

Tsunami Warning

CAN CHINA'S CENTRAL AUTHORITIES STOP A MASSIVE SURGE IN NEW COAL PLANTS CAUSED BY PROVINCIAL OVERPERMITTING?

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ABOUT COALSWARM

CoalSwarm is a global network of researchers developing collaborative informational resources on fossil fuels and alternatives.

Current projects include the Global Coal Plant Tracker, the Global Fossil Projects Tracker (coal, oil, and gas infrastructure), the CoalWire newsletter, and the CoalSwarm and FrackSwarm wiki portals.

ABOUT THE GLOBAL COAL PLANT TRACKER

The Global Coal Plant Tracker is an online database that identifies, maps, describes, and categorizes every known coal-fired generating unit and every new unit proposed since January 1, 2010 (30 MW and larger). Developed by CoalSwarm, the tracker uses footnoted wiki pages to document each plant and is updated biannually. For further details, see [Tracker Methodology](#) at EndCoal.org.

PRODUCTION

Design by Charlene Will. Additional design and page layout by David Van Ness.

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FURTHER RESOURCES

For additional data on proposed and existing coal plants, see [Summary Statistics](#) at EndCoal.org, which provides over 20 tables providing results from the Global Coal Plant Tracker (GPCT), broken down by province, nation, and region. For links to reports based on GPCT data, see [Reports](#) at EndCoal.org. To obtain primary data from the GPCT, contact Ted Nace (ted@tednace.com).

EXECUTIVE SUMMARY

Like an approaching tsunami triggered by a distant earthquake, a massive cohort of hundreds of new coal-fired power plants is on course to be added to the already overbuilt Chinese coal plant fleet. This wave of new capacity—comparable in size to the entire U.S. coal fleet—is the consequence of a little reported surge in permit approvals at the provincial level from late 2014 to early 2016.

While China's central authorities have sought to mitigate the surge through a series of special regulatory measures, new satellite imagery and plant-by-plant research show the measures to have been only partially effective. Rather than cancelling unneeded coal plants, China's officials in many cases have merely rescheduled them.

There is still time to stop the wave, but China's authorities must move quickly to cancel the unneeded projects. Otherwise the tsunami of coal power capacity will overwhelm China's own coal cap and seriously undermine global climate goals.

This report, based on a plant-by-plant survey by CoalSwarm's Global Coal Plant Tracker (GCPT) completed in July 2018, includes the following findings:

- 259 Gigawatts (GW) of new capacity are under development in China, comparable to the entire U.S. coal fleet (266 GW). If built, the new plants will increase China's current coal fleet of 993 GW by 25%.
- The new capacity is the result of a permitting surge from late 2014 to early 2016, after a regulatory devolution from central to provincial authorities.
- In 2016 and 2017, central authorities sought to rein in the surge through a series of suspension orders.
- Contrary to previous reporting and analysis, many of the restrictions only delayed new projects rather than stopping them.
- Adding 259 GW of new coal power in China is wildly out of line with the Paris climate agreement. According to the IEA, a 50% chance of limiting future temperature increases to 1.75°C requires that China phase out its traditional coal plants by 2045.
- The surge in new projects will overwhelm China's own 1100 GW coal cap in the country's current Five-Year Plan.
- Cancelling the 259 GW of new coal plants would free up US\$210 billion in capital expenditures, enough to build nearly 300 GW of solar PV or 175 GW of wind power.



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CAN CHINA'S CENTRAL AUTHORITIES STOP A MASSIVE SURGE
IN NEW COAL PLANTS CAUSED BY PROVINCIAL OVERPERMITTING?

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Since 2016, the central government of China has made repeated efforts to rein in the overbuilding of new coal-fired power plants through a series of suspension policies. But new evidence based on satellite photography and official documents shows hundreds of coal projects still in development, on course to overwhelm the country's own announced coal power cap and seriously undermine global climate goals.

According to a project-by-project survey completed in July 2018 by CoalSwarm's Global Coal Plant Tracker, 259 gigawatts (GW)¹ of coal-fired capacity are under development in China, comparable to the total installed coal power capacity of the United States (266 GW). Most of the capacity is the result of a massive surge in new project approvals by provincial authorities from late 2014 to early 2016. Mitigating that surge has been the principal goal of subsequent central government measures, but CoalSwarm's new survey shows those efforts have been significantly less effective than indicated by earlier media and analytical reports.

Coming on top of the 993 GW of coal power capacity already operating in China, the additional 259 GW put China on a trajectory to increase the size of its coal fleet by 25 percent and overshoot its own announced 1100 GW cap on coal-fired capacity during the current

Five-Year Plan (2016–2020). Recently, the central government has begun restricting which newly completed plants can connect to the grid each year, perhaps to avoid exceeding the 1100 GW capacity cap. While such a tactic may technically preserve the official cap, behind the scenes there will be a growing reservoir of coal plants ready to operate as soon as authorized.

For climate prospects, adding 259 GW of new coal power capacity to the Chinese coal fleet is wildly out of line with the goals of the international Paris agreement, no matter what their start date. According to the International Energy Agency (IEA 2017), a 50% chance of limiting average future temperature increases to 1.75°C requires that China, with half of the world's coal power capacity, close all coal plants without carbon capture and storage (CCS) by 2045.² Such a phase-out requires aggressive retirement of existing coal plants, not the building of huge numbers of new ones.

