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Power Crunch in Sichuan Province: Resource Curse or Short-sighted Energy Sector Development?

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In August 2022, Sichuan experienced an unexpected crisis of both power outage and associated industrial production disruption. The province is one of China's largest electricity producers who supply to meet growing demand in other parts of the country. It is also a key link in China's supply chains for key sectors such as semiconductor and auto mobile industries. Thus, the recent power crunch has made an impact that is far beyond its local economy.

According to Sichuan Electric Power Company, the power crunch was mainly caused by the extremely hot and dry weather in the summer of 2022. As Sichuan is a key electricity supplier of China's west-to-east power transmission (WEPT) programme, some online analyses also blamed the inflexible hydropower supply contract to other provinces for Sichuan's power shortage.

China has made efforts to raise the share of clean energy in its power generation system to achieve the "dual carbon" goal by 2060. The abundant clean energy endowment of Sichuan has become an important consideration in the government's development policymaking. Sichuan has seemingly fallen into the resource curse due to its rich clean energy. However, short-sighted pragmatic infrastructure development in the past might be a more important reason for the power outage.

THE OUTAGE

On 14 August 2022, the government of Sichuan announced the *Emergency Notice on Expanding the Implementation Scope of Prioritising Household over Industrial firms in Electricity Use* (*Guan Yu Kuo Da Gong Ye Qi Ye Rang Dian Yu Min Shi Shi Fan Wei De Jin Ji Tong Zhi*). The emergent document requested all industrial power users of Sichuan Power Grid in 19 cities to stop production. Except for power security purpose, even the workers of white-listed key guaranteed enterprises were required to take the high temperature leave for six days (15-20 August 2022).¹ The arrangement was extended on 20 August for another six days. Meanwhile, the Sichuan government also launched the *Emergency Response to Guarantee the Energy Supply Level 1* to minimise residential electricity consumption on 21 August 2022.²

As of 28 August 2022,³ the province's power shortage problem had eased due to a number of factors. First, as the temperature dropped, daily electricity consumption by households declined from a peak of 473 million kWh to 340 million kWh on 27 August. Second, thanks to rainfall in many localities, daily power generation capacity of hydropower rebounded by 9.5% from the lowest level on 13 August. The State Grid also provided various support, including power transmission from other provinces to Sichuan at maximum transmission channel capacity. Fifty medium-voltage generator cars were sent from 12 provinces to support Chengdu, the capital city of the province. As of 12 noon on 28 August, the general industrial and commercial power supply in Sichuan had been fully restored. Power supply to large industrial companies has gradually recovered, except for the high electricity consuming firms.

THE IMPACTS

Although the serious power shortage lasted only for two weeks, it raised great concerns due especially to the province's important position in the supply chains of China's several key industries.

Sichuan's five mainstay industries include electronic information, equipment manufacturing, food and beverage, advanced materials and energy chemical industry. It is also an important supplier for related sectors of the global supply chain.

For example, the electronic information sector of Sichuan covers important parts of the integrated circuit (IC) industry, such as IC design, wafer manufacturing, packaging and testing. Semiconductor manufacturers including Texas Instruments, Intel, ON Semiconductor, Diodes, Molex, Silan Micro and Zhongke Jingxin have factories in Sichuan. In 2021, China's polysilicon production was about half a million tonnes, accounting for more than 70% of global production. Sichuan's polysilicon production constituted about 13% of national production in the same year. The power crunch had put to a halt the production of more than 50 semiconductor producers in Sichuan.⁴

¹ <https://jxt.sc.gov.cn/scjxt/ldhd/2022/8/16/e8797536a69e45a3b89a9b27ec9668a3.shtml>, accessed 24 August 2022.

² Based on the regulation of *Sichuan Province Emergency Plan for Guarantee the Energy Supply Guarantee* publicised in January 2022. Source: <https://www.sc.gov.cn/10462/10464/13722/2022/8/21/42f05d40db464bcd8611a69efe1493ec.shtml>, accessed 24 August 2022.

³ For more details, please refer to <https://www.sc.gov.cn/10462/10464/13722/2022/8/28/b4940ae2494944c59a2582fa6b8fbb9e.shtml>, accessed 12 September 2022.

⁴ For more details, please refer to <https://www.zaobao.com.sg/realtime/china/story20220822-1305511>, accessed 12 September 2022.

