

Briefing, February 2022

Most coal power plants since 2016 entered construction in China in 2021, investment in coal-based steelmaking accelerated

A mapping of new coal power and steelmaking projects by CREA and GEM shows that Chinese power and steel companies continue to invest in coal-based production capacity at alarming rates, with new projects in China exceeding the rest of the world several-fold. The coal power and steel sectors are China's two largest emitters of CO₂, and there is no sign of investment in coal-based capacity being scaled back yet, despite the country's carbon neutrality targets. A complete shift of new investments into clean capacity is needed to put China on track to peak CO₂ emissions and avoid a glut of unneeded power and industrial capacity.

The new coal power and steel projects started in 2021, once completed and operated, will emit as much CO₂ annually as Florida, the third-highest emitter among U.S. states.

Key findings

- Construction was started on 33 GW of new coal power plants in 2021, the most since 2016 and almost three times as much as the rest of the world put together.
- 25 GW of new coal power plants were added to the grid, a drop from 2020 but still significantly more than the rest of the world put together. After accounting for plant retirements, which slowed down as well, China's coal power capacity continued to increase while that in the rest of the world continued to fall.
- Permitting new coal power projects was essentially frozen in 2021, as the leadership emphasized strictly controlling "high emissions" projects. However, reflecting shifting political signals, permitting has been restarted in 2022 with a bang, with 5 coal power projects totaling 7.3 GW of capacity cleared for construction in just the first six weeks of the year.
- China is rapidly replacing aged coal-based steel plants with new capacity. 74 million tonnes of new coal-based steelmaking capacity was approved in just one year,

rebounding from a hiatus in 2020, and 15 times the annual average capacity additions in the rest of the world in 2016–2020. The capacity approved in 2021 also exceeds all of the coal-based steel capacity under development in the rest of the world.

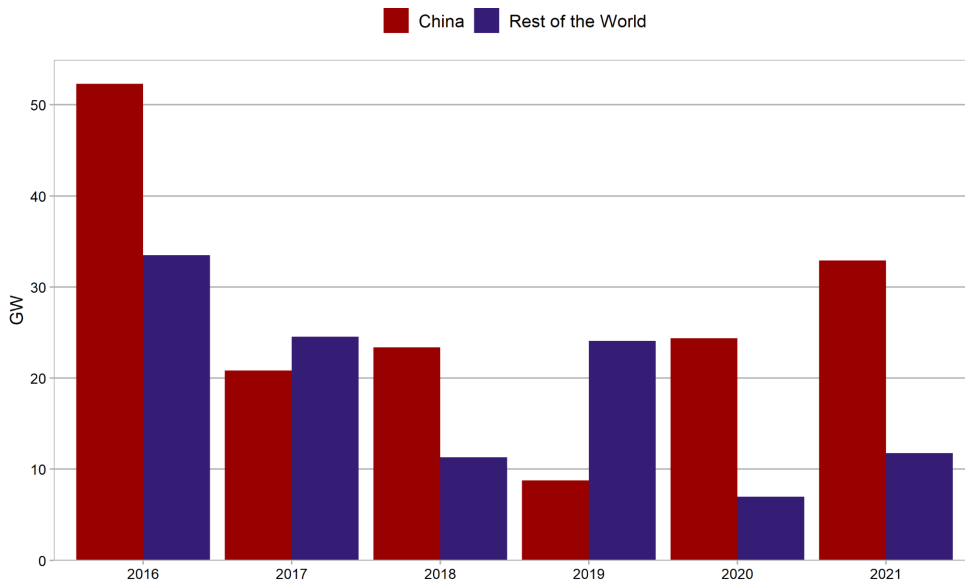
- New coal-based power plants and integrated steel plants have a typical lifetime of 20–40 years and will lock the sectors further into coal dependency. There is no space for this new capacity to be utilized under the goals of the Paris Agreement. The new coal-based steel projects initiated in 2021 alone will entail approximately 70–110 billion USD in stranded assets when the carbon emission reduction targets are realized, and the coal power plants imply a further stranded investment of 20 billion USD.

Policy recommendations

- Direct all new power generation investments into clean energy, and increase scale of these investments to match the projected growth in electricity demand, in order to peak power sector CO₂ emissions as a matter of urgency. Given that China’s power sector has been the main source of increases in global fossil emissions in the past two years, this would be a crucial contribution to meeting the goals of the Paris agreement. Such an increase is also eminently achievable given the scale that China has already achieved in clean energy, requiring less than a doubling of annual capacity installations.
- Align plans for investment in new iron & steel capacity with the aim for heavy industry sectors to peak their emissions early, increasing the share of non-coal-based steelmaking (direct reduced iron, hydrogen-based technology and electric arc furnaces), and retiring or relining older plants rather than replacing them with new coal-based capacity.

