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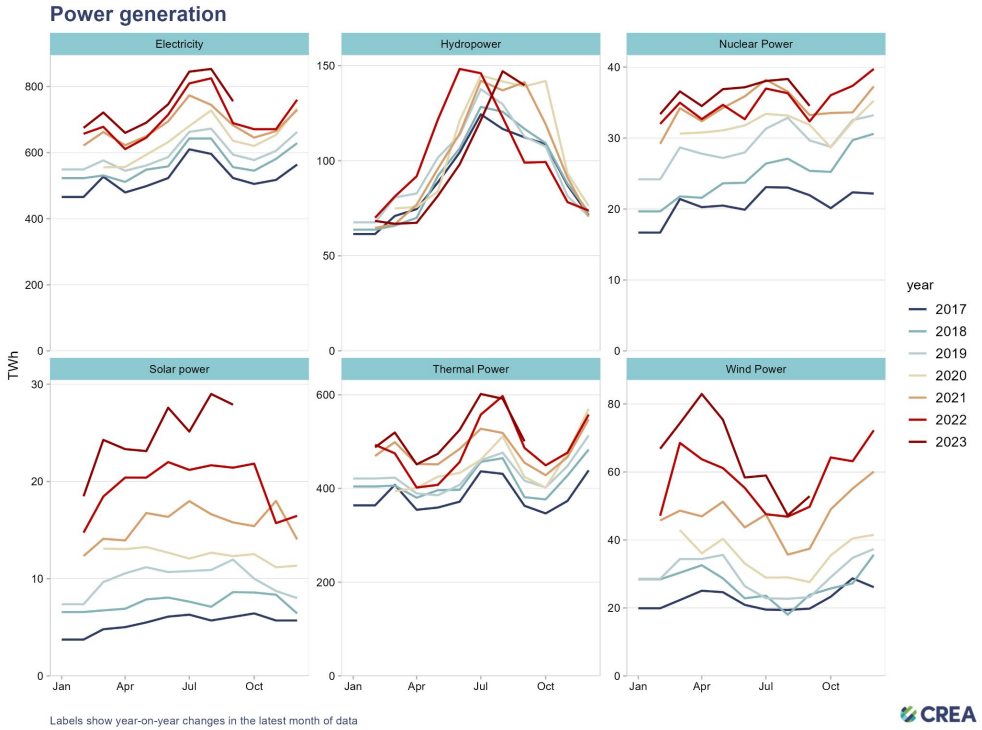
Centre for Research on Energy and Clean Air

China energy and emissions trends

October 2023 snapshot

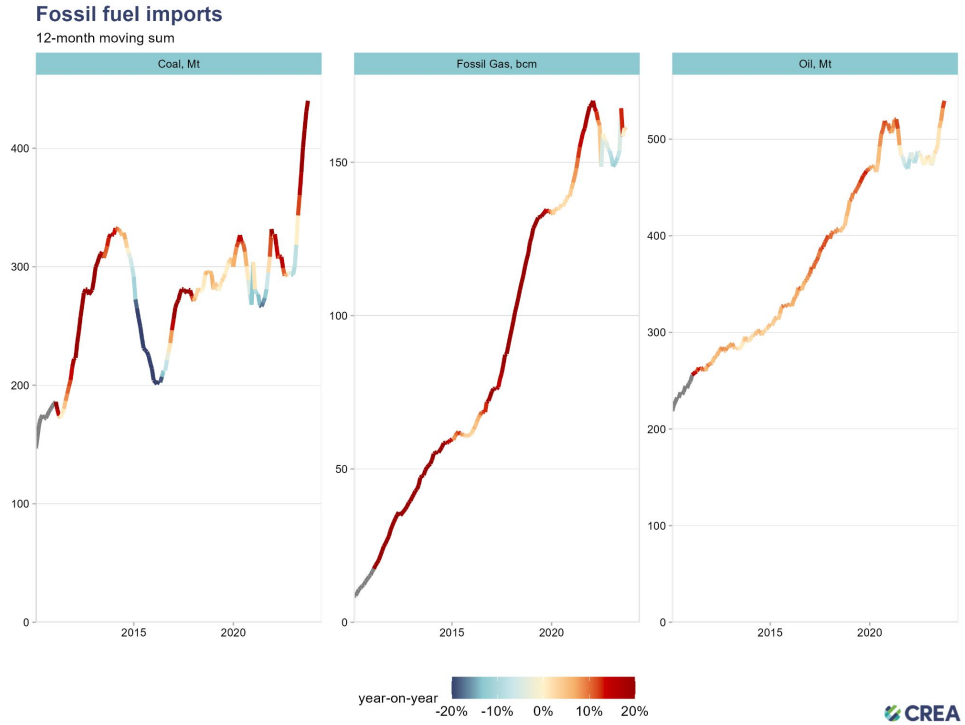
Hydropower comeback, solar surge

- **Electricity demand increased an eye-popping 10% year-on-year in September, but this was against a sluggish 1% growth rate last year, caused by COVID-19 lockdowns. Controlling for the base effect, growth was on trend.**
  - Service sector power demand increased 17%, evidence of strong activity even considering the baseline of a 5% drop in September 2022.
  - Industrial demand showed some signs of picking up, at 8% growth.
- **Thermal power generation grew 2% year-on-year, a very small increase compared to the major jump in total demand.**
- **Instead, most of the demand growth was covered by a resurgence of hydropower generation, which increased by a massive 39% from the record low utilisation caused by a historic drought in 2022.**
- **Solar power registered a sharp increase in generation and nuclear grew 7%, while wind power generation continued to be weak, considering increases in capacity compared with a year ago.**