Another seriously impacted industry is the photovoltaic industry. Due to the high level of power consumption in photovoltaic silicon material production and rod pulling, the impact of power cut on these two links had also been greater. In July 2022, Sichuan's silicon metal output was 65,600 tonnes, accounting for 21% of China's total supply. In 2021, China's silicon metal production formed about 77% of global production.⁵

The power crunch not only interrupted the production schedule of manufacturing companies located in the network of Sichuan's power grid, but also led to a supply chain disruption for partners outside of this network as Sichuan province is the manufacturing spare parts hub for the sectors of automobile, chemical and semiconductor. Many automobile-related manufacturers, including Toyota, Geely and Faw-Volkswagen, and major vehicle battery producer, Contemporary Amperex Technology Co. Limited (CATL), have followed the Sichuan government's notice to temporarily shut down the factory for reducing electricity consumption. Some automobile manufacturers in Shanghai such as Tesla and SAIC Motor have requested the Shanghai authority to coordinate with the Sichuan government to ensure the power supply of related upstream supplier in Sichuan province.

The impact of Sichuan's power crunch is considerable and far-reaching. The negative impacts have spilled from the factory to the households and from Sichuan to other provinces. The more important question is on the reliability of Sichuan's power supply in the future.

THE REASONS

To answer the aforementioned question, there is a need to evaluate the reasons for Sichuan's power shortage in August 2022. The four major reasons are the extremely hot and dry weather, heavy-reliance on hydropower, fast increase of industrial electricity consumption due to industrial policies favouring energy-intensive industries and unbalanced local grid development.

The first is the scorching heat in the summer of 2022 in Sichuan. On the supply side, the high temperature and declining rainfall had significantly brought down the water storage of reservoirs and the productivity of hydropower generation. Hydroelectric power generation of Sichuan province had been slashed by more than half, from about 900 million kWh in the same period to about 440 million kWh.

On the demand side, the heatwave dramatically increased the power usage of air-conditioning in residential and commercial areas, and cooling devices in particular factories. For example, according to the data of Sichuan Electric Power Company, from 4 to 16 July 2022, the maximum load of Sichuan power grid reached 59.1 million kilowatts, an increase of 14% over the same period last year. The average daily electricity consumption of residents in July 2022 reached 344 million kWh, a year-on-year increase of 93.3%. The imbalance between supply and demand directly led to the power shortage.

The second is the overreliance on hydropower. Sichuan has been called the "Thousand River Province", with more than 1,400 rivers flowing through its territory. Sichuan holds more than 20% of China's theoretical reserves of water energy, making it the province with the largest hydropower installed capacity and generation capacity in China. With abundant hydropower resources, 80% of Sichuan's energy supply comes from hydroelectricity. Meanwhile, thermal power generation can only meet at most 25% of the maximum load of Sichuan's power grid.

⁵ For more details, please refer to http://www.ce.cn/cysc/ny/gdxw/202208/16/t20220816_37965486.shtml, accessed 12 September 2022.

The capacity of other types of power generation is negligible in Sichuan, a reason for the lack of alternative power sources when hydropower generation dived.

The third is the mushrooming of many energy-intensive industries in Sichuan in recent years due to abundant energy supply and favourable industry policies. In addition to hydro energy, Sichuan is rich in other clean energy resources. According to the *2020 Sichuan Yearbook*, more than seven trillion cubic metres of natural gas reserves, or about 19% of China's total proven natural gas resources, have been discovered in Sichuan. Sichuan is ranked third in terms of geothermal resources in China; it is also rich in wind and solar resources. To take advantage of Sichuan's abundant clean energy endowment, central and local governments have adopted many industrial policies favourable to energy-intensive industries,⁶ another push factor.

Given the wealth in clean energy resources, the energy-intensive industries, including the semiconductor industry, and the photovoltaic silicon material production and rod pulling industry, have been well-developed in Sichuan. This development had raised the average annual growth rates of Sichuan's industrial electricity consumption for the period of 2015-2020 to 6.02%, which was significantly higher than the national level of 4.73%.

The fourth is the unbalanced development of state and local grids in Sichuan. The infrastructure of state grid focused only on the transmission from Sichuan to other regions but neglect the inverse channel for the power supply of Sichuan province. There is also a lag in the construction of local electricity transmission and distribution network in Sichuan.

The state grid

To solve the problem of hydropower abandon in Sichuan⁷ and ease the electricity shortage in the coastal region, Sichuan was selected as an important electricity supply base for China's WEPT programme in 1996. Since then, the State Grid invested a lot in the construction of 800-1,000kV ultra high voltage (UHV) Alternating Current (AC) and Direct Current (DC) transmission channels from Sichuan to the coastal region of China.

