Low Carbon Odyssey - People’s Republic of China’s Story

China’s Energy Transition toward Carbon Neutrality

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Accelerating the Clean Energy Transition and Ensuring Energy Security and Affordability – Time for Urgent Action Now

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Featured Speaker
China's CO₂ emissions has rebounded since 2017 (albeit at a slower pace), driven by the growing demand for coal-dominated power.

- China’s CO₂ emissions\(^1\) reached 12.6 Gt in 2023, mainly due to the surge of energy demand out of the post-COVID economic recovery, i.e., the growing passenger transport demand and energy-intensive industries esp. the chemical industry, though the growth is slowing down in the long run.

- CO₂ emissions by power sector expanded, driving overall emissions growth, while industry's share is decreasing.

Note 1: CO₂ emissions here include energy-related and industrial processes emissions.

Source: Energy Foundation China Analysis, IEA, NBS
China's power demand surged, spurred by extreme weather, energy-intensive, high-tech & equip mfg. and services sectors

- 2022 power demand: grew by 3.6%, residential use accounted for 50% of increase (high temperature).
- 2023 power demand: increased by 6.7%
  - Industry: contributed 65% of total growth, led by the four energy-intensive (20%) and high-tech & equip. mfg. (18%)
  - Services: contributed 31% of total growth
    - Wholesale and retail trades grew by 17.5%; hotels and catering services grew by 16.4%;
    - Transport, storage and post grew by 14.2%; leasing and business services grew by 16.3%.

Source: Energy Foundation China Analysis, CEC
Strategic emerging industries is driving China's economy, and its growing energy demand will increase China's power consumption in the future.

- The digital industry: consumed 370 TWh, 4.5% of total power consumption in 2022. Data centers consumed 76.6 TWh in 2022 and projected to reach 400 TWh by 2030.
- New Energy Vehicle industry: consumed 80 TWh in 2023, and will grow to 400 TWh by 2030.
- Power demand surge in High-tech & Equip. Mfg., grew by 11.3% in 2023.

Source: Energy Foundation China Analysis, CAICT
China is transitioning away from coal, to meet new power demand with diverse sources

- In 2023H1, hydro power fell 22.9% due to drought, leading to clean energy shortfall March to July, while newly added power demand peaked in September & December, boosted coal (base load) use.

- High RE installed capacity but less actual generation: Wind & solar surged to 293 GW in 2023, doubled that of 2022. However, power generation was lower, with 44.3% installed in Q4, due to the late installation rush by 2023.

Source: Energy Foundation China Analysis, CEC
Non-fossil fuel generation growth is expected to outpace power demand growth, putting China on path to peak CO₂ emissions

- Non-fossil fuel will contribute 105% of the power generation increase, and coal power will decline, assuming a 6% growth in power usage and no weather extremes in 2024.

- Coal power capacity will reach 1,250 GW by 2025, but the operation hours are projected to decrease.

**Projection of Power Generation by Energy Source in 2024**

- **Hydro**: 91 TWh
- **Biomass**: 13 TWh
- **Nuclear**: 47 TWh
- **Wind & Solar**: 444 TWh
- **Coal and Gas**: -28 TWh

2023's Power Generation: 9,456 TWh
2024's Projected Power Generation: 10,024 TWh

Note: The operation hours of each energy source (excluding coal, gas, and hydro) are assumed to be the same with those of 2023. Use power generation growth to represent the power demand growth.

Source: Energy Foundation China Analysis, CEC
Wind and solar will continue to expand rapidly and dominate in meeting the power demand growth.

**Wind and Solar Capacity Addition Projection, 2024-2030**

- **Wind Capacity Addition:** 75.9, 90.0, 112.0, 134.0, 156.0, 178.0, 200.0, 216.9, 224.5, 213.0, 227.5, 242.0, 247.0, 252.0
- **Solar Capacity Addition:** 88.7, 170.5, 224.5, 213.0, 227.5, 242.0, 247.0, 252.0

**Power Demand Growth vs. Wind & Solar Generation Addition, TWh**

- **Wind Addition:** 292.8, 259.2, 314.5, 325, 361.5, 398, 425, 452
- **Solar Addition:** 88.7, 170.5, 224.5, 213.0, 227.5, 242.0, 247.0, 252.0

Note: Considered GDP growth rate projection from multiple sources and electricity production elasticity coefficient. Projected 2024 wind and solar capacity additions are based on CEC’s estimates (relatively conservative). From 2025 to 2030, forecasts are from China Photovoltaic Industry Association’s conservative scenario and Chinese Wind Energy Association. Use power generation growth to represent the power demand growth.

Source: Energy Foundation China Analysis, CEC

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Carbon peaking trends in different provinces (Kuznets curve grouped by GDP per capita)

GDP per capita 80-160K RMB

GDP per capita 50-80K RMB

GDP per capita 30-50K RMB

Note: CO₂ emissions per capita encompass both scope 1 and 2 emissions. GDP per capita is at constant 2020 prices.

Source: Energy Foundation China Analysis, 2021
Carbon peaking progress across Chinese provinces

- 13 provinces ~40% emissions, have peaked
- 10 provinces ~40% emissions, nearly peaked
- 7 provinces ~20% emissions, still growing

China could achieve carbon peaking by 2025, with energy-related CO₂ emissions peaking at 10.6 billion tons.

Source: Energy Foundation China Analysis, 2021
Map is only for data presentation purposes.
From 2025 to 2035, China's CO\textsubscript{2} emissions\textsuperscript{1} are forecasted to reduce by 2.58 Gt, with a further decrease of 7.44 Gt by 2060.

Note 1: CO\textsubscript{2} emissions here only include energy-related emissions.
Early adoption and mature technologies are key to decarbonization: over 80% by 2035 and over 65% from 2035 to 2060

CO₂ Mitigation by Tech Readiness Levels

Source: Tsinghua Analysis
Significant carbon emissions reduction through technologies with negative abatement costs: 60% by 2035 and 55.5% by 2060

Incentive priorities

Note: Energy efficiency is accounted for within each technology.

Source: Tsinghua Analysis
Conclusions

Restructured demand for power will continue to grow while CO₂ emissions will decline towards net-zero. Efficiency improvement will go on.

Non-fossil power increase, esp. solar and wind, will determine the pace and extent of transition away from fossil fuel, with higher penetration and lower costs.

Energy storage and grid development will be key to stabilize power system with growing share of renewables.

Electrification of end users will maximize the role of power decarbonization.

In the coming decade, we should target and prioritize investment in and deployment of mature technologies (e.g., efficiency, nuclear, hybrid shipping, and renewables), with a focus on providing market incentives from carbon pricing and green finance (in view of competing opportunity costs).
THANK YOU