A new surge in China's coal expansion and implications for the country's climate and energy targets

Ryna Cui, Jenna Behrendt, Nate Hultman | March 2023
Center for Global Sustainability at the University of Maryland

New data shows a substantial increase in building, approving, and planning new coal power projects in China during 2022.[1] As of January 2023, China has 1,093 GW of coal power capacity in operation, accounting for 52% of the global total, 115 GW of new capacity under construction, and an additional 250 GW at various pre-construction stages (Table 1). It is particularly notable that 50 GW started construction and 106 GW received approval in 2022, which represents more than a 50% increase and a quadrupling from the previous year, respectively.[2]

Given the magnitude of the new activities, the slowdown in coal commissioning observed in 2021 and 2022 (Table 1) seems unlikely to continue in the coming years. In a more climate-optimistic scenario where none of the pre-construction projects proceed, installed coal power capacity would likely grow to at least 1,250 GW. If all projects in the existing pipeline are built, would result in roughly 1,500 GW.[3]

Table 1. Annual newly commissioned coal power capacity in China and globally, 2016-2022; and coal power capacity under development.[4]

	Annual Capacity Additions (GW)							Current Pipeline in 2023 (GW)	
	2016	2017	2018	2019	2020	2021	2022	Under construction	Pre-construction
China	49	40	33	49	41	26	27	115	250
Global	86	69	52	77	56	46	45	190	347
% of global	57%	58%	64%	63%	73%	58%	59%	61%	72%

At the same time, China has made rapid progress in renewable energy deployment, with even more ambitious targets announced at the provincial level. Since 2020, China has added 100–125 GW of solar and wind capacity annually in the past three consecutive years (Table 2). Total capacity reached 393 GW for solar and 365 GW for wind by the end of 2022.[5] Moreover, targets included in the provincial 14th Five-Year Plan (FYP) indicate that total solar and wind capacity would grow by 874 GW between 2021 and 2025 and reach 1,400 GW by the end of the 14th FYP.[6] To achieve these targets, however, another 642 GW needs to be added over the next three years, or 214 GW per year between 2023 and 2025, almost doubling the already high deployment rate in recent years.

Table 2. Annual solar and wind power capacity deployment in China, 2016-2022.[7,8]

Annual Solar and Wind Capacity Additions in China (GW)							
	2016	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Solar	32	53	45	27	48	55	87
% of global	44%	56%	48%	26%	38%	36%	36-42%[8]
Wind	20	17	21	26	72	48	38
% of global	40%	36%	43%	44%	65%	51%	33-39%[8]
Total Solar + Wind	52	71	67	52	120	103	125

MOTIVATIONS BEHIND THE NEW ROUND OF EXPANDED COAL ADDITIONS

China's new surge of coal expansion is mainly driven by two reasons: (1) energy security concerns and (2) the push for a rapid economic recovery from the global pandemic. Since late 2021, China has increasingly placed energy security as a top policy priority. Several major electricity shortage incidents across the country provided strong arguments for building new coal power capacity and bolstered stakeholders within China advocating for a slower coal phasedown. Many new coal plants are proposed as a package with large solar and wind power bases, supposedly to operate at low utilization to support intermittent renewables and a stable grid, especially during summer or winter peaking demand.

Across provinces, however, more coal-related activities are observed in provinces that expect high-demand growth, such as Guangdong, Jiangsu, Anhui, Jiangxi, and Zhejiang; provinces with large renewable development potential, like Inner Mongolia, Xinjiang, and Gansu, have low to moderate coal expansion planned.[9] It is unclear whether these new coal plants can be kept at low utilization in places with less renewable resources but high-demand growth: the risk is that they would simply be run at higher utilization once built.

Moreover, strict COVID control policies have slowed down economic growth in China, falling to 3% in 2022.[10]Infrastructure investment and the construction of large coal power projects in particular has been deemed as an effective way to boost local economies and employment in the short run. The high pressure to pursue a fast economic recovery is another key driver that contributes to the surge of new coal. Both the economic and security priorities outweigh climate mitigation concerns, particularly at the provincial level, where decision-making and official approvals of coal plants are ultimately authorized.

