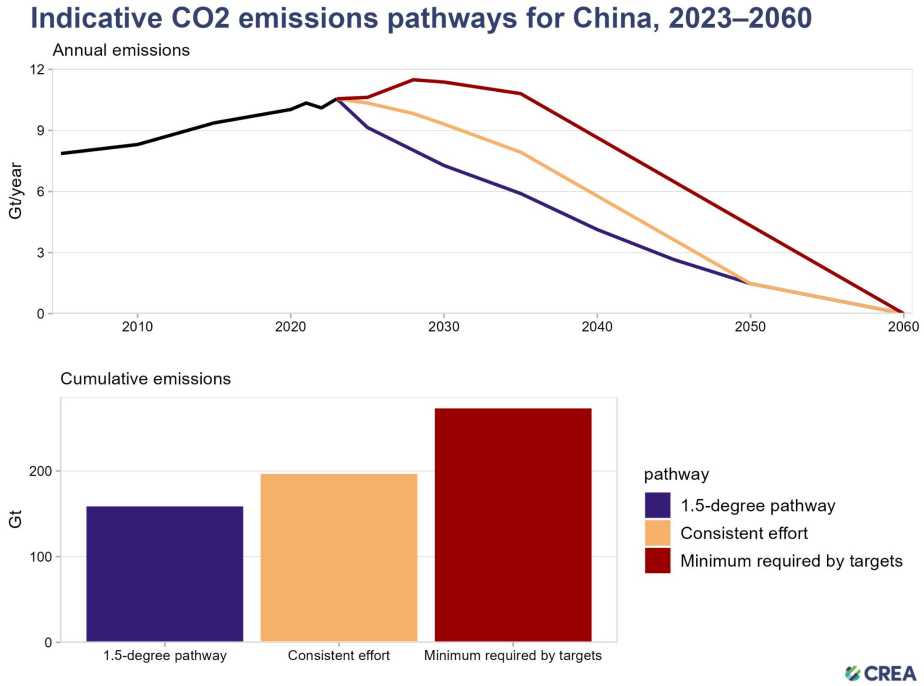
China's climate commitments to date

	Copenhagen 2009	Paris 2015	Glasgow 2021
CO2 intensity reduction from 2005 level	40–45% by 2020	60–65% by 2030	>65% by 2030
Share of non-fossil energy	15% by 2020	20% by 2030	25% by 2030
CO2 peak	—	around 2030	before 2030
CO2 neutrality	—	—	before 2060

"1+N" policy framework to implement the commitments:

- dedicated implementation plans for key areas such as energy, industry, construction, transport, coal, electricity, iron and steel, and cement
- supporting measures in terms of science and technology, carbon sinks, finance and taxation, and financial incentives.

China’s commitments leave space for a wide range of emissions pathways

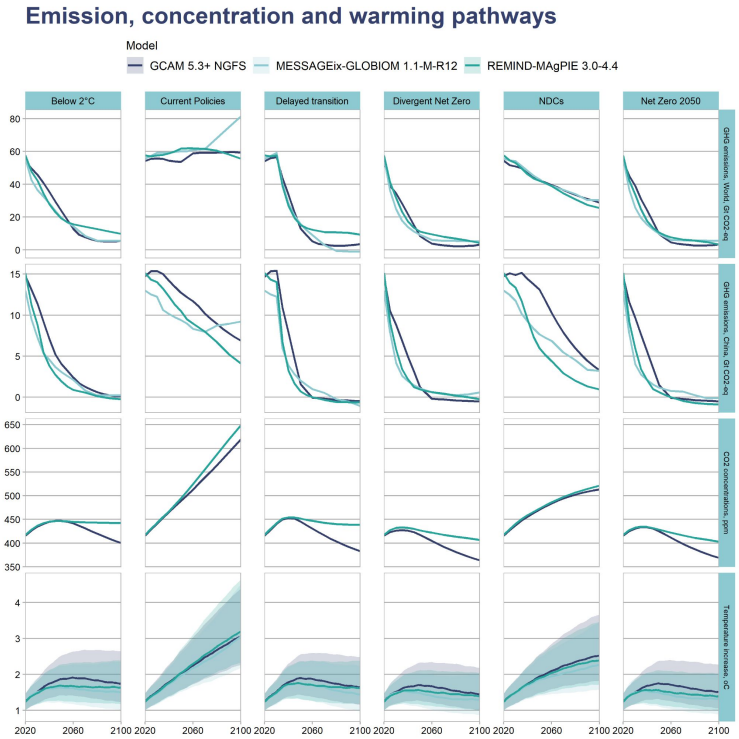


China’s current climate commitments allow a wide range of CO2 emissions outcomes.

- The pathway labelled “minimum required by targets” shows the highest possible emissions pathway that China could follow while meeting the 2025 and 2030 CO2 intensity targets and the commitment to peak emissions before 2030.
- The “consistent effort” pathway shows a path to the carbon neutrality target in which emissions plateau until 2025 and start falling thereafter, avoiding a large change in the amount of effort required in the following decades.
- The 1.5°C pathway would be extremely challenging to achieve, but it is what China and other countries should strive towards based on the Paris Agreement.
- China's cumulative CO2 emissions in 2023-2060 under the 1.5 degree pathway would be 160 Gt, 200 Gt in the “consistent” effort pathway and 270 Gt in the "minimum required by targets" pathway.

Research methodology

The framework as the basis for a regular re-assessment



Indicators

Sectors:

- Economywide total

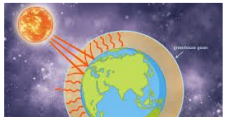
- Electricity

- Industry

- Buildings

- Transport

Indicators:



- CO2 emissions

- Fossil fuel consumption

- Clean energy production/consumption

- Energy consumption

- New investments / sales

- Electrification

Measuring progress: our framework

Time series data

Database of Chinese and international energy transition pathways

Indicators measuring key aspects of progress by sector

Annual change since 2015 compared to the average change in the pathways in 2020–2030

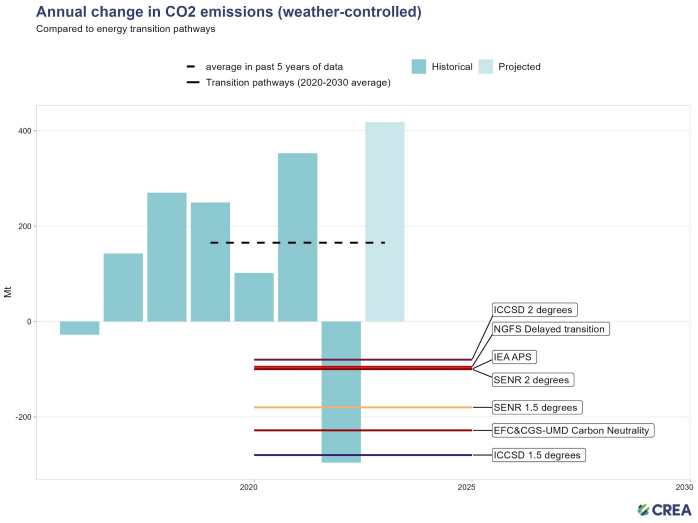


Table 1 | Overview of the global scenarios included.