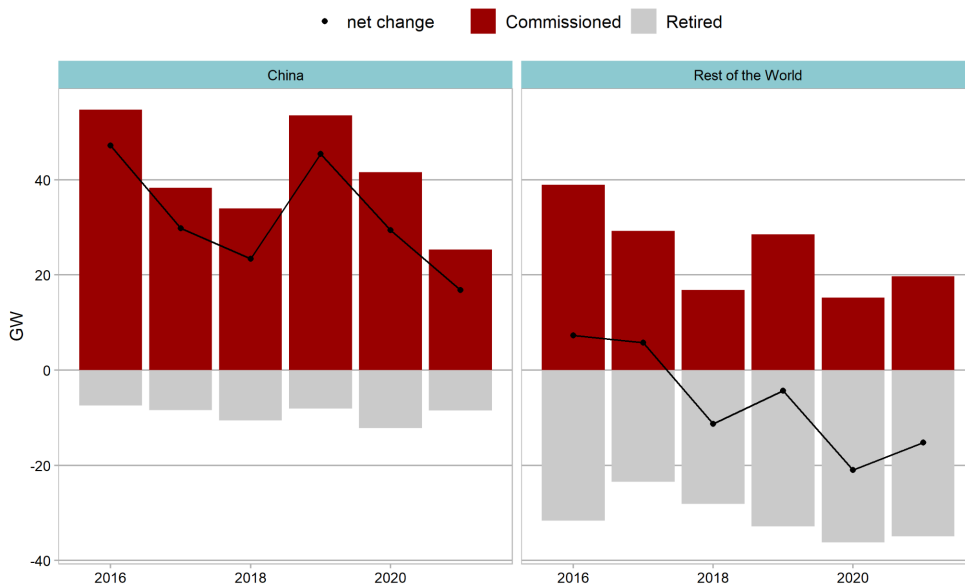
Coal power construction starts in China and the rest of the world

Changes in project status, yearly



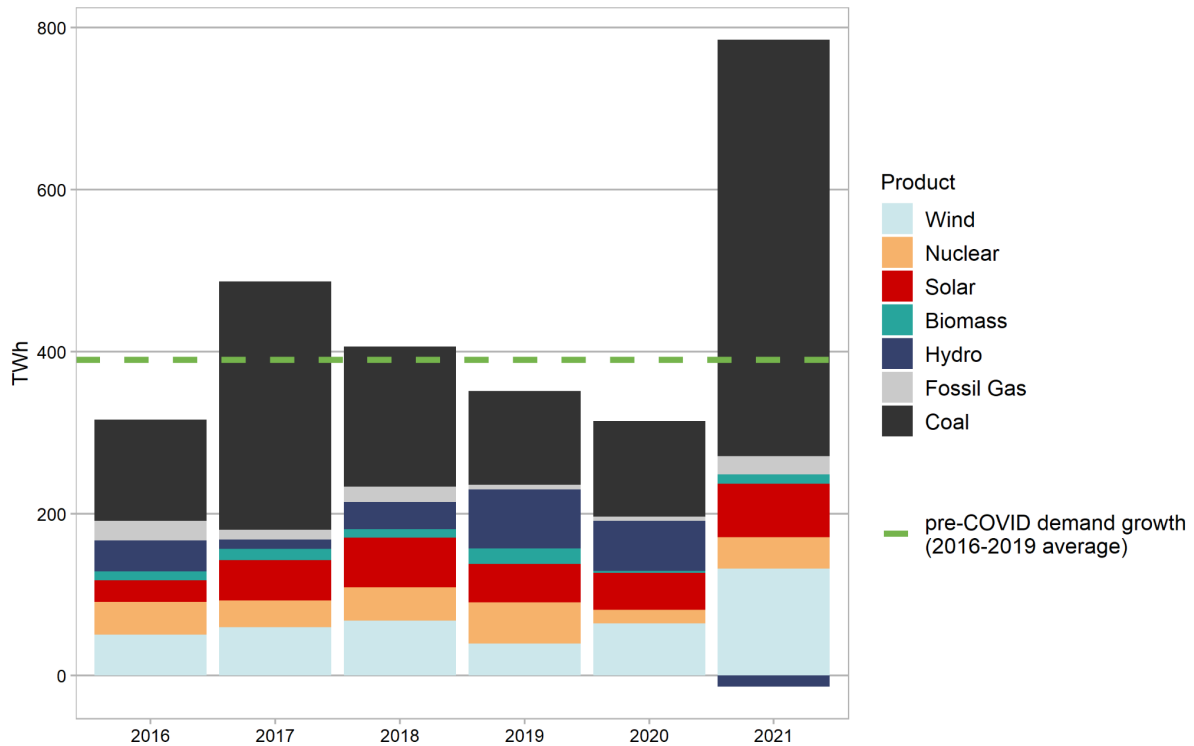
Changes in operating coal power capacity