China already has enough coal-fired power plants to meet its needs, with the average plant running less than half the time. Cancelling the current pipeline of 259 GW would free up US\$210 billion in capital expenditures—funds that could be used to build nearly 300 GW of solar PV or 175 GW of onshore wind power in China and move the country toward decarbonization.

1. A typical coal-fired unit in China has a gross electrical capacity between 350 megawatts (MW) and 1,000 MW, with most power stations having two or more units.

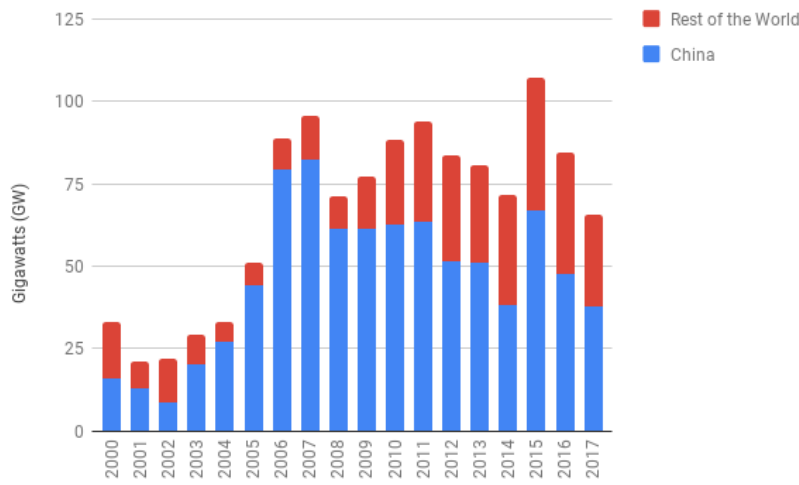
2. According to the [Global CCS database](#), China has no coal plants operating or under construction with CCS technology.

BACKGROUND: CONSTRUCTION ON STEROIDS

As with many economic dilemmas, China’s current crisis of excess coal plants is rooted in the country’s own success. Beginning in the late 1990s, the country developed unprecedented capabilities for building coal plants at a scale that had never been seen anywhere in the world. Indeed, no country has ever developed more power capacity more quickly and cheaply.

During the peak of the boom, the decade from 2006 through 2015, China added 618 GW of new coal power capacity, more than twice the entire coal-fired generating capacity of the United States (266 GW). That’s over 15 GW of new coal power every three months, more than the entire 14 GW coal power capacity of the United Kingdom. China’s coal expansion, often described as “one coal plant per week,” might arguably be characterized as the largest industrial project in global economic history (See Figure 1 and Sidebar: “History of a Boom”).

Figure 1. Since 2000, China has built 70% of the new coal power capacity added worldwide.



New coal-fired power capacity added in China and rest of the world, 2000–2017.
(Source: CoalSwarm, Global Coal Plant Tracker, July 2018)

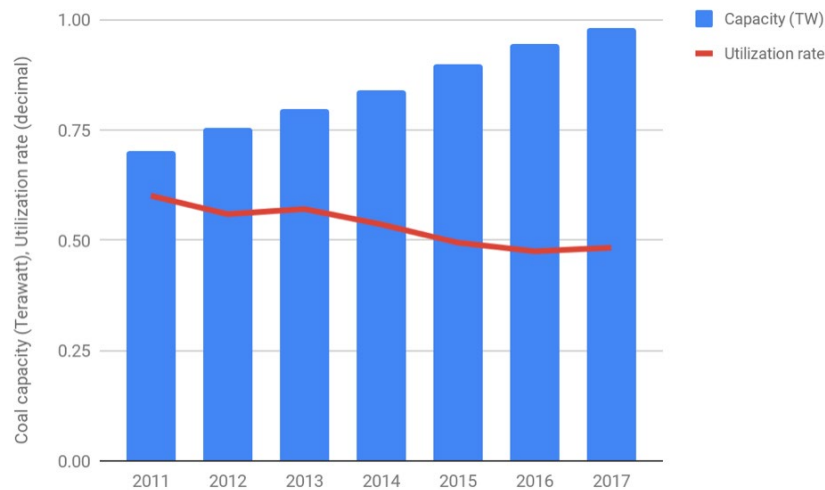
GROWING OVERCAPACITY

Beginning in 2013, it rapidly became clear that the country's coal plant boom was outstripping the country's needs. While high numbers of plants were continuing to come online, production of electricity by China's coal plants was actually declining, with fleetwide output dropping from 3,981 terawatt hours (TWh) in 2013 to 3,946 TWh in 2016, even though

coal-fired capacity rose in the same period from 796 GW to 946 GW (China Electricity Council 2013, China Electricity Council 2016).

Due to the growing overcapacity, by 2015 average coal plant utilization rates dropped to 49%, with the typical plant sitting idle more often than it was being used (Figure 2).

Figure 2. As total coal power capacity has gone up, average use per coal plant has gone down.