IMPLICATIONS FOR CHINA'S CLIMATE AND ENERGY TARGETS

With the new round of rapid coal expansion in China, questions emerge regarding how the country's climate and energy targets will be affected, which depends on not only the magnitude and speed of the coal capacity expansion but also how these plants are utilized in the power system. There are uncertainties related to both. Our analysis here focuses on how plants are utilized in the power system as coal is being added with the expectation to operate at low capacity. However, what if that does not happen and coal continues to generate baseload? Or if that does happen and renewables are being prioritized, do we understand the implications to coal plants?

To answer these questions, we assess two alternative scenarios that provide the possible outcomes under the ongoing coal expansion in China, including the impacts on emissions, RE deployment, and coal plant utilization through 2030. Both scenarios assume all coal power projects in the existing pipeline are implemented, including those at the pre-construction stages.[11] However, the scenarios vary with respect to how coal plants are being utilized in the power system.

Scenario 1: Coal plants are built but continue to provide baseload at today's level. In this scenario, as coal power continues to generate baseload and operate at today's utilization level (about 4,600 hours on average, equivalent to a capacity factor of 52% in 2021), total coal power generation and associated CO_2 emissions increase at a similar rate as the capacity buildout (Table 3). The increased coal power generation from new plants would produce additional 2.3 $GtCO_2$ emissions in 2030 or an additional 14.4 $GtCO_2$ cumulative emissions between 2021 and 2030. This would extend China's peak level of carbon dioxide emissions to beyond 2030 and thus add mitigation challenges in the post-2030 period to achieve carbon neutrality. Meanwhile, under this scenario, the majority of the electricity demand growth is met by coal power instead of renewables, where the ratio of coal to renewables is over 4 to 1 in 2025 and over 2 to 1 in 2030. As renewables fulfill a larger share of recent demand growth, this would suggest a future cutback in renewable deployment or integration.

Table 3. Potential increases in coal power capacity, generation, and CO_2 emissions between 2021 and 2030, assuming constant utilization level from today.[12]

Year	Coal Power Capacity (GW)		Coal Power Generation (TWh)		Coal Power CO_2 Emissions ($MtCO_2$)	
	Total	Increase from 2020	Total	Increase from 2020	Total	Increase from 2020
2020[12]	1,079	n.a.	4,630	n.a.	4,561	n.a.
2021[12]	1,110	29	5,043	413	4,967	406
2022	1,137	56	5,230	600	5,152	591
2023	1,205	124	5,544	914	5,461	900
2024	1,273	192	5,858	1,228	5,770	1,209
2025	1,341	260	6,172	1,542	6,079	1,518
2026	1,374	293	6,320	1,690	6,225	1,664
2027	1,406	325	6,468	1,838	6,371	1,810
2028	1,438	357	6,616	1,986	6,517	1,956
2029	1,470	389	6,764	2,134	6,663	2,102
2030	1,502	421	6,912	2,282	6,808	2,247

Scenario 2: RE deployment and integration are prioritized, and coal capacity idles more often. In the alternative case, RE deployment and integration are prioritized, where all RE targets included in the provincial 14th FYPs are achieved by 2025, and the same deployment rates continue through 2030 (avg. 175 GW/year). While coal capacity grows from 1,110 GW in 2021 to 1,341 GW in 2025 and to 1,502 GW in 2030, coal power generation declines from 5,043 TWh to 4,771 TWh and 4,578 TWh, respectively, even under a high-demand scenario (Table 4). Therefore, the same coal capacity expansion may result in declining CO_2 emissions, as far as strong progress on the RE side can sustain.