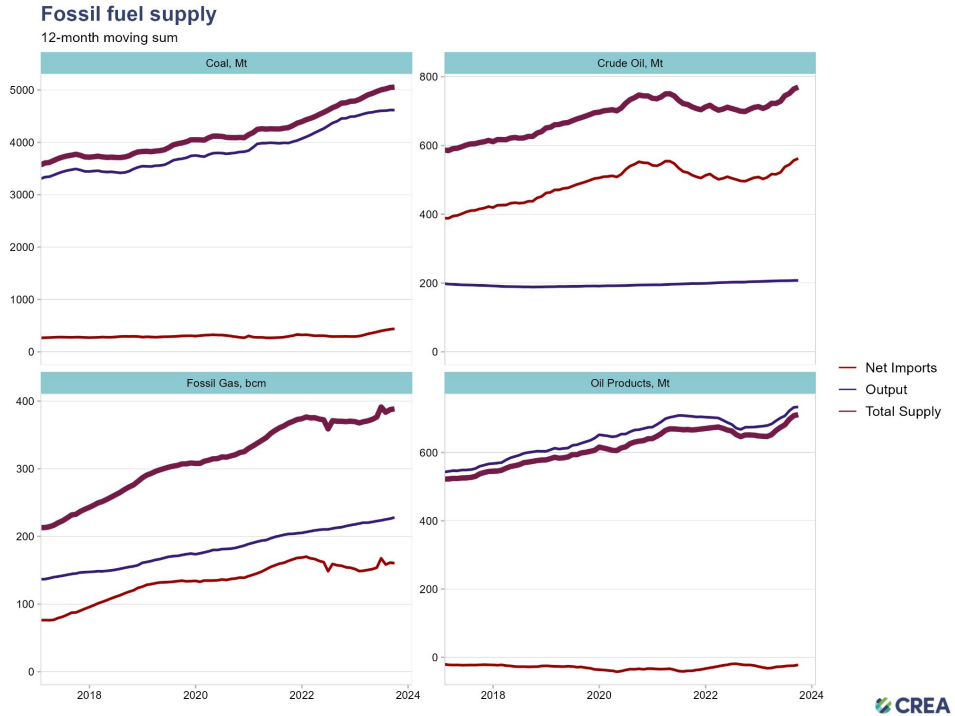
Oil and coal imports balloon, but for different reasons, while gas stumbles

- Crude oil imports increased 14% while net oil product exports fell 27% on year, showing the resurgence of domestic demand.
- Fossil gas imports returned to zero growth. While imports year-to-date are up from 2022, they are still down from their peak, showing the effects of high prices and change in policy towards gas.
- Coal imports climbed 28% year-on-year in September.



Coal mining boom runs out of steam, oil imports soar, gas stumbles again

- Domestic coal output continued to fall short of demand, at zero growth, while imports climbed. Overall supply growth slowed down, reflecting the slowdown in thermal power and steel.
- Domestic oil output is essentially flat, meaning that demand growth is entirely met with imports.