China coal power capacity (blue bars) and average plant utilization rate (red line), 2011–2017.
(Source: China Electricity Council 2018)

PERMITTING EXPLODES

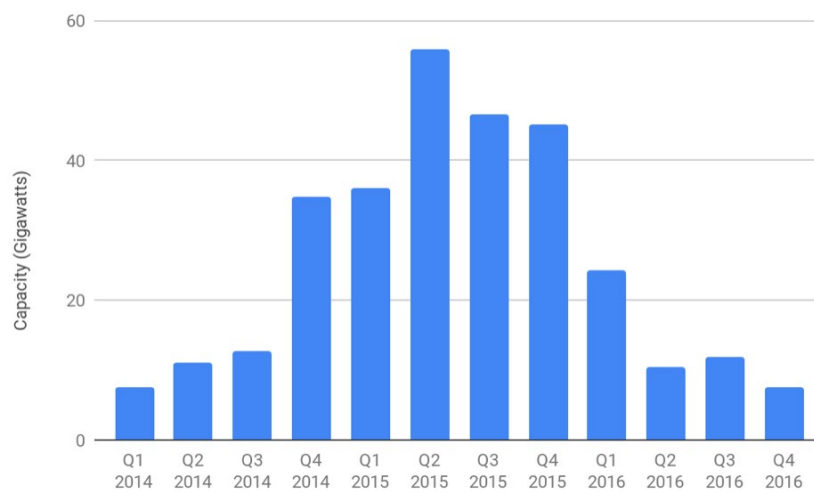
Finding itself in the midst of a worsening overcapacity problem, the Chinese government implemented measures that proved to be highly counterproductive: a decentralization program that moved coal plant permitting authority from Beijing to individual provinces. In September 2014, authority over coal plant construction approvals was moved from the National Development and Reform Commission (NDRC) to the provincial DRCs. In March 2015, environmental impact assessment (EIA) approvals by the Ministry of Environmental Protection (MEP) were moved to the provincial Environmental Protection Bureaus (EPBs).

The measures were reportedly intended to help provinces make investment decisions that better aligned their local power demand with supply, with the central government limiting its role to creating total capacity limits and policy guidelines. In practice the devolution of authority resulted in an unprecedented surge in permits, as local authorities raced to approve projects they believed would stimulate local economies and benefit economic interests with influence at the provincial level.

Provincial regulators soon showed themselves to be far more lenient than the central authorities, moving quickly to grant permits that had sat for several years on federal waiting lists, and even retroactively approving 15 GW of coal power plants that had been illegally operating for years without permits. Prior to handing authority to the provincial EPB, the federal MEP had vetoed two projects from Shanxi Province due to emission concerns in an already over-polluted area. Shanxi's EPB reapproved these two projects immediately after it received the authority, then approved 21 similar projects in seven months.

Overall, permits for construction saw a three-fold increase, from an average of 5 GW a month in 2013–2014 to 15 GW a month in 2015, as shown in Figure 3. There was also a three-fold increase in monthly EIA approvals over the same period (Myllyvirta and Shen 2016, Alkon and Wong 2018). By the time the central government began restricting new permitting in March 2016, the provinces had given construction approval to over 245 GW of new coal-fired capacity.

Figure 3. Coal power capacity approved for construction spiked after permitting authority was given to the provinces in late 2014.



Coal-fired capacity permitted for construction in China, before and after authority was transferred from the central government to the provinces in September 2014.

(Source: NDRC and Provincial DRC permit records, 2014-2016)

CHINA'S AUTHORITIES ATTEMPT TO ADDRESS THE OVERCAPACITY PROBLEM

Beginning in March 2016, central authorities took action to address the overcapacity problem, by means of a series of special edicts issued by the National Development and Reform Commission (NDRC) and its energy branch, the National Energy Administration (NEA). Initially, these announcements laid out a variety of measures aimed at reducing the amount of coal power capacity permitted or entering construction; later announcements also targeted projects that had already begun construction.

The measures, which range from provincial-level “traffic light” designations to lists of specific coal plants, are detailed in Appendix A. Table 1 shows the amount of capacity covered by each of the restrictive measures,

as well as the amount of capacity that continues moving forward in development as of July 2018, based on a plant-by-plant analysis of satellite photos, local reports, and permits. (For a table of all proposed and existing coal power capacity in China by province and status, see Appendix B. For a description of the methodology used to determine plant status, see Appendix C.)

Overall, as shown in Table 1, the seven restrictive measures applied to 512 GW of coal power capacity that had been moving forward in the pre-construction and construction pipelines. Of that total, 44 GW continue to move forward in pre-construction and 107 GW in construction, either due to regulatory loopholes, outright flouting of the rules, or individual administrative

Table 1

Restrictive measure and date of first implementation	Amount of coal capacity covered under restriction			
	Total (GW)	Pre-construction (GW)	Active construction (GW)	Construction on hold (GW)
Suspension of new approvals & construction through 2017 (March 2016)	37	0	0	0
Red light provinces (March 2016)	269	37	48	1
Cancellation of new coal projects (September 2016)	13	0	0	0
Limits on coal capacity for power export outside the province (October 2016)	24	0	9	3
Letters to provinces suggesting projects be postponed or cancelled (January 2017)	98	7	12	31
Projects proposed to slow development through 2020 (September 2017)	57	0	29	20
<i>Also listed in January 2017 letters to provinces</i>	<i>(13)</i>	<i>(0)</i>	<i>(2)</i>	<i>(11)</i>
Projects ordered to stop development and address permit irregularities (September 2017)	35	0	11	20
<i>Also listed in January 2017 letters to provinces</i>	<i>(7)</i>	<i>(0)</i>	<i>(0)</i>	<i>(7)</i>
Subtotal	512	44	107	57
Not covered by restrictions		32	19	0
Total	512	76	126	57

China central government restrictions on coal-fired capacity (left column), the amount of capacity affected (second column), and the amount that continues to move forward with permitting (third column) and construction (fourth column). The fifth column shows capacity frozen in mid-construction under postponement orders but expected eventually to proceed to completion. Note: 21 GW of coal-fired capacity (italics) was listed in both the January 2017 and September 2017 restrictions.