in China and the rest of the world, yearly



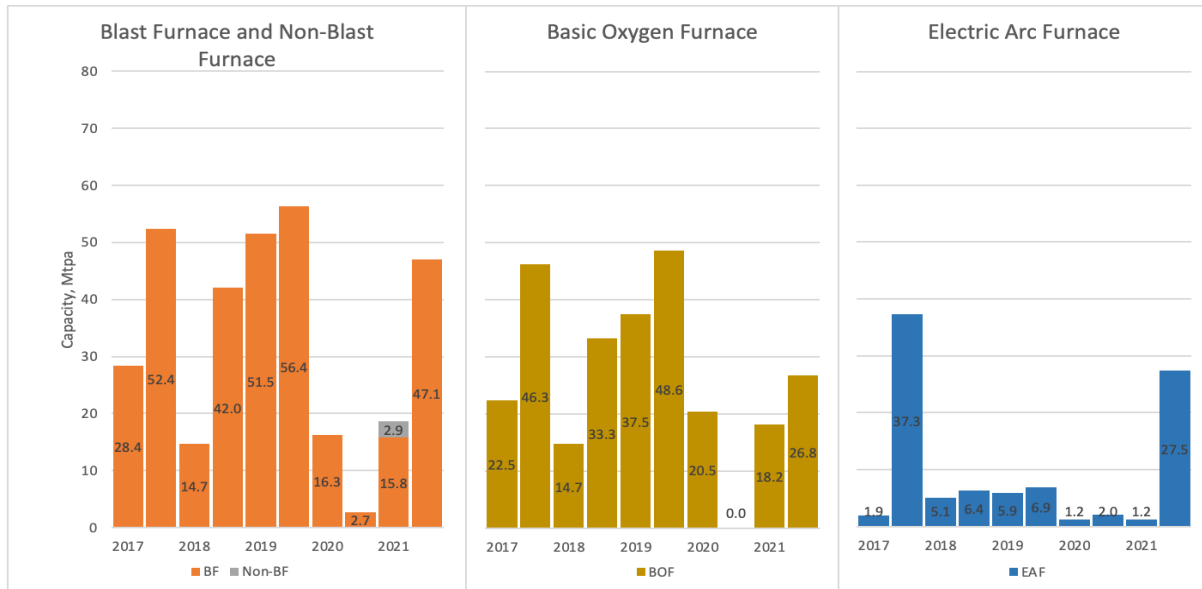
Annual changes in power generation in China

change compared with the preceding year



Coal-fired power generation increased in China in 2021 for the sixth year in a row. Growth in clean energy needs a substantial further acceleration to cover the average rate of growth in electricity demand. In 2021, electricity demand growth was twice as fast as the pre-COVID-19 average, leading to a dramatic one-off surge in coal-fired power generation. Source: IEA Monthly Electricity Statistics.

New iron & steelmaking capacity additions in 2017-2021 under capacity swap announcements (half-yearly)



Source: CREA, provincial government websites. Note: Data includes announcements made during 2017-2021. BF=blast furnace, Non-BF=non-blast furnace (here includes hydrogen-based direct reduction plant and HIs melt plant), BOF=basic oxygen furnace, EAF=electric arc furnace.

Power sector: coal power construction starts highest since 2016

Reflecting a resurgence of new coal power permits in 2020, construction starts continued to accelerate in 2021 for the second year in a row, hitting the highest level since 2016, and totaling three times the amount in the rest of the world put together. The key drivers of continued coal power expansion in China include:

- insufficient investment in clean energy, meaning that a significant share of the growth in electricity demand continues to be met by increasing coal-fired generation
- outdated grid planning and operation, with every province planning its capacity as an isolated island, leading to a high degree of redundancy and low capacity utilization
- conflict between central government policy of increasing electricity transmission from west to east and the preference of the governments in the eastern, coastal provinces to generate locally
- possible “dash for coal”, a race to install assets and secure market share before coal-fired capacity and generation are required to peak

In the second half of 2021, China experienced a coal and coal power shortage, leading to electricity rationing in more than half of the country’s provinces, at its peak in September. The crisis was [caused](#) by government efforts to lower electricity costs as part of a COVID-19 recovery policy focused on supporting industrial output, along with anti-corruption and safety campaigns affecting coal mine output. The government’s immediate response was to shore up the profitability of coal-fired power generation by increasing the tariffs paid to generators. The crisis was also successfully utilized by pro-coal interests to rewrite the country’s energy policy, paradoxically resulting in policy shifts that perpetuate the country’s dependence on coal.