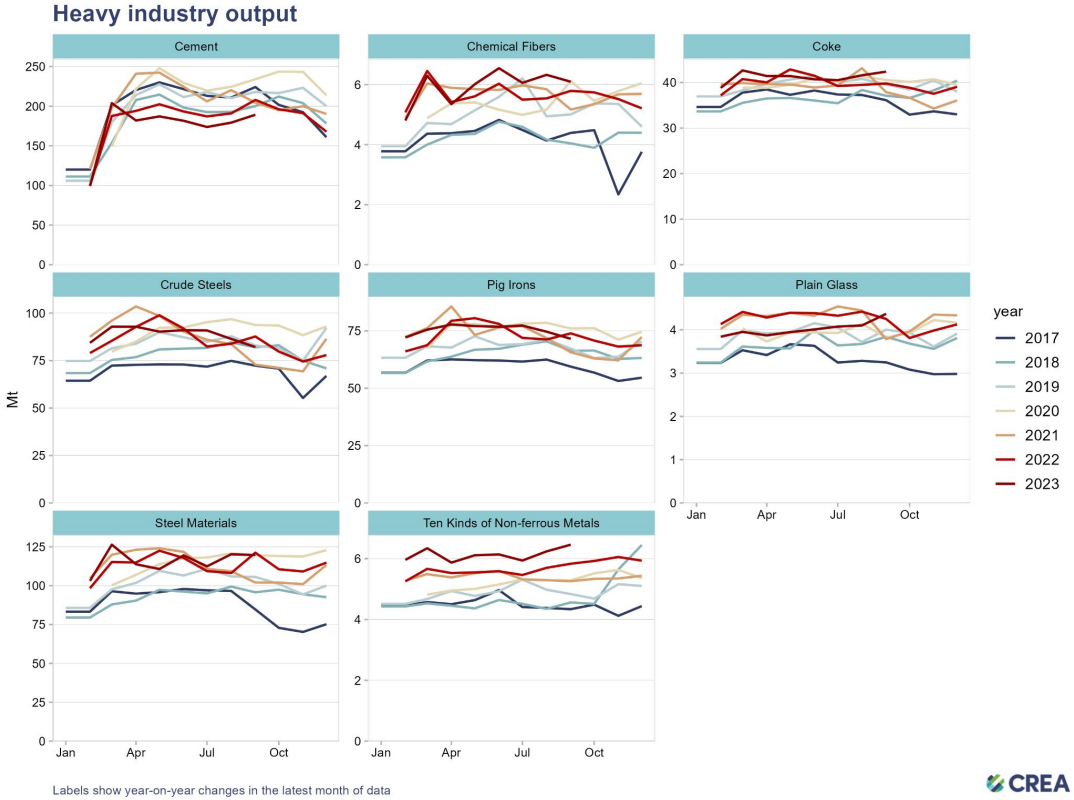


The government engaged in a major push to increase domestic coal production and suppress high prices in 2021–22. The result was a massive increase in the tonnage of coal produced, but at the cost of deteriorating coal quality, which means that the energy content of the coal produced didn't increase correspondingly. Coastal users shifted to imported coal en masse, which led to a surge in imports in 2023. The failure of the domestic coal mining push has major implications for China's approach to energy security. Read more: [What is causing the record rise in both China's coal production and imports?]

Iron, steel and cement output drops

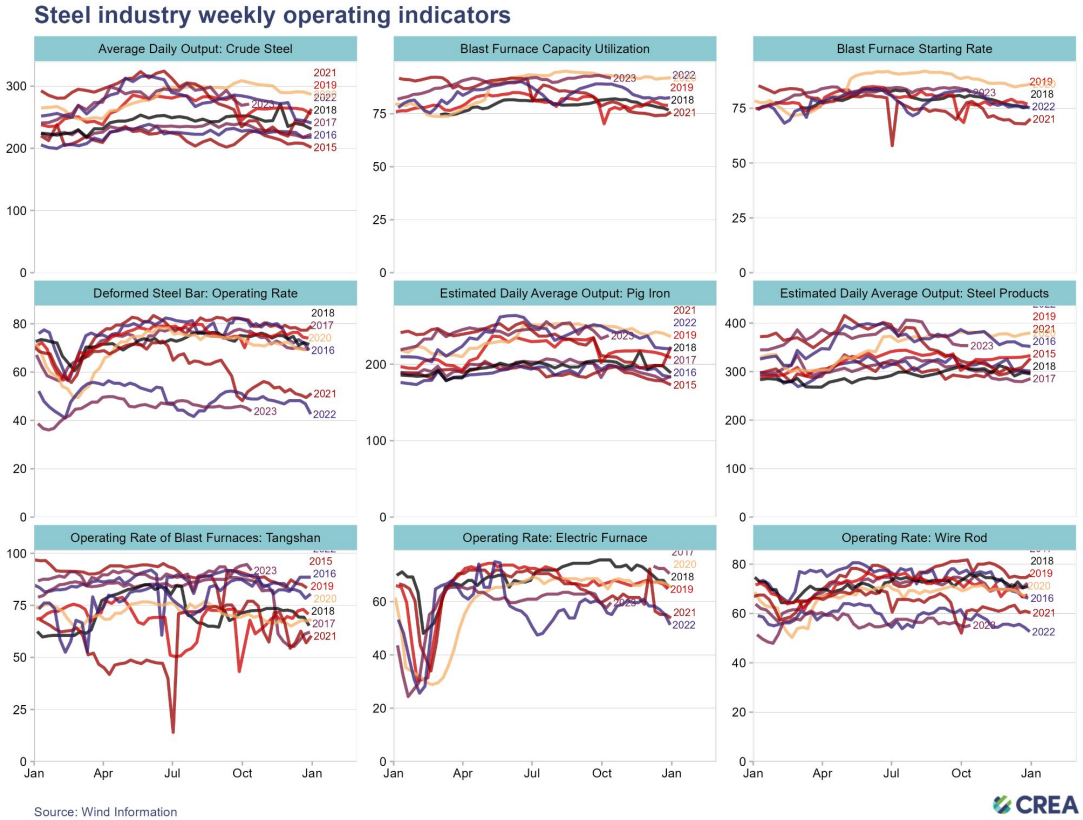
- Crude steel output fell 6% year-on-year, pig iron fell 3% and cement by 7% in September, showing the effect of a continued construction slump.
- The government aims to limit full-year crude steel output below 2022 level, requiring a 6% reduction in Oct–Dec.
- Railways and industrial machinery continue to support steel demand.
- Chemical and non-ferrous metals output accelerated.
- Cement output has been declining since 2020, leaving the industry with overcapacity and testifying to declining construction volumes.

The steel and cement industries are the largest CO2 emitters in China, when emissions from their electricity use are included. They are also bellwethers of real estate, infrastructure and other fixed asset investment which play an outsize role in China's emissions and economy.