(For more information, see [China's Restrictions on Development of Coal-Fired Capacity](#))

exemptions under the increasingly opaque regulatory regime. An additional 57 GW are currently frozen in mid-construction under postponement orders but are expected eventually to proceed to completion.

The most significant 2016 policy was the “traffic light” system, which assigned each province a color to signify the severity of restrictions that were being placed on its coal pipeline. The policy initially put all but four provinces under red light status, meaning the policy’s prohibition on new coal plant permits and new construction initially applied throughout much of the country. However, the number of provinces with a green or orange light allowing for new coal development increased to six in 2017 and ten in 2018. The policy also includes a number of loopholes that have allowed 85 GW of coal power capacity in red light provinces to advance. The loopholes include exemptions for plants in districts designated as economically underdeveloped, plants exporting electricity from northwestern “power bases” to eastern cities, and—most commonly—plants that provide steam heat to residential areas.

In 2017 the central government began naming specific projects in its restrictions, mainly projects in advanced stages of permitting or construction. While the 2017 restrictions do not have multiple exemptions like the red light policy, they have proven to be loosely designed and enforced, allowing many plants to advance in development.

The January 2017 action consisted of letters to provincial authorities that proposed the postponement of 95 GW of coal capacity for development after 2020, and cancelled another 3 GW of pre-construction capacity. Many news reports at the time mistakenly characterized this entire cohort of projects as being cancelled (e.g. Forsythe 2017). However, 50 GW appear likely to be built, including 7 GW that have received permits since January 2017, 12 GW shown to have further

construction activity since January 2017, and 31 GW that are currently frozen in mid-construction but expected to eventually resume construction and be completed.

In September 2017, the NEA ordered 57 GW of coal-fired capacity by name to slow down construction progress from 2017 to 2020, and prohibited the plants from connecting to the grid in 2017. Yet satellite data suggests about half of that capacity (29 GW) does not appear to have slowed construction much, if at all. The main effect of the policy appears to have been to limit the number of plants allowed to come online in 2017, with newly commissioned coal plants falling from the 2006–2016 annual average of 61 GW to 38 GW in 2017. However, this drop is misleading, since analysis of satellite data suggests additional coal power capacity was actually completed in 2017, but barred from connecting to the grid.

The September 2017 policy also ordered the owners of 35 GW of coal power capacity to stop development or operation altogether until problems with permitting or regulation were resolved. As of July 2018, satellite imagery shows that 11 GW of the 35 GW have already resumed construction, either flouting the policy or securing permission quietly and without public notice. It appears likely that the additional 24 GW will also eventually be commissioned, once the permitting or regulatory issues have been resolved. Some of the projects that appear to violate this policy include:

- [Linyou Waste Coal power station - Planet Labs satellite photos](#) from July 2017 to May 2018 show construction continued without stop at a rapid pace, with the coal plant near completion.
- [Shangluo power station - Planet Labs satellite photos](#) from July and November 2017 show that construction continued immediately after the suspension.

PIPELINE SUMMARY

Table 2 summarizes the current coal power pipeline in China. As shown in the table, 32 GW of pre-construction development and 19 GW of in-construction development were not covered by any of the restrictive measures imposed by the central government to rein in overcapacity. Of the projects that have proceeded despite the restrictive measures—due mainly to loopholes in the red light policy and loose enforcement of the 2017 restrictions—44 GW are in pre-construction, 107 GW are in active construction, and 57 GW are currently frozen in mid-construction under postponement orders but are expected eventually to be completed.

Overall, 126 GW of coal capacity are in active construction, 57 GW are currently frozen in mid-construction, and 76 GW are in unrestricted pre-construction development. Once completed, the pipeline of 259 GW will increase China's current operating capacity of 993 GW by 25%, an amount comparable to the current operating coal power capacity of the United States (266 GW).

FURTHER ADDITIONS TO PIPELINE DRY OUT IN 2018

Even as China's authorities appear to have been unable to prevent the massive surge of projects permitted in 2015 and 2016 from advancing toward completion, its coal plant restrictions and market reforms (see sidebar "Decline of a Boom") do appear to be having an impact on the initiation of further coal plant proposals. In the first six months of 2018, only 2 GW of coal power capacity have newly entered the pre-construction pipeline. This is a potentially optimistic sign that the pipeline for new proposals is finally beginning to dry out. But it does not resolve the danger posed by the massive excess capacity that is already under development.

Table 2. Summary of current coal power plant pipeline in China, July 2018.