Resumption of coal plant permitting

The political shift is apparent in the permits granted to coal power plants. Permitting was nigh on halted in 2021, with the country's leadership emphasizing "strictly controlling high-emissions projects". Towards the end of the year, the electricity crisis in September brought about a marked shift in political messaging. The leadership emphasized "coal as the basis of China's energy system" and the gradual nature of the energy transition. At the same time, the Central Economic Work Conference called for accelerated spending on construction projects to return GDP growth to an acceptable range. Despite the fact that the electricity crisis had nothing to do with lack of coal power plant capacity, this shift in political winds seems to have resulted in the resumption of coal plant permits in early 2022, with at least 7.3 GW of new capacity permitted just in the first six weeks of the year, more than twice as much as in all of 2021.

Most recently, the National Development and Reform Commission's (NDRC) [policy](#) to promote stable growth of industrial output called on provinces with power exporting plants and inter-province transmission lines to accelerate the approval and construction of new coal-fired power plants, and all provinces to accelerate the retrofitting of existing ones, to boost demand for (power plant) equipment manufacturing industry.

The five-year plan for the power sector reportedly targets a 150 GW increase in coal power capacity from the 2021 level by 2025, effectively giving provinces and power firms free hands to permit and initiate more projects. The increase in coal power tariffs and the time window for building more capacity before coal power generation and capacity are expected to peak in the next five year period could create a "dash for coal" as state power companies and provinces rush to grab market share.

Clean energy scale-up

Despite the growth in coal-based power and steel projects, there has been promising progress on accelerating investments in clean energy:

- The government implemented measures in response to the coal crisis that benefit renewables, such as giving industrial power users the ability to avoid power rationing by purchasing green electricity and excluding green electricity consumption from energy consumption control targets for provinces.
- [Targets](#) for wind and solar additions in 2021-25 published by 11 state-owned power firms add up to over 600GW, an average of more than 125GW added in each of the

next four years, after 100GW was added in 2021. This figure doesn't include distributed solar.

- The National Development and Reform Commission (NDRC) has recently [announced](#) the first batch of projects and plans for China's "[clean energy bases](#)" in the west around the Gobi desert, with a capacity of 100GW, and is [reportedly](#) finalizing the second batch, with 400GW of capacity to be installed by 2030. The bases will be a vast regional network of wind and solar power installations designed to transmit power to the demand centers in the east.

However, even the impressive renewable energy and nuclear targets aren't enough to meet China's additional electricity demand, if demand growth continues at past rates. At average utilization rates, the increases in wind, solar, nuclear and hydropower capacity from 2020 to 2025 will add approximately 1200 TWh of annual power generation, more than the total power generation of Japan or around 20% of China's total consumption in 2020. This would be enough to cover annual demand growth of approximately 3.5%. However, China Electricity Council still projects demand growth of 6%. Therefore, either clean energy growth needs to accelerate further or electricity demand growth needs to slow down in order to peak coal consumption in the power sector.

Over the previous five-year period, demand growth averaged 6% per year. Slower economic growth and the targeted structural shift to "high quality growth" less reliant on real estate and low-value infrastructure projects will slow electricity demand growth, while the replacement of direct use of fossil fuels with electricity will boost it.

If electricity demand growth returns to the pre-COVID-19 trend, approximately 175 GW per year of added wind and solar will be needed for power sector emissions to structurally peak, taking into account targeted nuclear and hydropower additions. This would be a 75% increase over the rate of wind and solar installations achieved in 2020 and 2021.

Provinces with the most new coal capacity in 2021

The most new coal power projects were started in Guizhou, where four large projects suspended in 2016–17 were reactivated and five entirely new projects were announced. The province is a significant power exporter and has been scaling up the ferrous and non-ferrous metals industries that are the largest energy consumers in Guizhou. The local government likes to point to its data center industry as a source of electricity demand growth, but in the first 11 months of 2021, this industry was responsible for only [1.5%](#) of total electricity demand. Guizhou's coal expansion aims to increase power exports to