Correspondingly, coal plants are expected to gradually change their role in the power system by lowering utilization level from about 4,600 hours today to 3,557 hours on average, or a capacity factor of 41% in 2025, and to 3,047 hours in 2030 (a capacity factor of 35%), under the high-demand scenario (Table 4). Utilization may even go down to less than 2,500 hours (a capacity factor below 30%) in 2030 under a low-demand scenario—which could be driven by expanding policy to deploy efficiency measures. As coal plants become increasingly idle, this round of new builds would exacerbate the issue of overcapacity and further diminish the overall economic performance of the coal power sector. In the end, not only do the new builds turn out to be stranded assets, but they also reduce the room for existing coal plants' profitability during the transition and further increase stranded assets.

Table 4. Implications of ambitious RE deployment on coal plant utilization through 2030.[13]

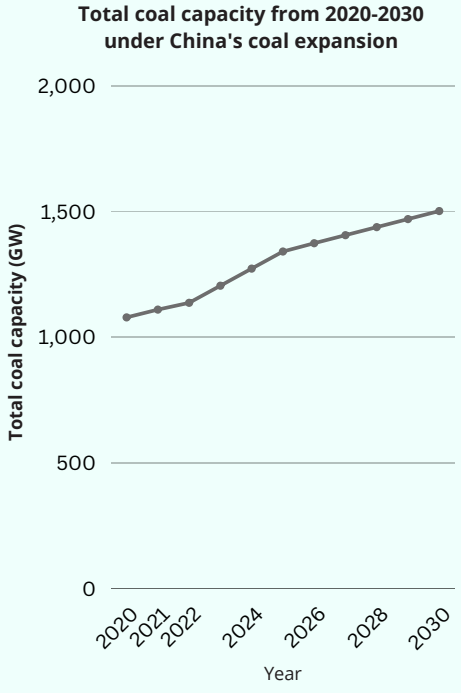
	Coal capacity		High-demand scenario (2025: 9,500 TWh; 2030: 11,000 TWh)		Low-demand scenario (2025: 9,000 TWh; 2030: 10,000 TWh)	
Year	New coal capacity	Total coal capacity	Total coal elec generation	Coal plants avg. utilization	Total coal elec generation	Coal plants avg. utilization
	GW	GW	TWh	hours/year	TWh	hours/year
2020 [13]	41	1,079	4,630	4,323	4,630	4,323
2021 [13]	29	1,110	5,043	4,601	5,043	4,601
2022	27	1,137	4,975	4,376	4,863	4,278
2023	68	1,205	4,907	4,072	4,683	3,887
2024	68	1,273	4,956	3,814	4,504	3,537
2025	68	1,341	4,771	3,557	4,324	3,223
2026	32	1,374	4,732	3,445	4,196	3,055
2027	32	1,406	4,694	3,339	4,068	2,894
2028	32	1,438	4,655	3,237	3,940	2,740
2029	32	1,470	4,616	3,140	3,811	2,593
2030	32	1,502	4,578	3,047	3,683	2,452