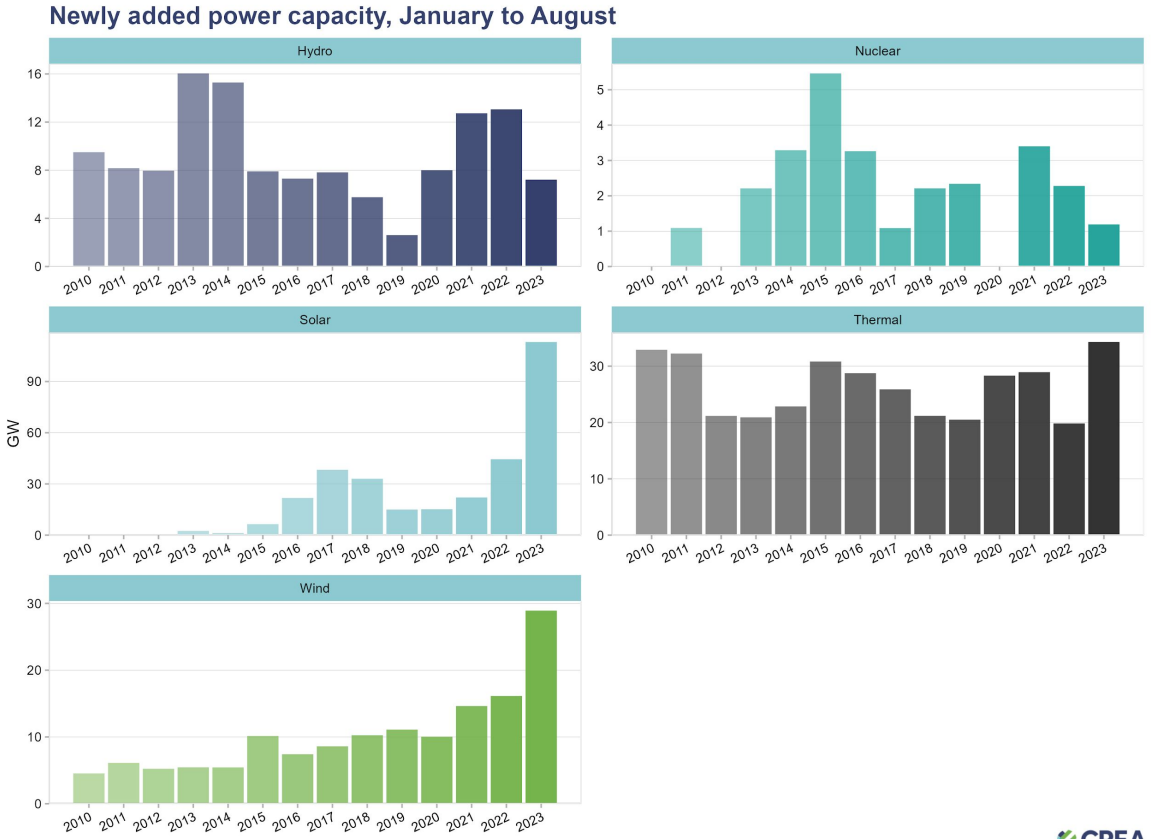
Steel products output begins to decline

- Pig iron and crude steel output have continued to slide further in early October.
- Production of steel products used in construction (rebar, wire rod) continues to plumb new lows.
- Steel products output began to fall year-on-year in October.
- The operating rate of blast furnaces in Tangshan, China's "steel capital" and an important source of air pollution in Beijing, reached the highest rate for September–October since at least 2015.
    - Hebei industrial output is a bellwether of national priorities: when air quality and emissions are the priority, it is the most tightly regulated area due to its impact on Beijing's pollution levels.



Record solar&wind — and coal — additions

- Strong wind and solar installations continue, with a whopping 113 GW of solar and 29 GW of wind installed in January–August.
- Commissioning of thermal (coal and gas) power plants made a new record for the first eight months of the year, since at least 2009. This is due to coal power projects being started or restarted in 2020 entering operation, showing the urgent pace of construction.
- Recent discussions on the coal-fired capacity-based electricity pricing mechanism have intensified. Multiple media in China suggested that energy regulators have issued a draft for public input, and it's set to be implemented next year.



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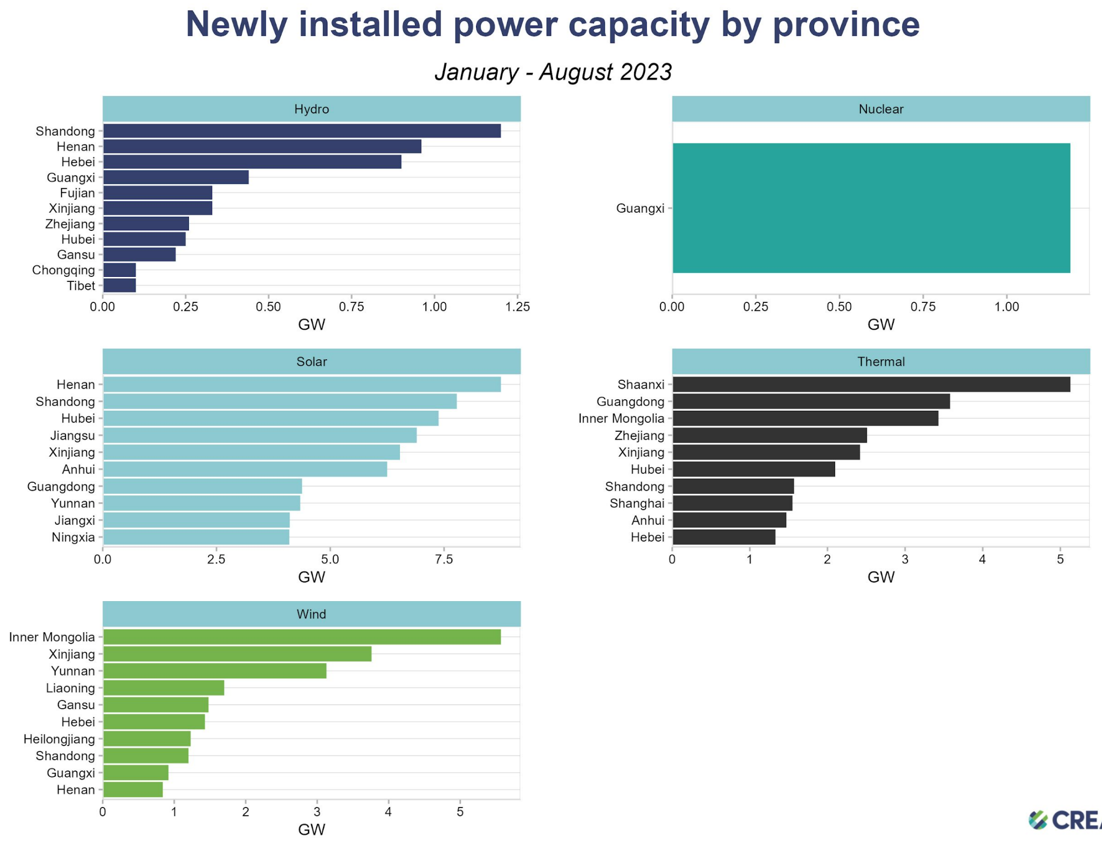
Distributed solar and centralized wind boom