Institute	Scenario
IEA	Announced Pledges (APS)
NGFS	Delayed transition
NGFS	Below 2°C
NGFS	Net Zero 2050
CAT	1.5 degrees
CAT	2 degrees

Table 2 | Overview of the included scenarios by Chinese researchers.

Institute	Scenario
Institute of Climate Change and Sustainable Development (ICCSD)	1.5 degrees
Institute of Climate Change and Sustainable Development (ICCSD)	2 degrees
School of Environment and Natural Resources (SENR), Renmin University	1.5 degrees
School of Environment and Natural Resources (SENR), Renmin University	2 degrees
North China Electric Power University (NCEPU) and Peking University (PKU)	Accelerated electrification with diverse power mix (shortened to "Accelerated" in the graphs)
North China Electric Power University (NCEPU) and Peking University (PKU)	Continued electrification led by new energy (shortened to "New Energy" in the graphs)

Institute	Scenario
Institute of Atmospheric Environment, China Academy of Environmental Planning (CAEP-IAE) and Electric Power Planning and Engineering Institute (EPPEI)	Baseline scenario: high electricity demand, energy mix trend as the 13th Five-Year Plan of China (FYP)
Institute of Atmospheric Environment, China Academy of Environmental Planning (CAEP-IAE) and Electric Power Planning and Engineering Institute (EPPEI)	Low carbon scenario: high electricity demand, maximise RE, lower coal consumption
Institute of Atmospheric Environment, China Academy of Environmental Planning (CAEP-IAE) and Electric Power Planning and Engineering Institute (EPPEI)	Strengthened scenario: low electricity demand, maximise RE, lower coal consumption
Energy Foundation China (EFC) and Center for Global Sustainability at the University of Maryland (CGS-UMD)	Based on updated NDC

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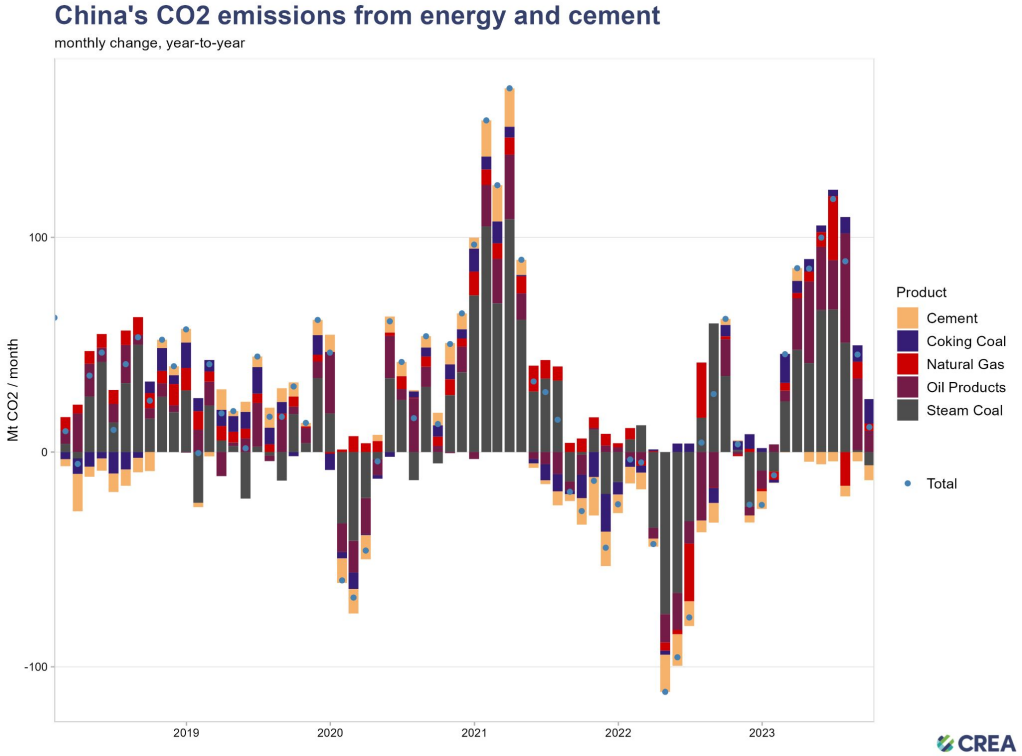
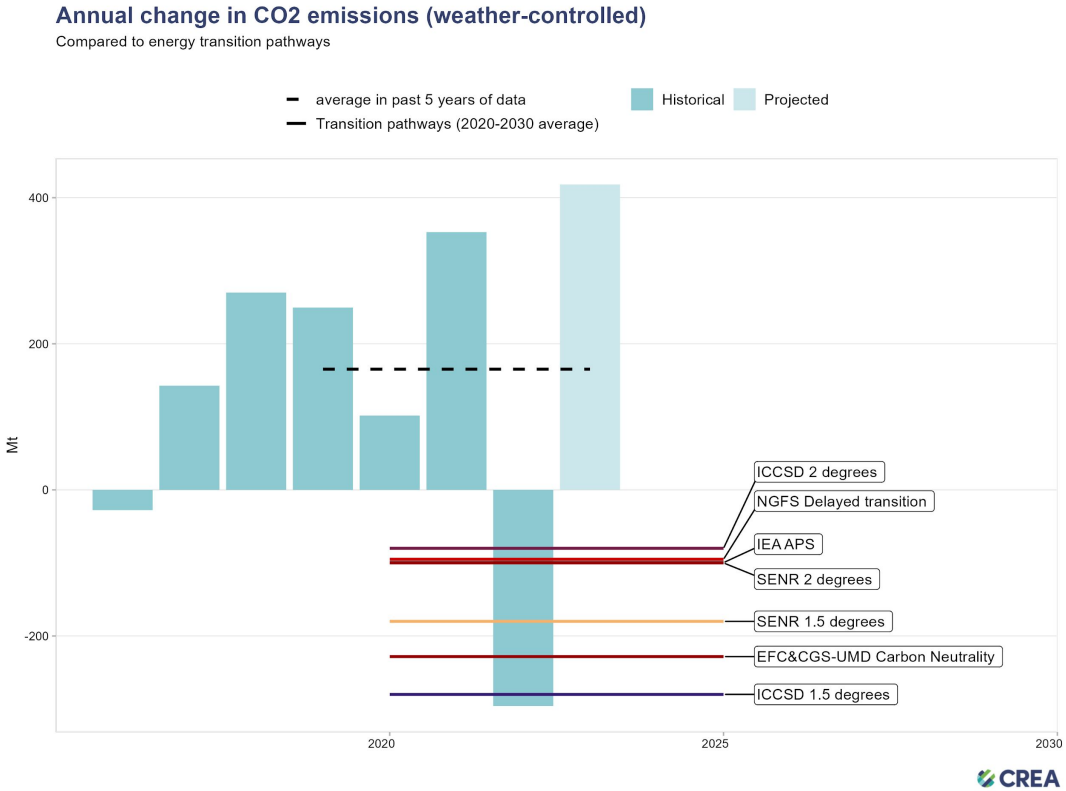
Results: Progress and setbacks in China’s transition in 2023

CO2 emissions growth accelerated in 2023 due to rebound from zero-COVID and weak hydropower output