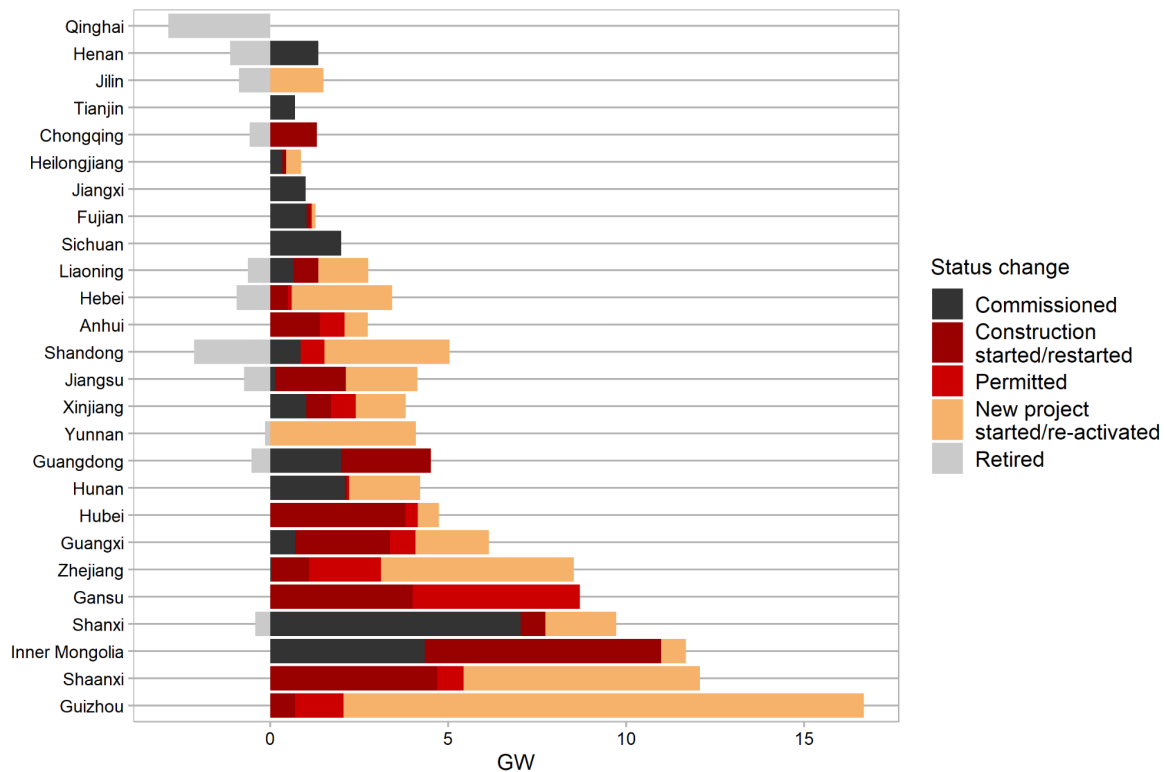
Guangdong through long-distance transmission lines, undermining the aim of cleaning up the power mix in inter-province transmission.

Inner Mongolia, Shanxi, Shaanxi and Gansu are major power exporters, with Inner Mongolia and Gansu also major players in wind and solar development. However, the new coal projects in these provinces show that China’s plans for west-to-east power transmission continue to rely heavily on expanding coal-fired power, despite State Grid’s stated aim to use the project for clean electricity transmission and increase the share of non-fossil sources.

Hunan announced 8 thermal power generation projects in its 14th energy Five Year Plan, after the electricity shortage in winter 2020–21, when many coal power plants [failed to operate](#) in sub-zero conditions and hydropower output was weak due to low rains. The shortages occurred despite the Central Grid Region, to which Hunan belongs, having far more power capacity than it needs. This development showcases the grid management

Coal power pipeline in China

Changes in project status, 2021



still often lacking in China, with each province planning and operating its power generation as an island.

Zhejiang, Jiangsu, Guangdong and Shandong are among China's most economically developed provinces, with the highest economic output and electricity demand. They are also expected to increase imports of electricity from the western provinces, as a part of the central government's plans, but there is a lot of local resistance to this. A brazen example is the local government's [statement](#) on one of the new coal power projects approved in early 2022, explicitly stating that the project aims to reduce cross-province electricity trading, in direct contradiction of central government priorities.

Iron and steel: 85% of world's new coal-based steel projects are in China

With one sixth of the world's population and economic output, China produces half of the world's steel. Due to the heavy reliance on the coal-based blast furnace - basic oxygen furnace (BF-BOF) route, the most polluting steelmaking pathway, steel production accounts for about [20%](#) of the country's total annual carbon emissions, making it [the largest industrial emitter](#). When emissions from electricity used by the sector are included, the share goes up to 24%. Thus, it is a key target in the government's efforts to curb carbon emissions and improve air quality.

However, China's steel industry continues to invest heavily in new coal-based capacity, where the country is responsible for 85% of new projects globally. More than 70% of new capacity announced in the past five years was coal-based. This trend shows that China's steel industry still has a long way to go to align new investments with the need to decarbonize, despite some promising signs toward increased clean steel projects in 2021.

New investments take place under the policy of capacity replacement. The policy requires that a larger amount of existing capacity is retired for all new capacity added, a process known as "capacity swaps". The ratio between retiring capacity and new capacity is called the "swap ratio", which depends on the facilities' location and type.

In theory, the policy, in place since 2014, should have ensured that total steelmaking capacity falls year by year. However, China's reported steel output in 2020 far exceeded the amount of capacity that was supposed to exist, showing that the enforcement of the policy

had failed. A new policy was instituted in 2021 with stricter swap ratios, and with the ministry denouncing earlier “number games” with capacity, heralding tougher enforcement.