- Solar power installations are led by Henan, Shandong and Hubei, which have ambitious rooftop solar policies (known as "whole-county distributed solar"), striving to meet rooftop solar installation targets by the end of 2023.

- Inner Mongolia leads in wind development, aiming for full operation of its large-scale clean energy bases by year-end.

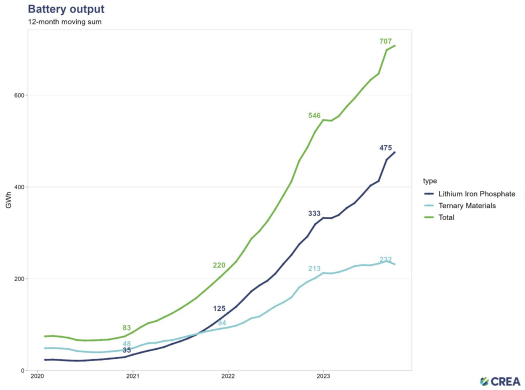
- Thermal (coal) power additions accelerated in Shaanxi, Inner Mongolia and Xinjiang, which are aiming to export power to eastern demand centres. However, Guangdong, Zhejiang and other eastern provinces have started a large wave of new coal power projects, leading to redundancy once plants are completed in a few years.

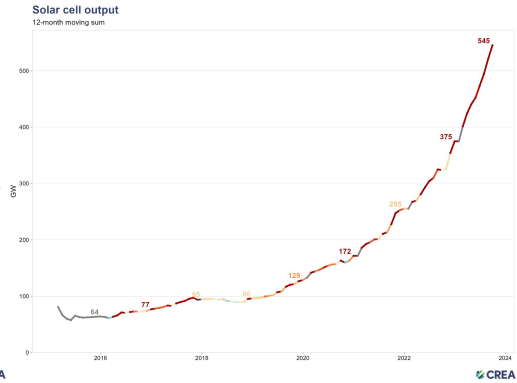
Read more: China's new coal power spree continues as more provinces jump on the bandwagon



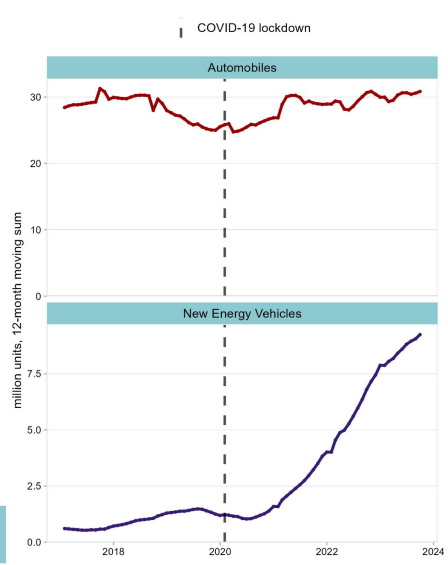
Record solar cell and electric vehicle output

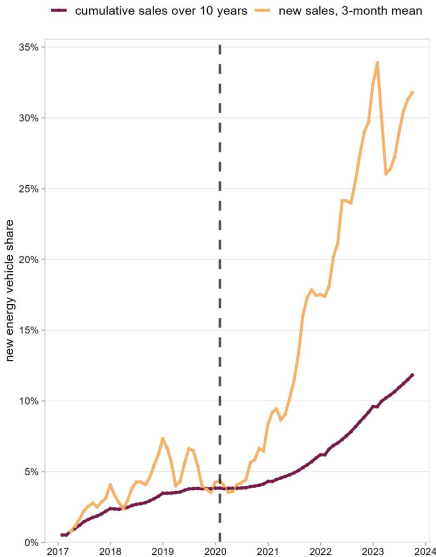
- Solar cell production in the past 12 months reached 545 gigawatts, doubling in the past two years and predicting rapid growth in global solar power installations. One more doubling will take solar cell output to the level needed to cut global emissions in line with Paris agreement.
- EV production continues to grow rapidly, with over 8 million vehicles produced in the past 12 months, representing more than 30% of all vehicles produced
- The strong growth in EVs is making a dent in gasoline demand for the first time. The share of EVs of all vehicles on the road increased from 5.3% a year ago to 8.3% now, shaving approximately 3%-points off gasoline demand growth.