- CO2 emissions increased by an estimated 6.5% in the first three months of 2023
- The growth was driven by power sector coal use, rebound in oil products consumption and increase in coal use for steel
  - Half of the growth in power sector coal use was due to weather variations (weak hydropower output)
- Emissions fell in the production of cement and other building materials, due to contracting output
- Full-year CO2 emissions will increase by at least 4%



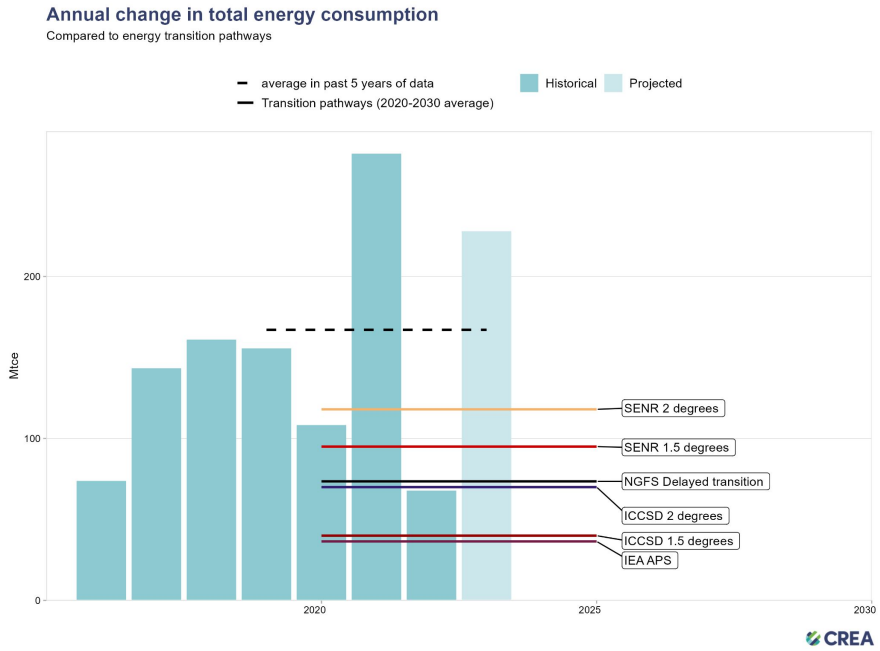
CO2 emissions rebounded



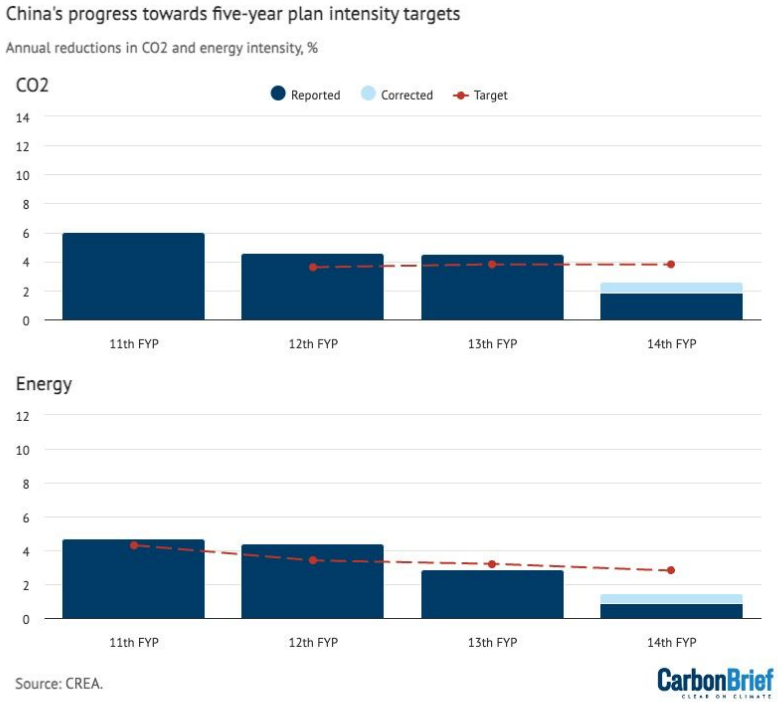
- After the increase in emissions since 2020, a significant reduction in CO2 is required from current levels by 2030 to align with the transition pathways.
- The government plans to introduce “Dual Control” of total CO2 emissions and CO2 intensity as a tool to implement CO2 peaking and any targeted emission reductions.
- Requires the development of a robust MRV (Monitoring, Reporting, and Verification) and accounting system.
- Credibility of China’s commitments also requires making CO2 emission data public.

The culprit: highly energy-intensive economic growth pattern

- Economic growth was dominated by energy-intensive industries during — and after — zero-COVID
- The potential for catch-up on technical energy efficiency in industry is largely exhausted; improvements in buildings are proving challenging



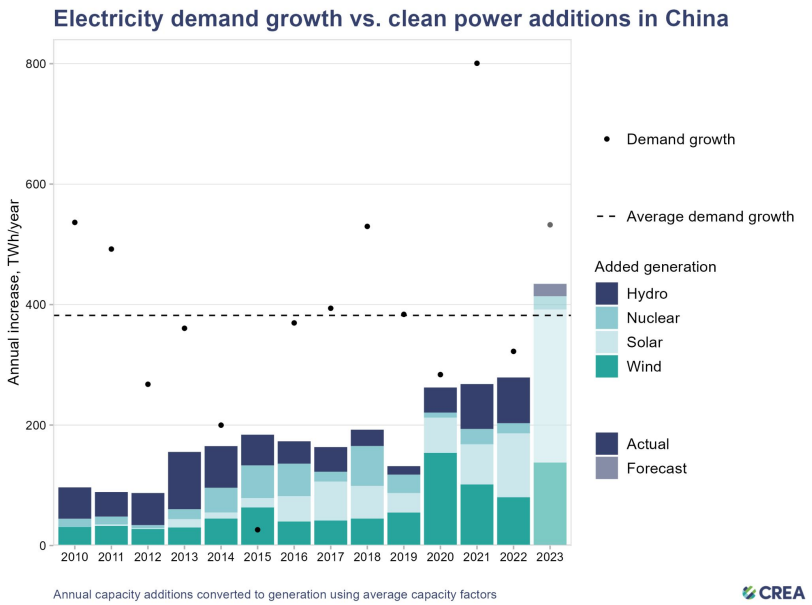
2025 energy intensity target in trouble

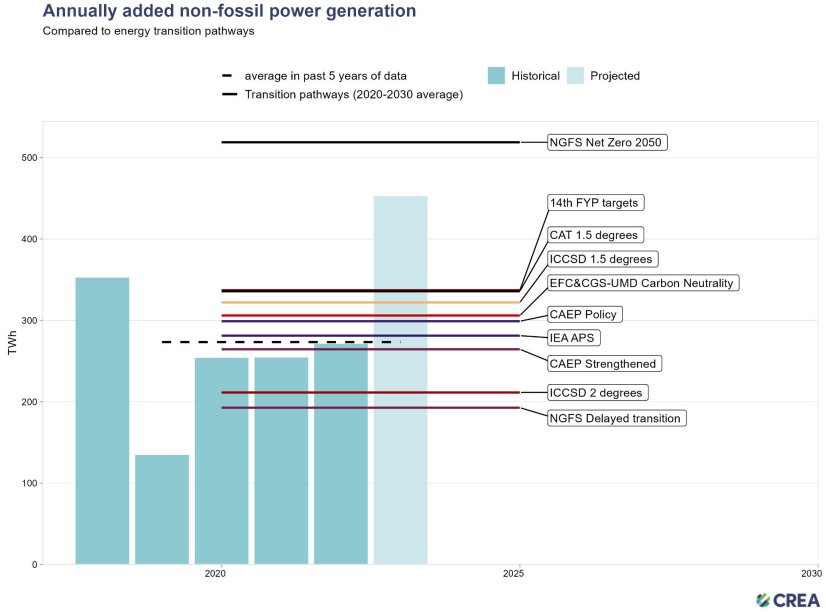


China's progress on reducing energy and CO2 intensity of GDP compared to five-year plan targets, converted into required annual rates of progress.