- During 2017-2021, capacity swap announcements show a total of 330.1 million tonnes per annum (Mtpa) of new ironmaking capacity and 347.6 Mtpa of new steelmaking capacity is going to be added. This far exceeds the 25 Mtpa of coal-based steelmaking capacity [added](#) in all of the rest of the world since 2016, as well as the 57 Mtpa of under-construction and planned capacity in the rest of the world. As a part of the swap arrangement, 397.5 Mtpa of ironmaking capacity and 453.5 Mtpa of steelmaking capacity will be retired.
- In 2021 alone, 56 iron & steel projects, or 65.8 Mtpa ironmaking and 73.6Mtpa steelmaking capacity, were approved by the provincial governments under the latest production capacity swap scheme starting from June 2021. These new swaps will reduce ironmaking capacity by 13.2 Mtpa and steelmaking capacity by 13.7 Mtpa.
- New iron and steel capacity continued to be dominated by coal-based blast furnace (BF) ironmaking capacity throughout the past five years, with total capacity reaching 327.3 Mtpa. In 2021, 62.9 Mtpa of new BF capacity was announced, which is 4.8% lower than the average of 2017-2020, or 23% lower than the average of 2017-2019 if we exclude 2020 when approvals were mostly halted.

However, 2021 saw some promising progress on shifting investments away from the coal-based pathway:

- Electric arc furnace (EAF) capacity addition announcements were significantly increased in 2021. A total of 28.7 Mtpa of EAF steelmaking capacity was announced in 2021, on top of 45.0 Mt basic oxygen furnace (BOF) capacity. The share of EAF in the newly announced steelmaking capacity increased from a low of 12.9% in 2019 to a record high of 38.9% in 2021.
- The first non-coal-based primary ironmaking projects were announced, with a total capacity of 2.9 Mtpa (hydrogen-based direct reduction plant and Hismelt plant).

Capacity swap announcements 2017-2021

Year		2017	2018	2019	2020	2021	Total
Ironmaking	Exit	108.3	70.4	121.6	18.2	79.0	397.5
	Addition	80.8	56.7	107.9	19.0	65.8	330.1
	Net change	-27.5	-13.7	-13.7	0.7	-13.2	-67.4
Steelmaking	Exit	142.9	73.8	121.0	28.6	87.3	453.5
	Addition	107.8	59.5	83.0	23.7	73.6	347.6
	Net change	-35.0	-14.3	-38.0	-4.9	-13.7	-105.9
	EAF % in the Addition	36.3%	19.3%	12.9%	13.5%	38.9%	26.2%

Source: CREA, provincial government websites. Note: Data includes announcements made during 2017-2021. As a certain number of exit capacities of one furnace were divided for several capacity swap projects, and may be announced in different years, we count the divided capacity into the major part of the exit capacity as a whole. EAF=electric arc furnace.

Capacity swap scheme revised

The capacity swap scheme is the most important policy intervention in the China steel industry. It was first introduced by the [Ministry of Industry and Information Technology \(MIIT\) in 2014](#) to alleviate the overcapacity of steel, aluminum, cement and glass in China.

MIIT published its “[steel industry adjustment and upgrading plan](#)” for 2016-2020 back in 2017. It set a target of cutting steelmaking capacity from 1,130Mt in 2015 to less than 1,000Mt in 2020. However, China produced a record-breaking 1,065 Mt of crude steel in 2020. The [estimated gap between the capacity control targets and steel capacity presumed to be operating has widened to well over 200Mt](#). The discrepancy may be caused by unreported capacity expansions, higher production efficiency and revival of low-quality steel production.

The government has found instances where some steel mills have expanded production capacity under the guise of capacity swaps. This development led to the [government halting approving new capacity and capacity swaps for iron & steel projects from 24 January 2020](#) until the [latest version of the scheme released by MIIT](#) on 17 April 2021 and

became effective from 1 June 2021. The new version shows the joint efforts to control steelmaking capacity, air pollution and carbon emissions.

The [2021 version of the capacity swap scheme](#) revised measures for certain regions, raising swap ratios to 1.5:1 from a previous 1.25:1. This measure will be applicable in air pollution control key regions, including Beijing-Tianjin-Hebei and surrounding areas (2+26 cities), the Yangtze River Delta, the Pearl River Delta, and Fenwei Plain.

The replacement ratio in other regions has been set at 1.25:1, compared with previous measures where capacity swaps were only required to lead to a reduction in capacity, but with no exact ratios.

The new version was also carefully designed to encourage EAF capacity and non-BF capacity expansions. If new iron ore and steelmaking facilities are environmentally friendly, such as electric arc furnaces, Corex, Finex, HIs melt or hydrogen-based ironmaking plants, capacity can be swapped equally.