Status	Capacity (GW)	Notes
Pre-construction	32	Not covered by restrictions
Construction	19	
Pre-construction	44	Moving forward despite restrictions due to loopholes, rule flouting, or individual exemptions
Construction	107	
Construction on hold	57	Frozen in mid-construction by postponement orders but expected to be completed.
Total	259	

CAPTIVE COAL PLANTS

“Captive” coal plants, i.e. plants run by energy-intensive enterprises such as aluminum smelters to supply their own internal electricity, represent a particularly extreme example of China’s ineffectiveness in controlling its power glut. Until 2015, captive plants were not covered by the same regulations as other power plants, and often entered construction without any permits.

One prominent builder of captive coal plants is Shandong Weiqiao Group, a collection of companies controlled by the Zhang Shiping family. Since the beginning of 2010, the company has built or begun construction on over 24 GW of coal power capacity—about the same coal-fired capacity as Australia. A second aluminum company located in Shandong is Xinfu Group, which has accounted for 14 GW of built or under construction coal plants in the same period—comparable to the entire coal-fired capacity of the UK. Both companies built most of their coal plants using less efficient “subcritical” technology without authorization and in violation of environmental laws. They also sell their surplus electricity at low rates to local buyers, undercutting government markets and regulations (Slater 2017).



In late 2015, the Department of State issued a new regulation aimed at bringing the development of captive power capacity into accord with national energy industry policy. The new regulation required the approval and operations of captive coal plants to follow all relevant requirements and standards. After the policy change, the central government began cracking down harder on captive coal plants built or operating illegally without permits, with mixed results:

- In 2018, China’s Environmental Protection Inspection Group issued a report finding that Shandong Weiqiao Group had illegally built 45 coal power units in Shandong since 2013. In May 2018, the Shandong provincial government responded to the inspection report with a plan to address the violations. According to the province, 33 of Weiqiao’s 45 illegally built coal power plants had since completed the necessary procedures to receive environment clearance and continue operating; 12 units did not complete any procedures and should stop construction and operation immediately: the eight-unit [Weiqiao Zouping-1 power station](#) and the four-unit [Weiqiao Zhanhua power station](#). Based on satellite images, there does not appear to be any activity at the two power stations since March 2018, suggesting they are for now complying with the order.
- The Xinfu Group, on the other hand, appears to be violating central government orders. In September 2017 the company was told by China’s NEA to cease operations and construction at its 3,960 MW Xinyuan Aluminum power station due to permit violations. However, [Planet Lab satellite images](#) from September 2017 to February 2018 show that the plant continued with both operation and development.

CHINA'S COAL POWER CAP AND INTERNATIONAL CLIMATE GOALS AT RISK

An important metric for China's Power Sector Thirteenth Five-Year Plan (2016–2020) is the 1100 GW cap on the overall size of the country's coal plant fleet. Many analysts argue that the cap far exceeds the country's needs, as China already has redundant coal power capacity and falling utilization rates (Feng et al. 2018, Li 2017, Gray 2016). Even so, that cap now appears to be at risk of being surpassed.

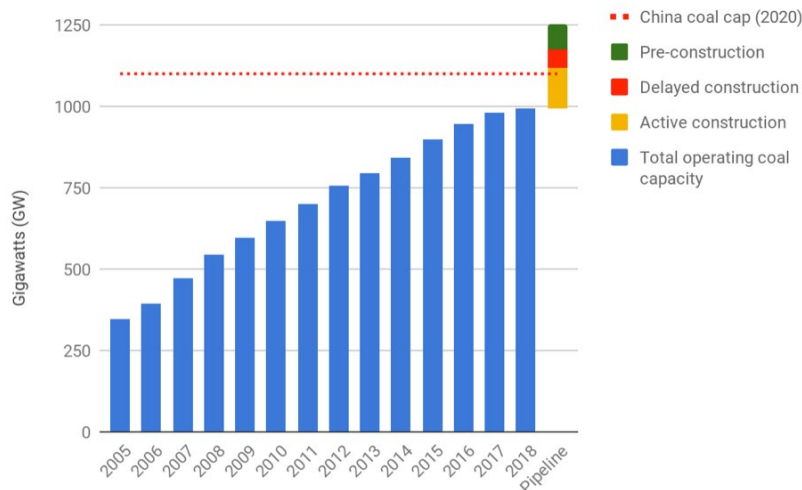
At the end of 2017, China's coal fleet stood at 981 GW, according to the China Electricity Council (2018).³ CoalSwarm estimates 12 GW were commissioned in the first six months of 2018, putting total coal power capacity at 993 GW. This allows only 107 GW of further capacity to be added through 2020, minus retirements, without violating the 1100 GW cap.⁴

As shown in Figure 4, as much as 259 GW of new capacity are poised to be added to the Chinese coal

fleet, compared to only 107 GW of room under the 1100 GW cap. Plants in active construction alone exceed the cap by 19 GW, with much of that capacity at an advanced stage of construction, if not already completed and waiting to come online. The resurgence of delayed construction—much of it also in advanced stages—will push completed coal power capacity further beyond the cap.

The capacity under development is also out of line with what is required under the Paris climate agreement. According to the International Energy Agency's Beyond 2°C Scenario, a 50% chance of limiting average future temperature increases to 1.75°C requires that China close all unabated coal plants (i.e. plants without carbon and capture storage technology) by 2045, and cease generating power from those plants by 2040 (IEA 2017).