- Previous targets since the 11th five-year plan (2006–11) have been met, but now progress has fallen short on both targets for four consecutive years.
- As a result, energy and carbon intensity targets for 2025 included in China's Paris pledge are severely off track
- The coming surge of low-carbon energy would put the country on track for the CO2 intensity target, if similar levels are added next year.
- The energy intensity target, in contrast, will not be met on current trends. Only a sharp shift to consumption-driven growth – which the government says it prefers, but has found the required measures hard to implement – could allow this target to be hit.

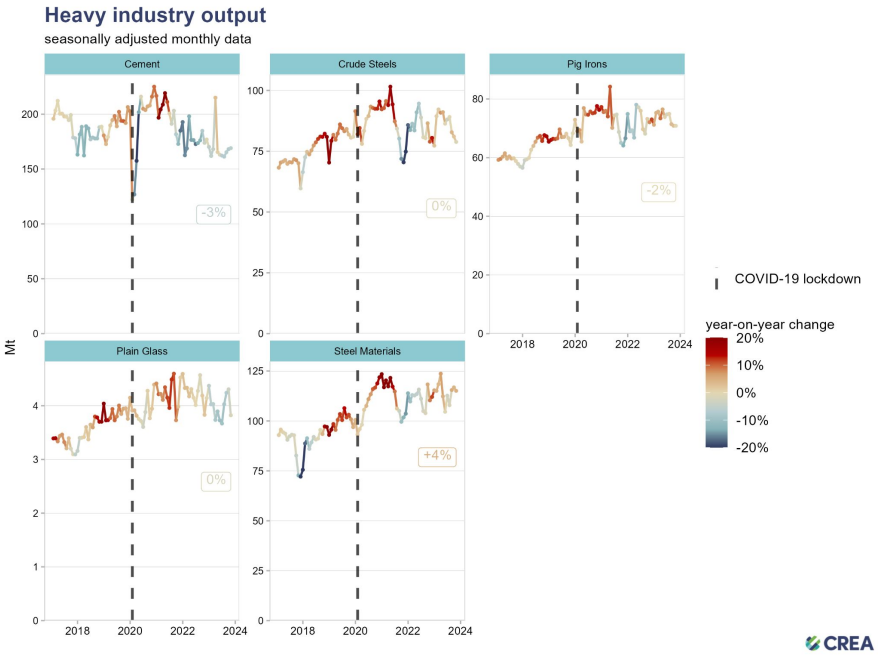
Clean energy growth reached an inflection point, putting immediate CO2 peak in reach





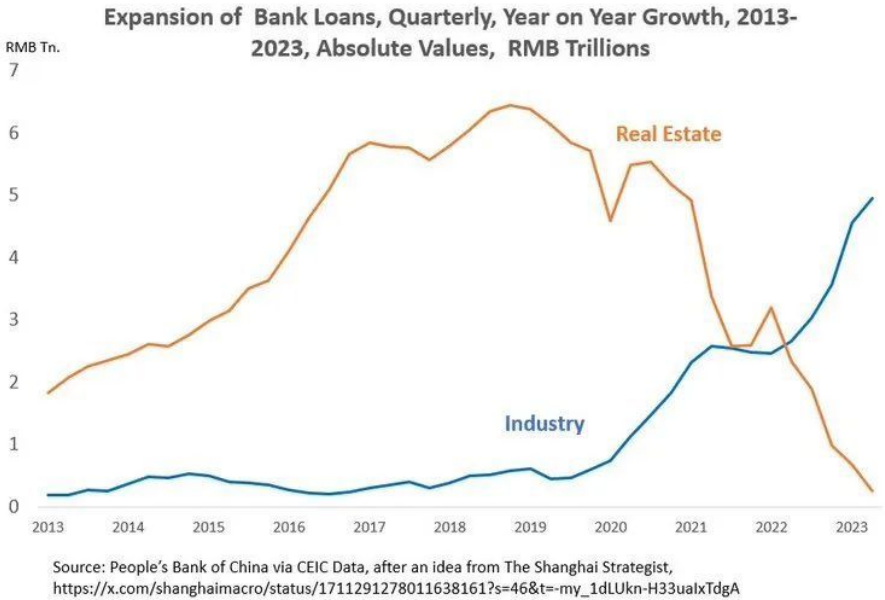
Progress in reforming the growth model: real estate downgraded

- Real estate and infrastructure construction were major drivers of China's emissions for the past two decades
  - Steel and cement, mainly used for construction, are the two largest CO2 emitting sectors in China when emissions from electricity are included
- Investment in real estate began to fall in 2021 and has continued to contract in 2023; spending on traditional "grey" infrastructure has stalled
- The fall in construction volumes has weighed on output of energy-intensive construction materials



Progress in reforming the growth model: real estate downgraded

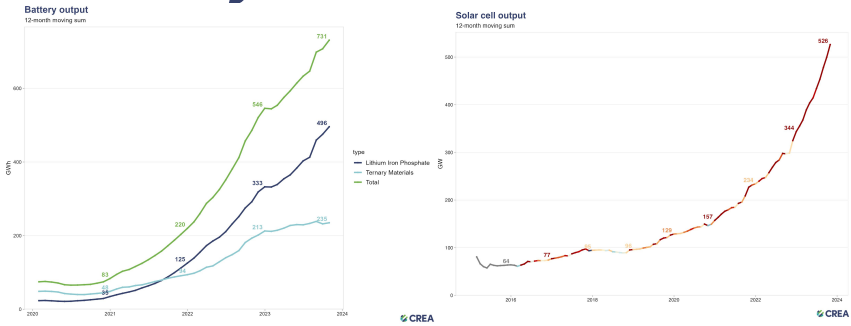
China's great rotation



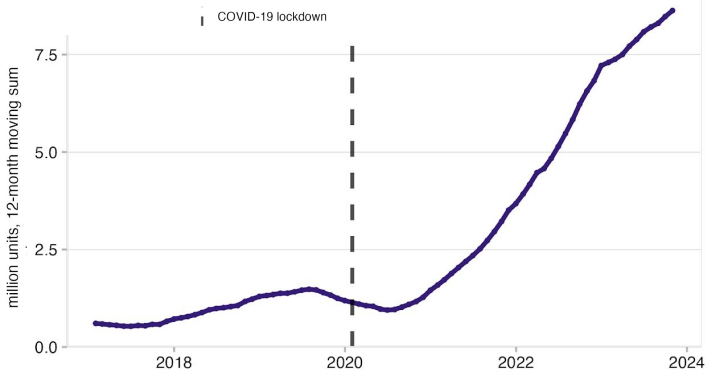
Source: People's Bank of China via CEIC Data, after an idea from The Shanghai Strategist, https://x.com/shanghaimacro/status/1711291278011638161?s=46&t=-my_1dLUkn-H33uaIxTdgA