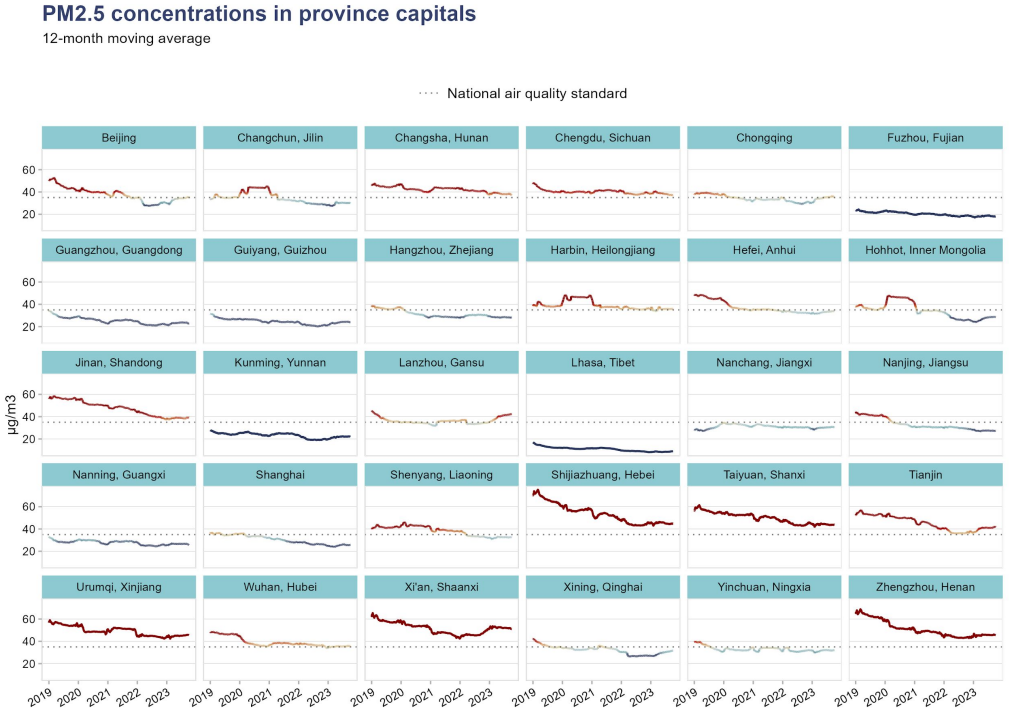
Vehicle production





Northern provincial capitals risk missing national PM2.5 standard after pollution bounceback

- PM2.5 level is bouncing back in 2023 in most of Chinese provincial capitals, and the reversing trend is especially explicit in northern provincial capitals: Beijing, Tianjin, Lanzhou and Zhengzhou.
- Provincial capitals located within Fenwei Plain and Beijing-Tianjin-Hebei areas had the highest PM2.5 levels since 2021, showing little sign of improvement in the past two years.
- At the end of this September, 13 out of the 30 provincial capitals exceeded the national PM2.5 air quality standard of 35 μg/m3 for their 12-month moving average of PM2.5. Xi'an, Zhengzhou and Shijiazhuang had the worst average PM2.5 levels at 53.3, 47.2 and 45.5 μg/m3, respectively.
- Central China provincial capitals, Changsha, Wuhan, and Chengdu also risk not meeting national standard this year, as well as Urumqi and Lanzhou in northwestern China.



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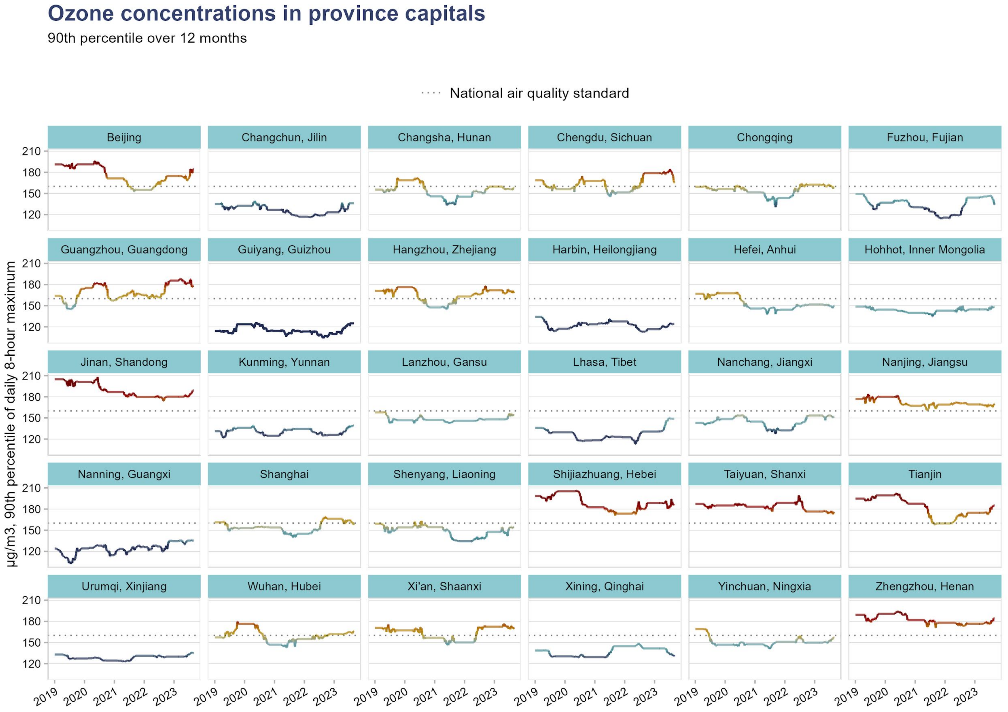
High ozone pollution occupies Jing-Jin-Ji area, rebounding this summer