Figure 4. Coal power poised to be added to the China coal fleet exceeds the country's 1100 GW cap.



Total coal power capacity in China, 2005 to mid-2018 (blue bars), coal power capacity under development as of mid-2018 (yellow, red, and green bars), and China's 2020 coal cap (red dotted lines). (Source: China Electricity Council 2018; CoalSwarm, Global Coal Plant Tracker, July 2018)

3. CoalSwarm's Global Coal Plant Tracker estimated the figure to be 936 GW in 2017, not including units under 30 MW.

4. Coal power retirements in China have averaged under 6 GW a year since 2010.

Figure 5 shows total operating coal power capacity in China if all active construction is commissioned evenly over three years, all delayed construction over four years, and all pre-construction from 2020 to 2026. The black line shows the IEA's Beyond 2°C Scenario. If coal plants retire as currently scheduled or at 40 years of age—roughly the global average—China would still have 750 GW of coal capacity in 2045 from its current operating capacity (light blue bars), and an additional

259 GW from what is currently under development (yellow, red, and green bars).

In all, China is on track to have 1,010 GW of operating coal capacity in 2045—the year the IEA scenario shows the country closing all its unabated coal plants in order to be in line with the Paris climate agreement. As shown by the black line, complying with the Paris agreement requires rapid retirement of the current coal fleet and no additional capacity additions.

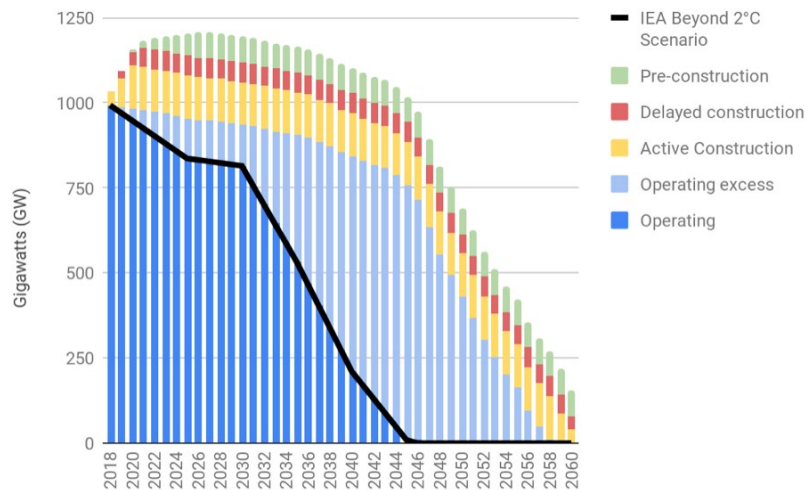
KICKING THE CAN DOWN THE ROAD

So far, China's authorities have shown little appetite for cancelling plants that have entered construction. Instead, they appear to be aiming to preserve the 1100 GW cap on coal power capacity through administrative sleight of hand: i.e. simply holding back on official start-up of many completed plants until after the end

of the country's current Five-Year Economic Plan (2016–2020).

For 2018, authorities have listed by name the coal-fired units that can go online in the current calendar year, totaling 21 GW of capacity. An additional 11 GW of projects are seeking authorization to go online, and

Figure 5. Coal power operating and poised to be added to the coal fleet exceeds international climate goals



Currently operating coal power capacity (blue bars) and a projection of what is currently under development (yellow, red, and green bars) retired at 40 years of age will exceed the IEA's Beyond 2°C Scenario (shaded area above black line).

(Source: CoalSwarm, Global Coal Plant Tracker, July 2018; China Electricity Council 2018)

it is not yet clear how much completed capacity will be authorized for operation in 2018, and how much will be postponed to a later date.

Presumably limits on total operating capacity could also be imposed in 2019 and 2020, and be designed to keep the operating coal fleet technically under the 1100 GW cap. But such limits do not actually address

the overcapacity problem, which can only be solved by cancelling capacity outright, not by rescheduling it. Any solution based on shifting start dates would be illusory, since it would simply create a growing reservoir of fully completed plants that are ready to begin operating after the end of 2020, as soon as they receive authorization from the central government.

CONCLUSION: CHINA'S OVERBUILDING THREATENS ITS ECONOMY AND THE GLOBAL CLIMATE

Guaranteed tariffs, easy access to cheap credit, and a recent permitting spree by provincial authorities have led to a rapid build-up of coal power capacity in China, far exceeding the country's needs. In response, China's central government began implementing a series of restrictive measures in 2016, but loopholes and loose enforcement have weakened their effectiveness. As a result, 259 GW of new coal power capacity are now poised to be added to an already crowded coal fleet. While China's central government appears reluctant to cancel these plants, doing so would both benefit China's economy and keep global climate goals within reach.

China already has more than enough power capacity to meet its needs, with the average coal plant running only half the time. Construction of an additional 259 GW of coal plants represents approximately US\$210 billion in wasted capital expenditures—funds that could be used to build 289 GW of solar PV or 175 GW of onshore wind power in China (IEA 2015).⁵ Excess coal power also puts coal plant owners in competition with alternatives, locking out the building of lower-carbon capacity and encouraging restrictive

policies such as curtailment of wind power—i.e. forced reductions in the amount of energy that may be transmitted into the grid.