Clean energy manufacturing became a key economic driver

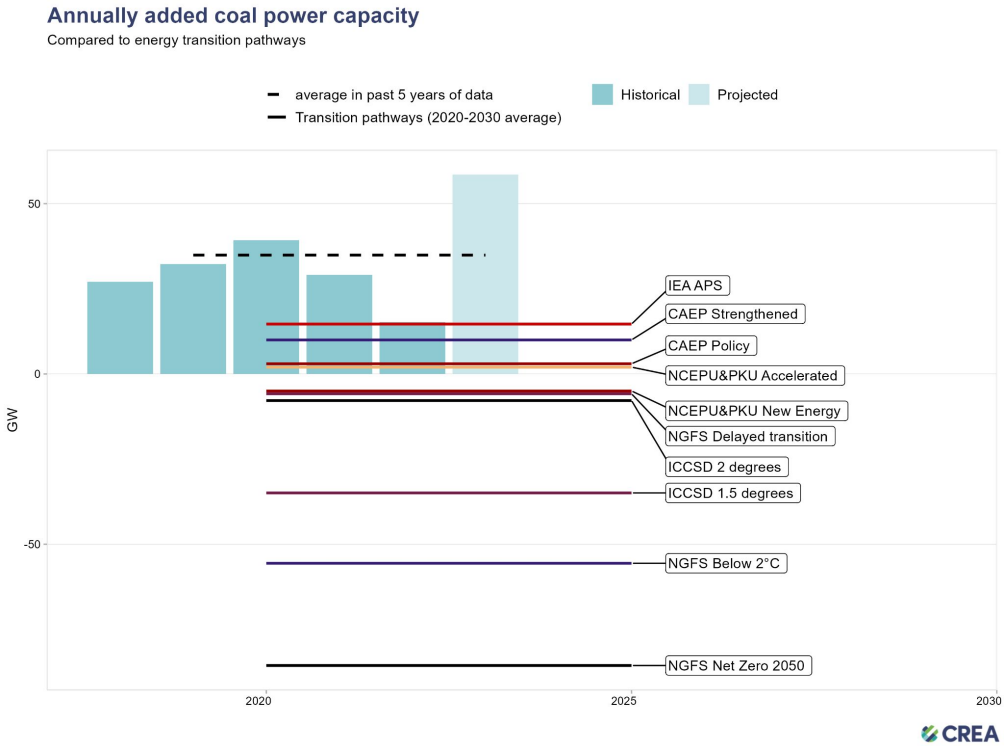
- China is building the manufacturing capacity to supply all the solar panels, batteries and EVs for a rapid global energy transition
- Investment in cleantech manufacturing and deployment is a key economic driver this year, for the first time, potentially delivering <u>all of net FAI growth</u>
- This helps cement the political economy of China's energy transition



Electric vehicle production

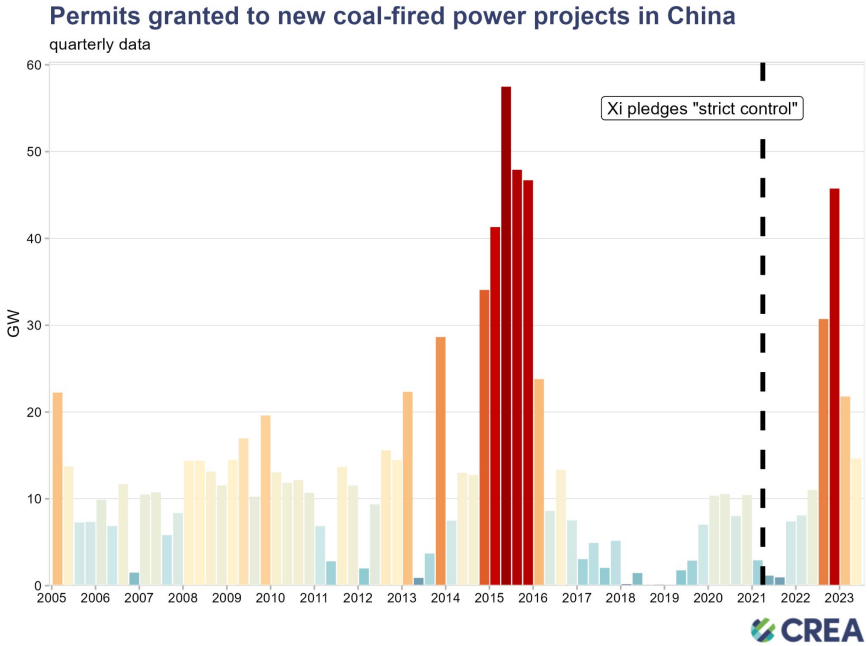


Coal power capacity additions running far ahead of transition scenarios



From “strict control” of new coal power capacity to a permitting boom

- President Xi pledged in April 2021 that China would “strictly control new coal-fired power projects” in the period up to 2025
- The exact opposite happened: approvals of new coal projects doubled in the two years after the pledge
- Electricity shortages in 2021–22 led central government to endorse coal power projects
  - Most of the approved projects cannot be justified by lack of existing capacity
  - Fundamental cause is outdated grid management



“Climbing to the peak”

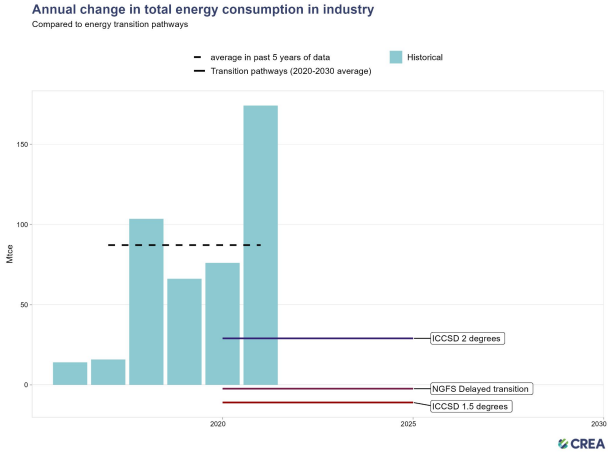
- Coal power, steel and other high-emitting industries are engaging in a last-minute scramble to lock in more polluting capacity before emissions are due to peak

