China 5G and Data Center Carbon Emissions Outlook 2035

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China is home to the world's largest 5G network[1] and the world's second biggest data center industry.[2] With developments such as the Internet of Things, blockchain and 5G, carbon emissions from China's digital infrastructure[3] are rising fast.

New research from Greenpeace East Asia finds that electricity consumption from digital infrastructure in China is on track to increase an estimated 289% by 2035.[4] Electricity use at 5G base stations in China is rising at an even more dramatic rate and is projected to increase nearly 500% over the same period. In 2020, 61% of electricity that powered China's digital infrastructure was generated from coal.[5]

China's government has pledged to achieve carbon neutrality by 2060, and tech companies have begun to take steps to reduce their own carbon footprint. However, to date, only two major Chinese data center companies, Chindata[6] and AtHub,[7] have committed to achieve 100% clean energy by 2030, a key step in bringing down the sector's emissions.

Without urgent action to increase clean energy use, the internet sector's contribution to China's carbon footprint will continue to grow. By contrast, if internet giants, including Alibaba, Baidu and Tencent, work to achieve 100% renewable energy by 2030, they would play a critical role in catalyzing China's low-carbon transition.

1. Xinhua. China Builds World's Largest 5G Mobile Network. Retrieved from http://www.xinhuanet.com/english/2021-04/19/c_139891198.htm#:~:text=BEIJING%2C%20April%2019%20(Xinhua),Technology%20(MIIT)%20said%20Monday.
2. Arizton Advisory & Intelligence. China and Hong Kong Data Center Market Size to Reach Revenues around $27 Billion by 2025 - Arizton. Retrieved from https://www.prnewswire.com/news-releases/china-and-hong-kong-data-center-market-size-to-reach-revenues-around-27-billion-by-2025--arizton-301118834.html
3. In this report the term "digital infrastructure" refers to data centers and 5G base stations.
4. All 2035 projections included in this briefing represent the mid-level energy efficiency scenario. For a higher energy efficiency scenario, please refer to the Chinese-language version of the report.
5. China Electricity Council. 2020-2021 National Electricity Supply and Demand Situation Analysis and Forecast Report. Retrieved from https://www.cec.org.cn/detail/index.html?3-293198
6. Chindata. INSPIRING WITH POWER: 2020 Chindata Group ESG Report. Retrieved from https://www.chindatagroup.com/upload/admin/20210401/1228afcd8ef6de2dc5c1128b74bca2b2.pdf
7. Finance Sina. Athub founder Zeng Li: Will Implement a "Carbon Neutrality" Commitment with Practical Actions to Promote High-Quality Development of the Data Center Industry. Retrieved from https://finance.sina.com.cn/stock/carbon/2021-05-12/doc-ikmyaawc4894396.shtml

Key Findings

In 2020, China's data center and 5G sectors consumed 201 billion kilowatt hours (kWh) of electricity, roughly equivalent to the total electricity consumption of Beijing and Shenzhen combined.[8] The same year, carbon emissions from China's digital infrastructure reached an estimated 123 million tonnes.

Power consumption from digital infrastructure in China is on track to shoot up 289% between 2020 and 2035. By 2035, electricity consumption from China's digital infrastructure is projected to reach **782 billion kWh,** more than the total power consumption of any single Chinese province in 2020.[9] By 2035, digital infrastructure is projected to account for 5-7% of China's total power consumption, compared to just 2.7% in 2020.

Carbon emissions from digital infrastructure in China are projected to reach 310 million tonnes by 2035.[10] Emissions from China's digital infrastructure are forecast to continue to rise through 2035, long after emissions from other sectors in the country peak. By contrast, heavy emitting sectors, such as steel,[11] non-ferrous metal,[12] and cement,[13] are expected to peak emissions around 2025. China's government has pledged to peak national emissions before 2030, though many analysts believe the peak will come earlier.[14,15]

5G is one of the fastest growing sources of internet sector emissions in China. **Power consumption from 5G in China is on track to skyrocket 488% by 2035,** reaching 297 billion kWh by 2035, roughly equivalent to Sichuan's total electricity consumption in 2020.[16]