Since the launch of the first power transmission channel in Sichuan in 1998, five UHV transmission channels starting from Sichuan have been built, accounting for more than 1/6 of the 29 in China. The UHV lines originating from Sichuan which are under construction are 14,000 kilometres long, accounting for more than 30% of China's UHV lines under construction.⁸ However, all these lines (marked by orange lines in Figure 1) are one-way channels from Sichuan's hydropower bases located in far west and south Sichuan to other regions, without going through Chengdu, the local electricity load centre of Sichuan. They are part of the state grid and not connected to the local grid of Sichuan.

⁶ For more details, please refer to <https://www.sc.gov.cn/10462/10464/10797/2021/12/8/74e1f8013f874f5c9e2f2a2aafd4141b.shtml>, accessed 12 September 2022.

⁷ With rich hydropower resource, the problem of hydropower abandon has been very serious for a long time in Sichuan. According to National Energy Administration's report, about 30.1 billion kWh of hydropower was abandoned in major watersheds in China, of which about two-thirds occurred in Sichuan. For more details, please refer to http://www.nea.gov.cn/2021-01/30/c_139708580.htm, accessed 12 September 2022.

⁸ For more details, please refer to http://sc.news.cn/content/2022-07/02/c_1128797879.htm, accessed 12 September 2022.

The local grid

On the other hand, the power supply for local users relies on hydropower bases located in west Sichuan connected through local grid (marked by green lines in Figure 1). The local grid of Sichuan has very limited connection with other provincial grids or the state grid through at most 500 kV transmission channels. This hampered supply from south Sichuan or other provinces when users of Sichuan local grid suffered from power shortage.

The inflexible WEPT hydropower supply contract with other provinces was named as an important cause of Sichuan's power shortage. The contract was determined at the beginning of the year to ensure the whole year's power supply of other provinces. Any changes or violation would not only be considered as a breach of agreement, but also disrupt the power plan of other provinces. Sichuan would rather bear the power crunch that caused most of its manufacturing companies to close for a couple of days than breach the contract that would lead to the instability of power supply nationwide.

However, the truth is that, even if other provinces decrease their usage of electricity from Sichuan, Sichuan does not have the infrastructure to receive enough electricity from other regions or the four hydropower bases (Baihetan, Jinpin, Xiangjiaba and Xiluodu) responsible for WEPT (red stars in Figure 1). During the power shortage in August 2022, the eight transmission channels from other regions to Sichuan were all in full load, delivering more than 130 million kWh of electricity to Sichuan every day.

FIGURE 1 THE DEVELOPMENT OF ELECTRICITY TRANSMISSION CHANNELS IN SICHUAN



Source: Sichuan 14th Five-Year Plan for Electric Power Development.

POSSIBLE SOLUTIONS

China's "dual carbon" goal can be a big development opportunity for Sichuan, a clean energy-rich province. China is building a new power system dominated by renewable clean energy and raising the share of water, wind and photovoltaic power generation to more than 70% by 2060.

However, with inappropriate development plans or policies, the abundant resource can also become "Resource Curse". China is likely to experience more severe climate fluctuations as the country has encountered increasing extreme weather events since the beginning of 2022 due to the faster than expected climate change. When the share of renewable clean energy in the power system increases, the stability of the power grid will be more easily affected by extreme weather, making it more challenging to ensure power supply.

The fight against climate change needs long-run efforts. In the short-run, Sichuan or other provinces rich in energy resource should review and adjust their energy production and consumption structure, industry policies and infrastructure development to increase the resilience of their power system.

Specifically, for the case of Sichuan, efforts in three areas should be launched as soon as possible. First is the diversification of energy production and consumption at the provincial level and acceleration of the development of clean energy other than hydropower. It is also important to retain conventional coal-fired power units as strategic backup power sources in case of power shortage related to renewable energy.

Second is to consider the resilience of supply chain in industry policies. Endowment advantages should not be the only basis for policymaking, nor should loose energy saving policy be part of industry policies to attract high-tech but also energy-intensive enterprises, even for regions rich in energy.

Third is to ensure that the construction of within region and inter-region power grid should be balanced and accelerated. The pragmatic infrastructure development tends to be short-sighted. For example, the state grid transmission channels originating from Sichuan are mainly DC channels currently. DC transmission lines can maximise outbound transmission capacity with high efficiency desirable for China's WEPT programme. However, DC channels have relatively weak return capacity. For renewable energy power, the power generation base (the hydropower bases marked with red stars in Figure 1) often does not overlap with the electricity load centre of local grid (Chengdu, in the case of Sichuan). In the event of a power shortage in the local grid, DC channels can hardly be used for emergency support. Strengthening inter-provincial AC interconnection between power grids, enhancing power exchange capacity between power grids, and moving from the adjustment of surplus and deficiency to mutual backup so as to improve the rebalancing ability of the entire power grid in space are crucial.

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