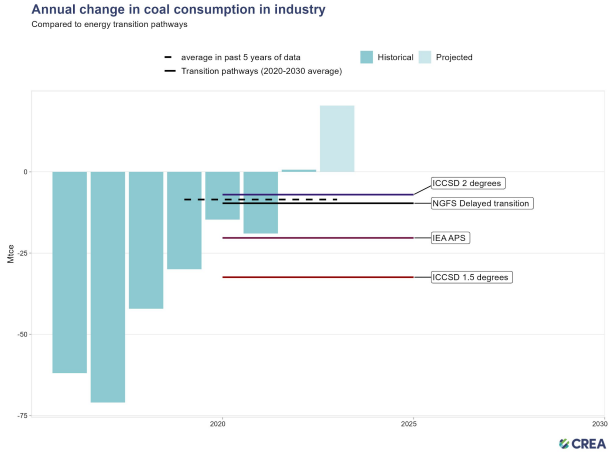
bloomberg.com

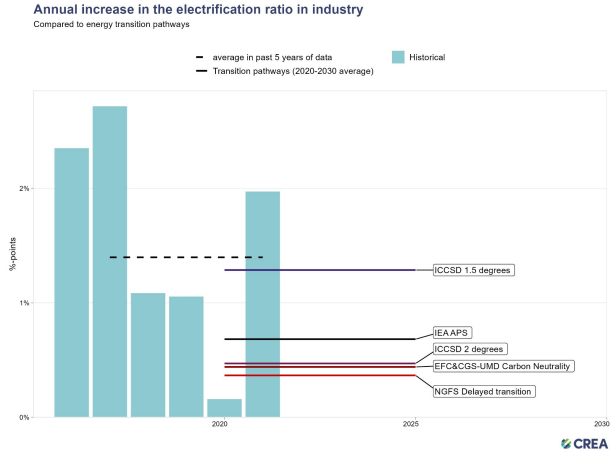
China Coal Giant ‘Seizing’ Window of Opportunity for New Plants

China’s biggest coal company said it is “seizing” the opportunity to build more fossil fuel power plants before 2025 as the government prioritizes energy ...

Industry







Industrial energy consumption growth was much faster than in the transition pathways from 2017–2021, with growth accelerating from 2018. This reflects the energy-intensive pattern of economic growth after President Trump's tariffs and the onset of the COVID-19 pandemic.

The sector in which emissions trends are in line with the transition pathways is cement and building materials. Cement production, the main source of emissions in the sector, fell at 3% per year from 2017 to 2022, due to the declining volume of infrastructure construction, which reflects progress with the economic transition.

Even as industrial energy consumption has increased at a high rate, direct coal consumption in the industry has been falling quite rapidly, faster than in the transition pathways. This has been largely driven by air pollution policies that have required or encouraged the replacement of direct coal use with fossil gas and electricity. The use of both energy sources has increased rapidly.

Accordingly, electrification has progressed faster in the industrial sector than projected in the transition pathways.

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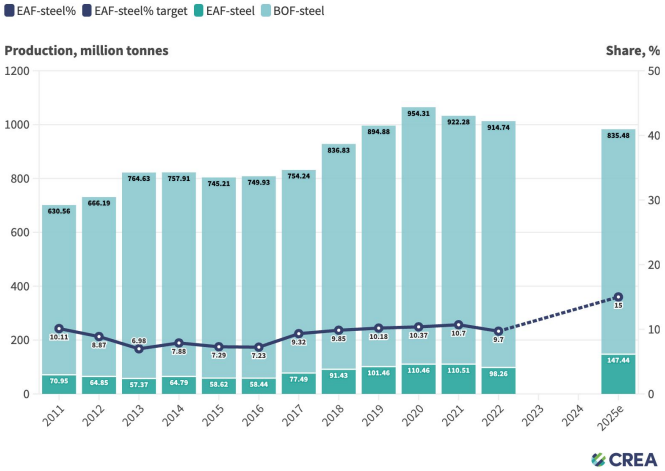
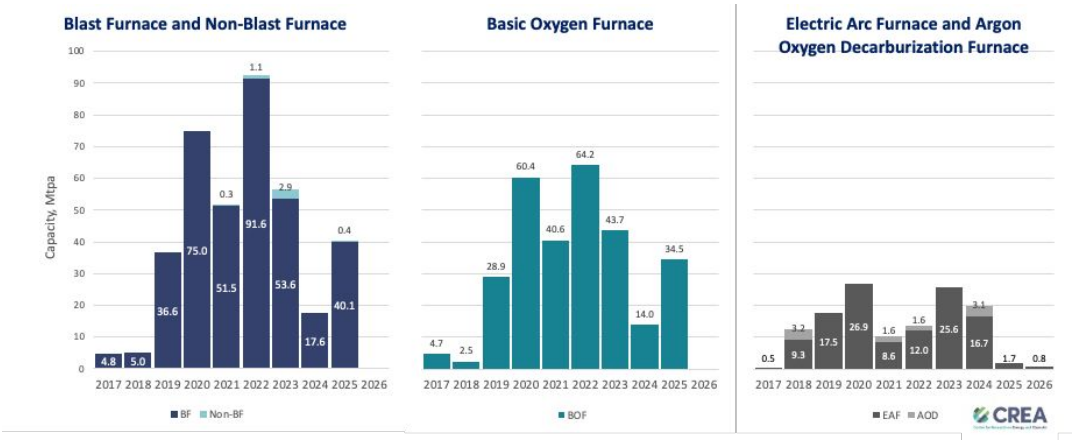
New investment in coal-based steelmaking capacity



China's steel production share and EAF-steel output target by 2025

The increase stock of scrap steel constitutes a major opportunity for the sector to shift to electric steelmaking. The steel industry targets an increase in the share of electric arc furnace-based steel (EAF-steel) from the current 10% to 15% of steel production by 2025.

The huge potential scrap resource and policy targets have not, however, translated into a boom of EAF-steel production.



New iron and steelmaking capacity additions by their estimated commision year (data only include new project permitted from 2017 to the first half of 2023)

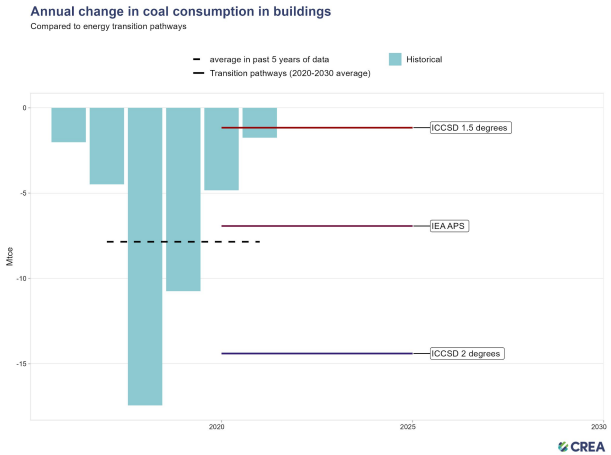
On average, approximately 30 Mtpa steelmaking capacity was approved every six months, which is almost equal to the total steel capacity of Germany.

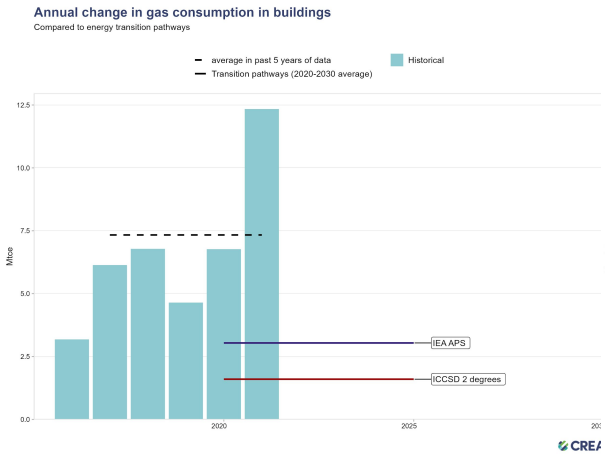
New iron and steel capacity is continuously dominated by the blast furnace–basic oxygen furnace route.