Moreover, while subsidized loans and tariffs guaranteed by the central government may make coal plants profitable now, that situation is likely to soon change as the country's power sector transitions (for more details, see sidebar "Decline of a Boom"). As more coal plants face competitive markets and restricted operating hours, they will be unable to secure the tariffs needed to recoup development costs. Adding even more coal power capacity will only heighten the problem of reduced grid access and tariffs.

Finally, the sheer size of China's coal fleet—48% of the global total—means China's coal policies have an outsized effect on global climate prospects. Yet China's current development puts it on a trajectory to have 1,010 GW of operating coal capacity in 2045, the year it should have phased out its unabated coal plants. To meet Paris climate goals, China's central government needs to aggressively retire its existing coal plants, not build huge numbers of new ones.

5. Based on IEA "overnight costs" (pre-construction, construction, and contingency costs, not including interest) for generating technologies in China: US\$813/kW for ultra-supercritical coal plants (the most commonly installed in China), US\$728/kW for commercial solar PV, and US\$1200 for onshore wind.

HISTORY OF A BOOM

From 1979 to 2017, China's real gross domestic product grew at 9.5% a year, a pace described by the World Bank as "the fastest sustained expansion by a major economy in history" (Morrison 2018). The country's growth strategy emphasized heavy industry fueled predominantly by coal, with most of the country's power consumption going toward industry (China Electricity Council 2018).

The rapid expansion of coal power capacity, in turn, was driven by high levels of capital spending funded by easily accessible financing. China's banking system is largely dominated by state-owned entities, which are used by the Chinese central government to issue loans at subsidized rates to boost credit and meet growth objectives. Bank lending for plants also has implicit government backing, with minimal due diligence (Spencer et al. 2017). China's investment spending makes up half of China's GDP, compared to around 20% in developed economies (Myllyvirta and Shen 2016).

In addition to large amounts of subsidized credit, coal plant building has been enabled by coal-friendly policies: First, the country's electricity tariffs cover operating costs while guaranteeing a return on investment for an average plant. Second, the country's "equal share dispatch" scheme generally allocates equal operating hours to all plants in a region, allowing costlier, emissions-intensive plants to run just as much as more efficient ones. Third, some utility contracts provide a guaranteed allotment of hours during which coal plants can sell power to the grid.

An analysis by the Chinese National Institute of Financial Research argues that such implicit government assurances are a key driver of overcapacity in China (Ning 2017). Both investors and banks have come to expect guaranteed returns, leading to excessive and risky investments.

Further encouraging continued capacity expansion is the uniquely low cost of building new coal plants in China. With the benefit of low labor costs and commodity prices, large average plant sizes, and economies of scale, Chinese coal plants cost a third to half as much per MW as the global average (Hervé-Mignucci and Wang 2015). Operating costs are also relatively low,

since China's newest plants lead the world in efficiency. The Coal Power Energy Saving and Emission Reduction Upgrade Action Plan, introduced in 2014, requires that all new plants be at least 600 MW in size and use ultra-supercritical combustion technology (Hervé-Mignucci and Wang 2015).

DECLINE OF A BOOM

While government subsidies and tariffs may guarantee profits for coal plants now, that situation is likely to change soon. In 2015, China announced plans to move toward a more market-based organization of the electricity sector to replace regulated pricing and "equal share dispatch." Coal power projects permitted by the provincial DRCs after March 15, 2015, will no longer have guaranteed hours and will have to compete in wholesale electricity markets. The shift towards competitive energy procurement and dispatch has already decreased tariffs received by coal plants in pilot provinces (Zhao et al. 2017).

In addition, the Chinese government began implementing a national carbon trading market in 2017. Coal plant owners will have to purchase carbon permits to offset their greenhouse gas emissions, raising the input costs of the plants and making them less competitive compared to lower-carbon alternatives (Zhao et al. 2017). Also, the central government has begun mandating that grid companies purchase a minimum number of hours for renewable power, which will cut into coal plant's preferential access to the grid and further lower their utilization hours (Alkon and Wong 2018).

Finally, in 2017 the central government began regulating the number of new coal plants allowed to connect to the grid. The move means surplus coal power capacity will be unable to immediately come online and begin recouping development costs. The average coal plant is already operating for fewer and fewer hours while overall power capacity continues to grow (China Electricity Council 2018). Recent estimates find China already has excess coal power capacity far beyond its needs, representing "stranded assets" unable to earn an economic return on investment (Feng et al. 2018, Myllyvirta and Shen 2016, Gray 2016).

APPENDIX A

CHINA'S RESTRICTIVE MEASURES ON COAL PLANT DEVELOPMENT, 2016–2018

In response to growing overcapacity, the central government began introducing a series of restrictions and proposals to slow development on nearly all new coal plants, with some exemptions. This was followed in 2017 by the naming of specific projects for postponement. Policies and proposals included:

March 17, 2016. China's NRDC ordered 13 provinces and regions with excess coal-fired power capacity to halt all new project approvals until 2017. With some overlap, 15 provinces were told to delay the construction of approved projects until after 2017. Exemptions to the policy included coal plants for residential heating and power, projects in “coal power bases” exporting power to other provinces, and projects supporting poverty reduction in “revolutionary” areas (i.e. rural districts that supported the Chinese revolutionary struggle and typically remain economically underdeveloped) and poor areas.