8. National Business Daily. The country's latest electricity consumption map. Retrieved from https://m.nbd.com.cn/articles/2021-04-21/1709804.html?formPage=shareRepoter
9. National Business Daily. The country's latest electricity consumption map. Retrieved from https://m.nbd.com.cn/articles/2021-04-21/1709804.html?formPage=shareRepoter
10. Assuming China's grid decarbonizes toward between 1.5°C and 2°C goals, which would mean that non-fossil share of power generation reaches 53%-61% in 2035.
11. Xinhua. Steel Industry Carbon Peak and Carbon Reduction Action Plan Take Shape. Retrieved from http://www.xinhuanet.com/fortune/2021-03/30/c_1127270603.htm
12. Eeo. The "Implementation Plan for Carbon Peak in the Non-ferrous Metals Industry" is Seeking Industry Opinions: Plans to Achieve Carbon Peak in 2025. Retrieved from https://www.yicai.com/news/101016814.html
13. China Building Materials Federation. Building Materials Industry Issues a Carbon Peak and Carbon Neutrality Action Initiative. Cement and Other Industries Should be the First to Achieve Peak Carbon by 2023. Retrieved from http://www.cbmf.org/cbmf/xydt/xyxx/7051160/index.html
14. Dr. Mi Zhifu: China Will Achieve Peak Carbon Ahead of Schedule. Retrieved from https://www.iyiou.com/interview/202104281017148
15. NCSC. Analysis of China's Carbon Emission Peak Situation Under the New Normal. Retrieved from http://www.ncsc.org.cn/yjcg/zlyj/201801/P020180920508766067159.pdf
16. National Business Daily. The country's latest electricity consumption map. Retrieved from https://m.nbd.com.cn/articles/2021-04-21/1709804.html?formPage=shareRepoter

Geographic Distribution of Digital Infrastructure in China

In 2020, just five regions were responsible for approximately 54% of all carbon emissions from digital infrastructure in China: Hebei (24 million tonnes), Jiangsu (13 million tonnes), Beijing (11 million tonnes), Guangdong (10 million tonnes), and Zhejiang (8 million tonnes).

Carbon emissions from data centers in Hebei and Jiangsu accounted for 35% of all data center emissions nationwide in 2020.

In response to China's pledge to peak carbon emissions by 2030, provincial governments are required to formulate plans to peak emissions in their provinces. Rising carbon emissions from digital infrastructure present a significant challenge for provincial governments to consider.

Opportunities for Renewable Energy Procurement

A transition to 100% renewable energy use is the most effective pathway to reduce direct emissions and achieve carbon neutrality. Internet companies in China can increase their renewable energy use via:

1. Investment in distributed solar and wind projects
2. Investment in utility-scale centralized renewables projects
3. Direct power purchase from renewable energy generators
4. Purchase of green power certificates

While China's digital infrastructure industry has made significant progress in terms of energy efficiency, much less progress has been made on renewable energy use.

In many regions of China, wind and solar energy have already reached grid parity. By 2050, their levelized cost will drop to 20-30 USD/MWh, significantly lower than coal (40 USD/MWh).[17] Meanwhile, the cost of energy storage is also falling rapidly and is projected to halve between 2019 and 2030.[18] Given these promising trends, renewable energy is on track to soar over the next decade, creating abundant opportunities for internet companies to transition to 100% renewable energy by 2030.

17. BNEF. 2019 New Energy Outlook.
18. BNEF. Energy Storage System Costs Survey 2020.

Policy Recommendations

Researchers provide the following recommendations:

For policymakers:

1. Formulate a sectorial carbon peak and carbon neutrality action plan, and guide the sector's transition to 100% renewable energy as soon as possible.
2. Mandate that companies utilize renewable energy to power digital infrastructure. Link provincial energy consumption and energy intensity caps (aka "dual control targets") with digital infrastructure construction approval policies.
3. Enhance electricity market reform and trading mechanisms, further enable digital infrastructure companies to directly procure renewable energy, and increase flexibility of the green power certificate trading market.
4. Create financial incentives to promote the use of renewable energy in the internet industry, such as tax incentives, subsidies, and access to green finance.

For internet companies:

1. Achieve 100% renewable energy and carbon neutrality (scope 1-3) by 2030.
2. Scale up renewable energy procurement and actively collaborate with local governments, grid companies and power retailers to expand renewable energy procurement market mechanisms.
3. Actively disclose energy and greenhouse gas emission data, and corporate environmental governance information.

Methodology

Researchers relied on a combination of field work and existing literature to model the electricity consumption and energy mix of digital infrastructure in China and to issue forecasts for growth in energy consumption and carbon emissions.

Data was derived primarily from on-site investigation and public sources, including government information platforms, reports from national scientific research institutions, industrial associations, and corporate publications. Market scale and energy consumption data was collected for major cities across China.

Nationwide statistics were calculated based on a model developed by China Saibao Lab (CEPREI) Calibration and Testing Center, also known as The Fifth Electronic Research Institute at the Ministry of Industry and Information Technology. Total carbon emissions for the digital infrastructure sector were calculated by experts from the National Center for Climate Change Strategy and International Cooperation (NCSC).

Due to data limitations, the following factors are not included in the scope of the study:

1. Emissions from smart devices, such as mobile phones, computers, tablets, smart wearables, etc.
2. Upstream emissions from materials used in the manufacture and construction of digital infrastructure and equipment, such as steel, cement, and metals
3. New energy demand and corresponding carbon emissions from next generation compute-intensive applications like AI, quantum computing, blockchain, autonomous driving, virtual reality, etc.
4. Slowing Moore's Law and associated efficiency gains

The omission of these factors means that this report may be relatively conservative in its forecasts of 5G and data center energy consumption and carbon emissions.

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