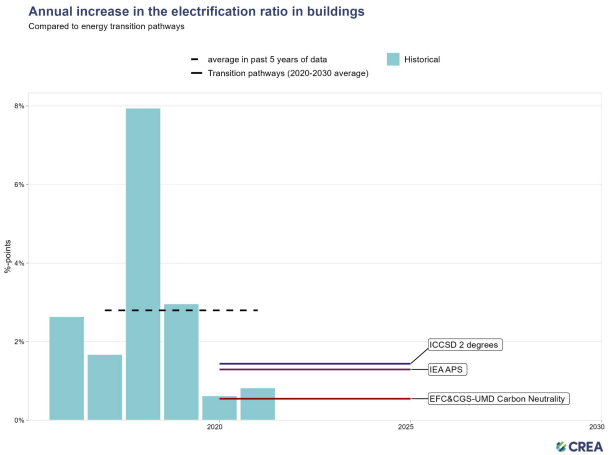
By 2025, nearly all new permitted iron and steel projects will commence operations. **Through these replacements, approximately 40% of China's iron and steelmaking capacity will be renewed.**

Buildings

Energy consumption in buildings increased faster with most growth in electricity consumption in 2022–2023, due to heatwaves and increased prevalence of air conditioning. It then resulted in increased coal use in the power sector as clean power generation additions were insufficient to meet increased demand.



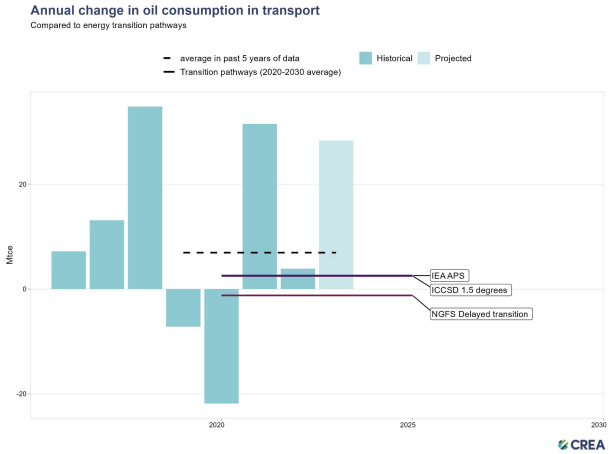


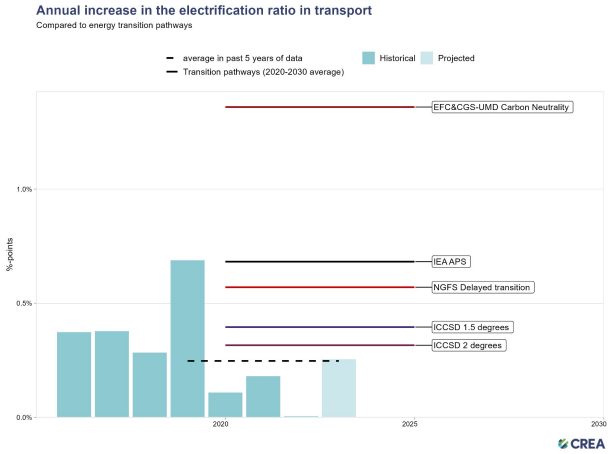


China's ambitious air pollution policies, targeting small-scale coal use in buildings as one of the key sources of air pollution, have led to a rapid reduction in coal use, in line with the transition pathways.

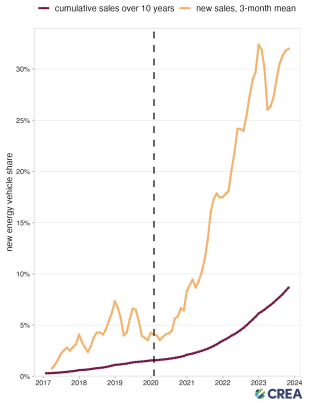
However, total energy consumption in buildings increased by 5% per year from 2015 to 2020, while the transition pathways have projected falling total energy consumption from 2020 to 2030. As a result, the use of fossil gas and electricity increased faster than in the transition pathways.

Transportation





Electric vehicles gain share



China's oil consumption was almost stable from 2019 to 2022, largely due to the reduction in mobility caused by COVID-19 control measures. The removal of pandemic control measures resulted in a significant rebound in 2023. For road vehicles, electrification represents the main thrust of emission reductions. The share of electricity in transport energy use rose from 3.4% in 2018 to 4.7% in 2023.

Electric vehicle production and sales have been skyrocketing, with the share of EVs out of all vehicles produced increasing from 5% in 2019 to 30% in the 12 months up to August 2023.

The decarbonisation and electrification of transport are supported by a highly developed network of high-speed rail connections between cities, as well as urban rail and bus transport. However, there is little sign of a modal shift; the investments seem to be needed just to keep public transport competitive.

Non-CO2 Greenhouse Gases

Current Status:

- Lack of substantial progress in overall policies for non-CO2 greenhouse gases.
- Absence of official quantitative targets and regular emissions reporting.
- Most recent complete greenhouse gas emissions inventory dates back to 2014.

Urgent Requirement:

- Establishment of clear, measurable targets, especially for methane.
- Enhancement of official monitoring and disclosure practices for greenhouse gas emissions.

Policy Update:

- The national action plan on methane emission reduction lacks specific or measurable targets.
- Only calling for “improvement” in emissions monitoring during the 14th and 15th Five-Year Plan periods.

Policy developments in 2023

- Policies promoting the deployment of solar and wind power proved highly effective, as did industrial policies stimulating new capacity in the solar, battery, electric vehicle and other cleantech industries.
- Promote green electricity trading and use the emissions trading system to promote emission reductions through certified emissions reductions (CCER).
- Coal power capacity payment mechanism, incentivizing an increase in coal power capacity and deferment of retirements.
- Emissions monitoring and reporting obligations were strengthened for industrial sectors, encouraged in part by the EU carbon tariffs, which create an incentive for improved emissions data.
- National methane emission reduction action plan

Policy developments: areas with unclear or no progress

- No timeline was specified for controlling total emissions or for the expansion of the carbon market.
- For power market reform, regulatory work continued but no new milestones were specified beyond the long-held aim of creating a unified national market by 2030.
- Progress in other areas of non-CO2 greenhouse gas emissions remains stalled. There has been no advancement in improving the MRV for the broader spectrum of non-CO2 emissions
- No progress the public reporting of energy use and emissions at a national/provincial/sectoral level.