- Ozone in megacities Beijing, Guangdong and Chengdu has elevated drastically since the start of 2022, and reaching the worst levels since 2019 in many cities. Beijing's worst ozone period this year was in late August and early September.
- Ozone level of Shijiazhuang, the provincial capital of Hebei, dipped in this June to 176 ug/m3 due to short-term measures like limiting steel production. However, its ozone level has gone back to high level quickly since July, showing long-term measures and fundamental structural change are required to alter the pollution trend.
- Other northern cities including Jinan, Tianjin and Zhengzhou, are have seen an increase in ozone levels in the past two years with little sign of stopping.



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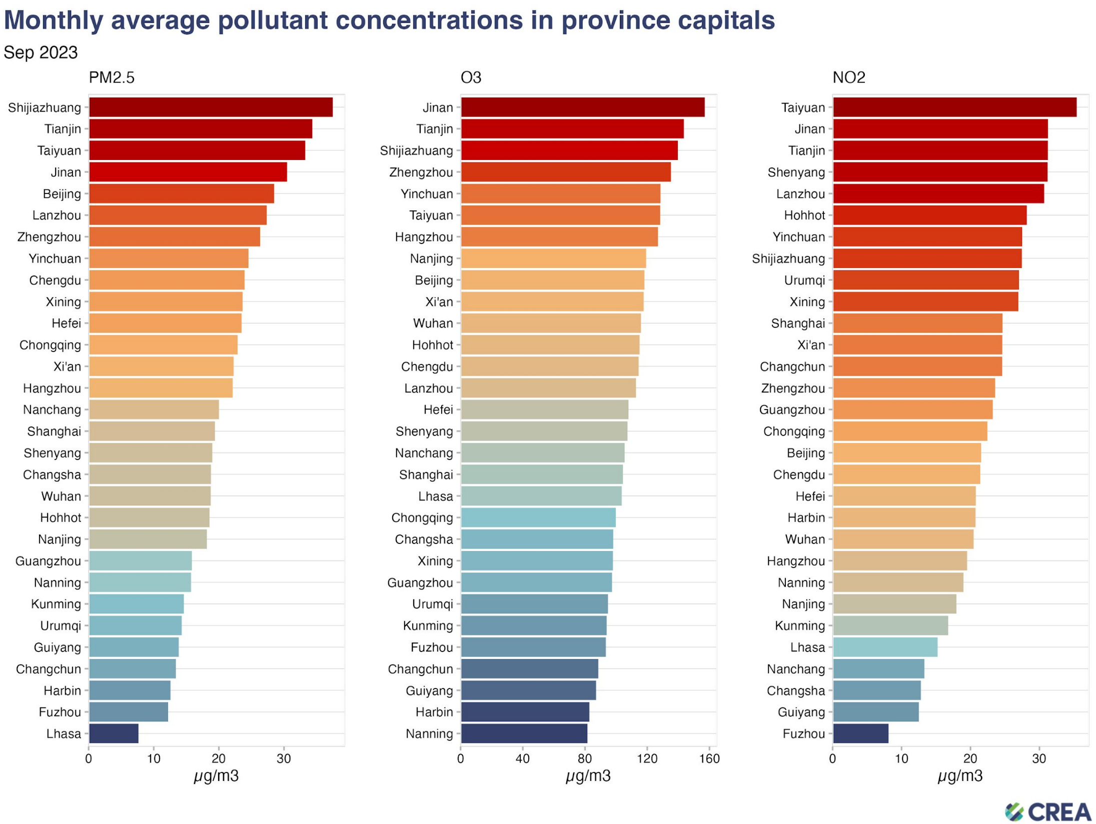
North and Northwest China face worst air pollution in September

- North and Northwest China had the worst PM2.5 levels in September. Shijiazhuang, capital of Hebei province, and Tianjin, both neighboring Beijing, rose to the top. Followed by Taiyuan, Jinan and Beijing.
- The worst ozone levels were measured in the capitals of Shandong, Tianjin, Shijiazhuang, Henan and Ningxia, focusing in north and northwest China.
- Taiyuan, capital of Shanxi, ranked worst for NO2 levels, and is followed by Jinan. NO2 contributes to PM2.5 and ozone levels, besides being a dangerous pollutant in its own right.