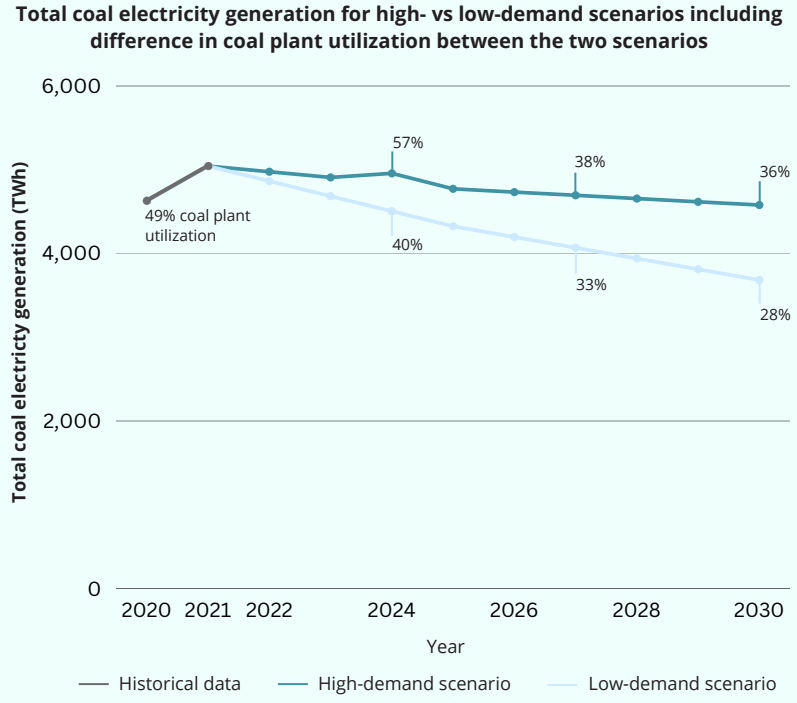
DISCUSSION

The two scenarios presented are more likely to provide two boundary conditions and the outcomes may fall somewhere in between. On the one hand, it is unlikely that renewables will be completely cut back given the strong growth of the green industry domestically; on the other hand, there are uncertainties about renewable integration and whether coal plant utilization can be kept low once built. For example, while wind curtailment has been mostly resolved in recent years, it used to be a serious issue and could become one again.

While our analysis focuses on different utilization scenarios of coal plants, it shows that adding all the planned capacity is undesirable and unnecessary; it both hobbles China's climate and energy goals and will generate poor investments and a waste of financial resources. Within China, building excess coal has become a default response to China's energy security and economic recovery situation; however, it is neither the only nor the best answer. In fact, the reliance on coal increases vulnerability to market fluctuations; a coal price spike was, for example, one of the main reasons for the power shortages in late 2021. Instead, a large set of alternative solutions can feasibly be implemented immediately, including, for example, energy efficiency improvements, storage technologies, transmission and cross-region balancing, and power market policies. The investments and resources saved from canceling new coal can be reallocated to alternative solutions. The next steps in this analysis will conduct a deeper dive into individual provinces to understand the provincial-specific implications.

Summary Figure. Coal electricity generation and plant utilization under China's coal expansion with ambitious RE deployment.





References

1. CREA, GEM, China permits two new coal power plants per week in 2022 (January 2023). https://energyandcleanair.org/wp/wp-content/uploads/2023/02/CREA_GEM_China-permits-two-new-coal-power-plants-per-week-in-2022.pdf
2. Ibid.
3. Based on total coal power capacity of 1,110 GW by 2021 from China Electricity Council.
4. Data source: Global Coal Plant Tracker (January 2023).
5. Data source: China Electricity Council (January 2023).
6. https://mp.weixin.qq.com/s/pYG4B112dNnP9zfPs7k9XQ
7. Data source: China Electricity Council (2016-2021), National Energy Bureau (NEB) (2022); Global: IRENA (2016-2020), IEA (2021), IEA Renewables 2022 (2022).
8. Global 2022 solar and wind data are estimates, not historical data, from IEA's Renewables 2022 report. The range of China solar and wind shares of global capacity are based on the two scenarios in the IEA report, which have different assumptions about ambition and renewable deployment. For additional information, please see the IEA Renewables 2022 report: https://iea.blob.core.windows.net/assets/ada7af90-e280-46c4-a577-df2e4fb44254/Renewables2022.pdf.
9. CREA, GEM, China permits two new coal power plants per week in 2022 (January 2023). https://energyandcleanair.org/wp/wp-content/uploads/2023/02/CREA_GEM_China-permits-two-new-coal-power-plants-per-week-in-2022.pdf
10. National Bureau of Statistics of China (February 2023).
11. We assume under-construction and permitted projects are implemented by 2025, and other early-stage projects are implemented by 2030.
12. Note: Coal power capacity and generation in 2020 and 2021 are historical data from China Electricity Council; 2022 and onward years and coal power CO2 emissions are scenario analysis.
13. Note: 2020 and 2021 historical data are from China Electricity Council; 2022 and onward years are scenario analysis

Suggested citation: R. Cui, J. Behrendt, N. Hultman (March 2023). "A new surge in China's coal expansion and implications for the country's climate and energy targets". Center for Global Sustainability, College Park.