Expert survey and interviews

Experts grew more optimistic

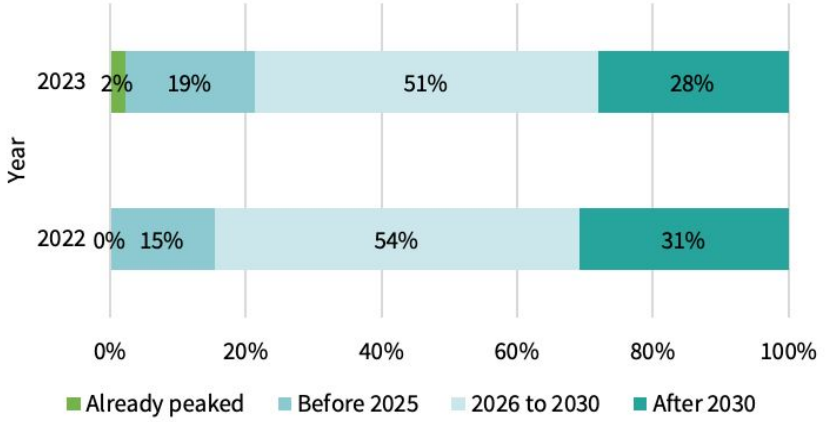
New features of 2023 Expert survey

1. Expanded pool: from 26 to 89 experts
2. Detailed comparison with last year's results aimed to identify changes and trends since last year, especially to determine if significant changes have occurred in specific areas or issues

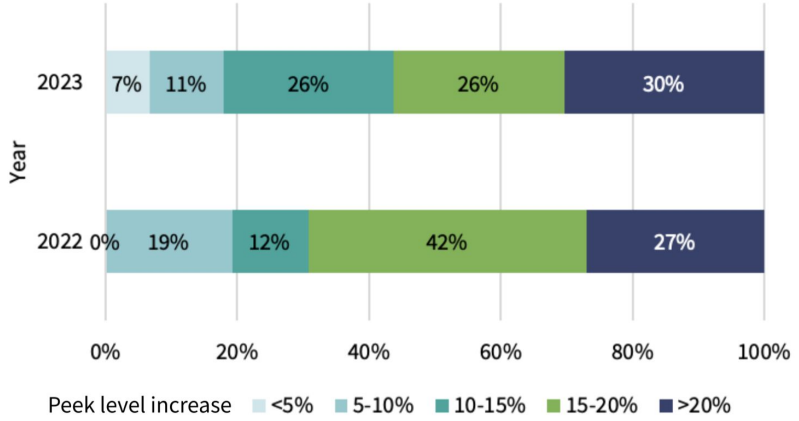
Timing of carbon peak

Growing optimism towards carbon peaking by 2030, while 56% of experts concern about carbon peaking level is too high (>15%)

What year will China's carbon emissions peak?



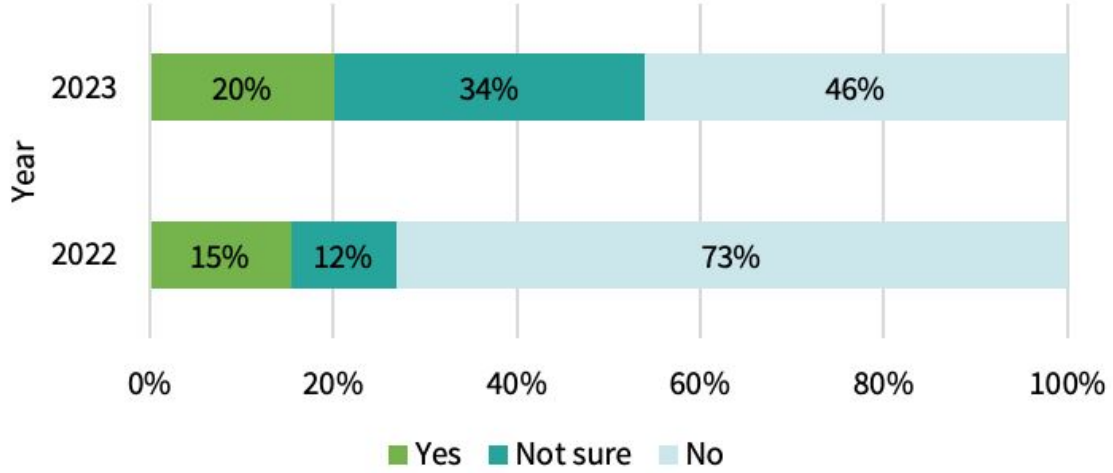
What will be the peak level of China's carbon emissions relative to 2020 level?



Has coal consumption peaked?

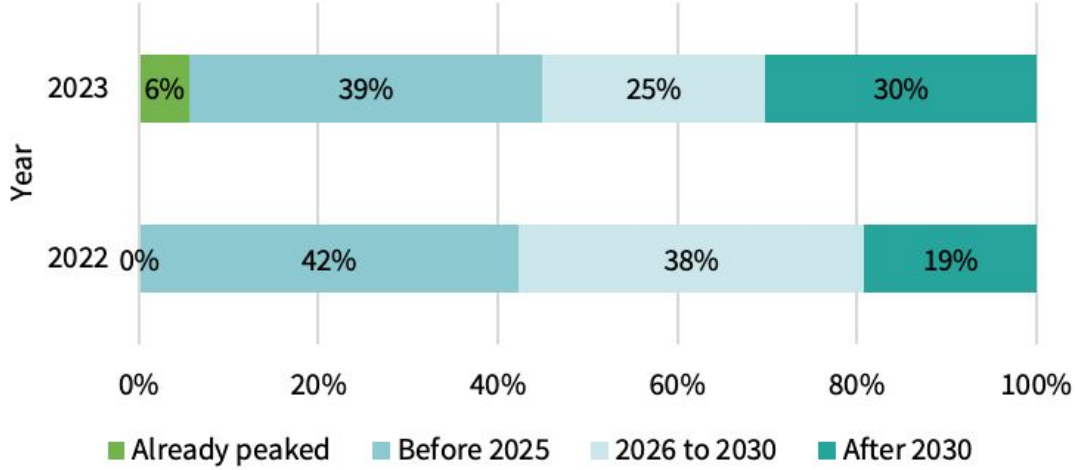
Majority of experts now think China's coal consumption has peaked or are "not sure", while in 2022 73% said consumption hasn't peaked.

Has China's coal consumption peaked already?



When will power sector emissions peak?

Growing divergence in carbon peaking in power sector: both the proportions of experts believing it already peaked or the peak will occur after 2030 have both increased.



Economic situation impact on energy transition

The majority of experts say China's current economic challenges have accelerated the energy transition, while a third say the effect has been to slow down the transition.

Table 8 | Survey results on the impact of China's post-pandemic economic situation on the energy transition process

How do you think the economic situation in China after the pandemic will affect the energy transition process?		
A. No impact	8	9%
B. Accelerate the energy transition	45	51%
C. Slow down the energy transition process.	30	34%
D. Unclear	6	7%

Conclusions

Key developments in 2023

- CO2 emissions rebounded
- Surge in clean energy paved the way for earlier peak
- Manufacturing boom strengthened the economic&political weight of clean technology
- Investments in coal-based capacity accelerated
- Experts grew more optimistic on carbon peaking
- Disappointing progress on emissions reporting and controlling non-CO2 greenhouse gases

Indicators

On track:

- Clean energy investments
- Electrification
- Building sector coal use
- Steel and cement output
- Construction materials sector emissions
- Electric vehicle sales

Off track at least until 2022–2023:

- Total CO_2 emissions
- Total energy consumption
- Industrial energy consumption
- Transport energy consumption
- Buildings energy consumption
- Investments in coal-based power capacity
- Investments in coal-based industrial capacity, particularly iron and steel capacity

Thank you!

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