Easing emission peak timeline

On 7 February 2022, [three ministries' guiding opinions for the steel 5-year plan](#) were issued, serving as the guideline for the development of the steel industry 14th Five-Year-Plan (2021-2025). Compared with the [December 2020 consultancy version](#), the final guideline makes the timetable to achieve peak carbon emissions from “by 2025” to “before 2030”. However, the policy of aiming for “early peaking” in the main energy consuming industries remains, and it is clear that steel sector emissions need to peak well before 2030 to achieve the economy-wide emissions peaking target.

Decarbonization of the sector is only possible through a major shift towards steelmaking from scrap and/or DRI iron making, as the scope for a further decrease in emissions per tonne in coal-based iron making is technologically limited. This means in effect that blast furnace output has to fall in line with the reduction in CO₂ emissions.

The emissions targets for the steel sector don't include emissions associated with electricity production to power the mills. Decarbonizing the steel sector adds to the

demand for increasing zero-carbon energy capacity to power EAF and DRI steelmaking and for green hydrogen production.

BF-BOF capacity face the risk of stranded assets

Under China's iron and steel capacity control rules, new projects "replace" retiring capacity so total capacity doesn't increase, but old capacity ripe to retire gets replaced by brand new capacity.

As peaking CO₂ emissions and getting on track to carbon neutrality means that demand for pig iron produced in blast furnaces is bound to fall steeply, replacing blast furnaces with new ones risks creating an overcapacity situation, with blast furnaces at risk of becoming stranded assets when steel prices fall and the operators of brand new facilities face financial distress. This would then put pressure on the government to slow down the transition, or even institute a new round of domestic stimulus to support heavy industry.

The ministries' guideline also aims to increase scrap use to 300 Mt by 2025, which would ensure emissions peak if output doesn't grow. This would also replace 10% of the pig iron produced in blast furnaces already by 2025, and much more by 2030. By replacing 40% of the oldest existing BF-BOF capacity with brand new capacity, the capacity swap scheme risks creating stranded assets.

According to [a report](#) by Global Energy Monitor in June 2021, about 77% (790 Mtpa) of China's operating steel capacity is BF-BOF steelmaking. Over 80% of BF-BOF steelmaking capacity in China was built after the year 2000, giving BF in the country an average age of just 12 years, compared to an average lifetime of 40 years and investment cycle of 15–20 years. A recent [report](#) by Valentin Vogl discovered that the typical length of each reinvestment cycle for blast furnaces grows shorter as the unit ages, starting with about 19 years for the first reinvestment, 16 years for the second, and only 10.5 years for the third one. Thus, investments in brand new BF-BOF capacity carries even more risk in terms of committed emissions and stranded asset potential than re-investments in existing BF-BOF capacity, as continued reinvestment can keep the unit operating for decades.

Moreover, our analysis indicates the dominance of BF-BOF capacity in the swap announcements during 2017-2021, comprising about 73.8% of the swaps (BOF capacity 268.2 Mtpa vs EAF capacity 95.2). If these facilities are built, it will lock the sector further

into coal dependency and means about 268.2 to 402.4 billion USD¹ of estimated stranded assets when the carbon emission reduction targets are realized.

EAF capacity expansions

The above guideline also aims to increase EAF steel production to more than 15% of China's total crude steel output by 2025. EAF capacity is also encouraged by the MIIT's latest capacity swap scheme.