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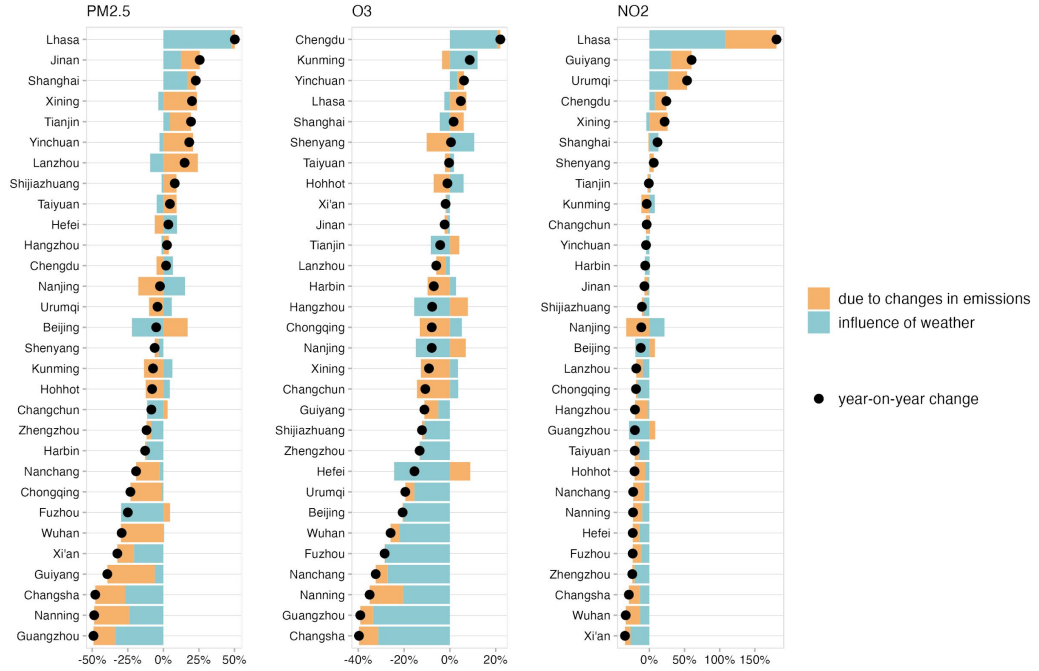
North and Northwest China suffers from PM2.5 while Southwest China sees rebound in O3 and NO2

- Emissions of PM2.5-forming pollutants increased across northwestern China mainly due to increases in emissions. The year-on-year increase in PM2.5 attributed to emissions increases was the most significant in Xining (Qinghai), Lanzhou (Gansu), Yinchuan (Ningxia), as well as in Tianjin.
- Shanghai saw an increase in ozone levels year-on-year in September, despite weather conditions that were more favorable than last year. Other provincial capitals within the Yangtze River Delta region, Hangzhou, Nanjing and Hefei, saw reductions in ozone levels due to favorable weather conditions, even as our analysis indicates an increase in ozone-forming emissions.
- Ozone levels fell in many northern and central China provincial capitals, compared with September last year, due to the influence of weather.
- Southwest cities including Chengdu and Kunming experienced increased ozone levels mainly due to the influence of weather.
- NO2 increase was highest in Lhasa, Guiyang and Urumqi.

Our analysis projects the influence of weather conditions on air pollution levels using a machine-learning model trained on actual data for each city. The variation that cannot be explained by weather conditions is attributed to changes in emissions.

Year-on-year changes in pollutant concentrations in province capitals

Sep 2023



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Worst 7-day air pollution episodes by pollutant

PM2.5 (excluding sandstorms)

city	province	dates	average concentration	highest daily concentration
Hotan	Xinjiang	Sep 29 – Oct 05	83	98
Kashi	Xinjiang	Sep 14 – Sep 20	77	139
Tianjin	Tianjin	Sep 03 – Sep 09	57	75
Langfang	Hebei	Sep 02 – Sep 08	57	72
Tangshan	Hebei	Sep 03 – Sep 09	54	71

Ozone

city	province	dates	average concentration	highest daily concentration
Jinan	Shandong	Sep 03 – Sep 09	209	223
Zibo	Shandong	Sep 03 – Sep 09	208	232
Liaocheng	Shandong	Sep 03 – Sep 09	197	221
Tai'an	Shandong	Sep 03 – Sep 09	197	207
Xingtai	Hebei	Sep 02 – Sep 08	194	216

Sandstorms ($PM_{2.5}$)

city	province	dates	average concentration	highest daily concentration
Hotan	Xinjiang	Sep 01 – Sep 07	81	109
Kezilesu State	Xinjiang	Sep 14 – Sep 20	61	142
Aksu	Xinjiang	Sep 12 – Sep 18	41	111
Jiuquan	Gansu	Aug 26 – Sep 01	37	70
Zhangye	Gansu	Aug 31 – Sep 06	25	94

NO_2

city	province	dates	average concentration	highest daily concentration
Taiyuan	Shanxi	Sep 27 – Oct 03	45	52
Qinhuangdao	Hebei	Sep 24 – Sep 30	43	50
Yangquan	Shanxi	Sep 28 – Oct 04	43	51
Tianjin	Tianjin	Sep 23 – Sep 29	42	48
Huludao	Liaoning	Sep 22 – Sep 28	41	68

Unit: μg/m³

Data sources

- Industrial output, power generation and power capacity additions, as well as fuel imports and exports are based on Chinese government data, through Wind Financial Terminal. Some of the data is not included in public releases.
- Measured air quality data is compiled from Chinese government air quality monitoring stations. Weather-controlled air quality is derived from CREA's deweathering algorithm.