March 17, 2016. China's National Energy Administration (NEA), which oversees the country's energy policies, released the Coal Bubble Alert System, dubbed the “traffic light” system. The System introduced a coal power planning risk management mechanism for provinces based on three factors: 1) the profitability of their coal-fired generation, 2) the adequacy of their existing coal capacity, and 3) their “resource constraints,” such as water availability and air quality. Based on these three factors, each province was assigned a color to signify the viability of its coal pipeline. Red means no new coal projects should be permitted. Orange indicates local governments should tread carefully. Green indicates space for new coal. The policy had the same exemptions as the March 17, 2016 NRDC order.

September 13, 2016. The NEA canceled 15 new coal projects (13 GW) in nine provinces.

October 10, 2016. The NEA suspended construction that began in 2016 or later in all provinces with a red light under the traffic light system, if the power from the plants is for use within the province (i.e. not exported). It also ordered projects in coal power bases that were designed to export power to other provinces to “scale down” to about half of the planned capacity within 2020. Exemptions included coal plants for residential heating and power, as well as projects in poor areas and national demonstration projects.

November 7, 2016. China's Power Sector 13th Five-Year Plan (2016–2020) placed a cap on total coal power capacity of 1,100 GW in 2020.

January 16, 2017. To help meet the coal capacity limit set out in China's 13th Five-Year Plan, NEA sent letters to 13 provinces proposing the suspension of specific coal plants under planning or construction, totaling 95 GW of capacity. In the letters, it said the projects included should be postponed to the 14th Five-Year Plan (2021–2025). In addition, 3 GW of pre-construction coal plant capacity were cancelled.

September 26, 2017. NEA ordered 58 GW of coal-fired capacity to slow down construction progress from 2017 to 2020, and prohibited them from connecting to the grid in 2017. In addition, 35 GW were halted indefinitely for permitting and regulation violations. The list partly overlapped with the projects listed in the January NEA letter to 13 provinces (21 GW total).

APPENDIX B

COAL POWER CAPACITY (MEGAWATTS) IN CHINA BY STATUS AND PROVINCE

Province	Pre-construction	Construction	Shelved	Operating	Cancelled 2010–2018
Anhui	13,960	5,490	17,760	47,710	11,000
Chongqing	805	2,730	940	13,190	4,000
Fujian	1,460	1,400	12,060	25,588	5,320
Gansu	2,000	2,700	25,460	19,480	8,050
Guangdong	4,120	4,700	14,420	58,726	25,380
Guangxi	1,900	59	5,030	19,535	7,660
Guizhou	5,540	4,270	33,820	29,950	13,370
Hainan	1,320	0	700	3,060	0
Hebei	2,800	6,470	2,350	42,886	7,420
Heilongjiang	735	0	8,000	18,835	2,885
Henan	700	9,200	14,320	60,845	11,120
Hubei	240	4,020	13,860	23,345	6,700
Hunan	4,060	0	6,700	19,664	6,270
Inner Mongolia	6,070	16,330	65,330	79,650	65,200
Jiangsu	325	4,020	16,480	74,543	11,100
Jiangxi	5,320	3,320	6,000	19,334	5,360
Jilin	1,600	0	0	16,446	9,390
Liaoning	1,000	2,650	2,000	30,495	12,800
Ningxia	180	6,110	6,060	23,490	9,820
Qinghai	0	0	4,000	3,860	3,745
Shaanxi	11,380	12,760	17,380	32,480	27,020
Shandong	5,010	12,570	14,480	92,224	27,080
Shanghai	0	0	0	14,310	0
Shanxi	2,000	10,010	29,480	56,553	24,780
Sichuan	0	2,000	4,000	11,695	5,200
Tianjin	1,310	1,350	0	10,632	3,450
Xinjiang	2,490	14,180	32,380	53,705	31,290
Yunnan	0	0	900	12,535	4,800
Zhejiang	0	0	4,640	42,514	9,100
Total	76,325	126,339	358,550	957,280	359,310

(Source: CoalSwarm, Global Coal Plant Tracker, July 2018)

APPENDIX C

METHODOLOGY

The data in this report is based on a project-by-project survey completed in July 2018 by CoalSwarm, as part of the Global Coal Plant Tracker (GCPT) database. The database tracks every coal-fired unit in the world 30 MW and larger, including all known operating units and all units proposed or retired since 2010. The GCPT also features a footnoted wiki page for each plant in the database, including location data. The GCPT tracks coal plants used for power generation and combined heat and power, as well as plants used for captive industrial use.

For China, the plants covered by each restrictive measure were identified, including consideration of which plants fell under the various loopholes in the policies. Government permitting data, Chinese news reports, and satellite imagery were then used to identify the developmental status of each plant, and whether the

plant was progressing toward completion. Satellite imagery from Planet Labs allowed for date-specific comparisons of construction activity.

Each plant ordered to slow or postpone its construction development was analyzed using Planet Labs satellite data. Units that showed further construction progress after the restriction measure were marked as active construction. Units that did not show further construction progress after the restriction measure were marked as shelved construction (i.e. on hold).

Pre-construction includes plants that have appeared in corporate or government plans, that have completed feasibility studies, or that have sought or received permits. Any coal plant proposal without activity for two years or more is marked shelved, and projects with no activity for four years or more are marked cancelled.

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