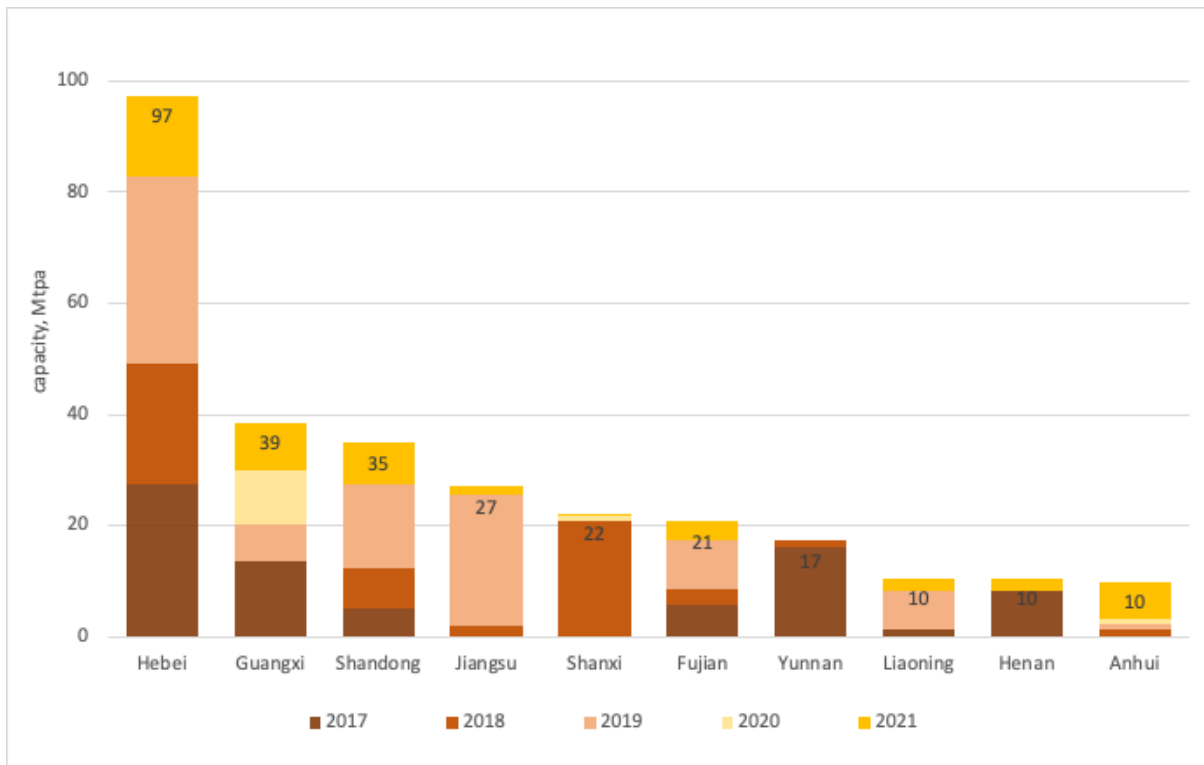
In 2021, China approved 39 new EAFs with a total capacity of 28.7 Mtpa through capacity swaps, which is more than the sum of 2018-2020, according to CREA calculations based on announcements by local governments. These new EAFs approved from 2021 would be commissioned mainly from late-2022 to 2025. The development of EAF is forecast to play a big role in reducing China's steel industry carbon emissions. However, the large volume and dominance of BF-BOF swap capacity approved by provincial governments poses difficulties to increase EAF steel production to more than 15%, according to China's [Ministry of Ecology and Environment \(MEE\)'s statement](#).

Top 10 provinces with BF capacity addition plans

Hebei province is the heartland of China's steel industry, producing about one quarter of the country's steel. The province also has been suffering from air pollution caused by steel, coal power and other heavy industries for years. Its new BF capacity approvals under the swap scheme, with a total capacity of 97 Mtpa, also ranked the first among the top provinces during 2017-2021. There has been a policy of moving heavy industry away from the air pollution "key control regions" since 2013, but the policy has proven ineffective, with Hebei and other provinces that belong to the control region surrounding Beijing retaining their share of national output in key heavy industrial sectors.

¹ The capital cost of a new integrated BF-BOF steelmaking facility is approximately [1–1.5 billion USD/Mtpa](#).

Capacity swap announcements 2017-2021, blast furnace capacity addition plan by top 10 provinces



Source: CREA, provincial government websites. Note: Data includes announcements made during 2017-2021.

Eight of the nine top provinces with BF capacity plans – including Guangxi, Jiangsu, Shanxi, Fujian, Yunnan, Liaoning, Henan, and Anhui – have been warned [by China's National Development and Reform Commission in August 2021](#) for their failure to meet the "Dual control target of Energy Consumption". "Dual control" to reduce energy intensity and to limit total energy consumption is a key measure that the Chinese government implements to help meet its energy and climate goals. They have to halt or cancel high energy consumption projects under approval.

Methodology

The changes in coal power project status analyzed for this briefing are based on the latest January 2022 update of the Global Energy Monitor's Global Coal Plant Tracker (GCPT), with complementary data on retirements compiled from the provincial Development and Reform Commission and National Development and Reform Commission in China. GCPT is the most detailed dataset available on the global coal power fleet, and has provided biannual updates on coal-fired generating capacity since 2015. GCPT data is used by the International Energy Agency (IEA), the OECD Environment Directorate, UN Environment Programme, U.S. Treasury Department, and the World Bank. GCPT data is licensed by Bloomberg LP and UBS Evidence Lab, and is used by the Economist Intelligence Unit and Bloomberg New Energy Finance.

Information on new iron and steel projects was compiled from the websites of provincial Industrial and Information Technology Bureaus and Ecology and Environment Bureaus, which are responsible for implementing steel overcapacity and capacity replacement policies, and environmental permitting of new steel plants, respectively. New project announcements were mapped systematically, and total blast furnace, basic oxygen furnace and electric arc capacity, as well as capacity being replaced, was captured for each project.

About Global Energy Monitor

Global Energy Monitor (GEM) develops and shares information on energy projects in support of the worldwide movement for clean energy. Current projects include the Global Steel Plant Tracker, Global Coal Mine Tracker, Global Coal Plant Tracker, Global Fossil Infrastructure Tracker, Europe Gas Tracker, CoalWire newsletter, Global Gas Plant Tracker, Global Registry of Fossil Fuels, Latin America Energy Portal, and GEM.wiki.

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