

China Methodology

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This document describes how Ember produces electricity generation data for China. It supplements our main [Data Methodology](#), which describes our datasets, definitions and general methods.

It covers the following datasets:

- Monthly and annual national electricity generation (TWh), by fuel type
- Monthly and annual provincial electricity generation (TWh), by fuel type

Monthly generation data is available from 2016. Annual national data is available from 2000, and annual provincial data from 2011.

All data is available to download for free on the Ember website. It is provided on an 'as is' basis, and is assembled using the best data available to us at any given time. Every effort has been made to ensure accuracy, and where possible we compare multiple sources to confirm their agreement. We take no responsibility for errors.

If you notice an issue or have any suggestions, comments, or questions, please do contact us at data@ember-energy.org.

Overview

No single public source gives a complete picture of China's power generation. The monthly statistics published by the National Bureau of Statistics (NBS) cover only larger enterprises, report thermal generation as a single total, and significantly under-report solar generation, as most distributed solar falls outside the reporting threshold. Sources with fuller coverage, such as the annual statistics published by the NBS and the China Electricity Council, are published less frequently and on a longer lag.

We therefore produce our China data by combining sources. Monthly NBS data provides the timely month-to-month shape of generation, and is disaggregated and corrected using quarterly and annual sources with fuller coverage. Provincial data is produced by a similar approach..

Sources

- National Bureau of Statistics of China (NBS) - monthly generation from thermal, hydro, nuclear, wind and solar power. Only enterprises with annual revenue above RMB 20 million ("above designated size") are covered. NBS also publishes annual statistics with full coverage, covering national generation by fuel and provincial generation totals with thermal and hydro.
- China Electricity Council (CEC) - annual provincial generation by fuel. CEC statistics have substantially fuller coverage than NBS monthly data, but thermal generation is consistently lower than NBS annual data.
- National Energy Administration (NEA) - quarterly national generation from wind, solar, hydro and bioenergy, and quarterly provincial solar capacity split between utility-scale, distributed and residential installations.
- Energy Institute (EI) - annual generation by fuel from the Statistical Review of World Energy, which is consistent with final NBS annual statistics.
- Carbon Monitor - independent daily estimates of generation by fuel based on non-public CEC data. Used to split thermal generation into coal, gas and other fuels.
- CEC new energy generation index - a monthly index of new energy generation published by the CEC, used to correct solar values for the most recent year.
- National New Energy Consumption Monitoring and Early Warning Center - monthly provincial wind and solar utilisation rates. Compiled by Robbie Andrew.
- ERA5 - hourly weather reanalysis data from ECMWF, used with the atlite library to model solar output by province.
- Global Energy Monitor (GEM) - unit-level capacity data for coal, gas, oil, bioenergy and utility-scale solar plants, including locations and operating dates.

National monthly generation

Correcting NBS data

NBS reports monthly generation from thermal, hydro, nuclear, wind and solar power, but only covers enterprises with annual revenue above RMB 20 million. Coverage of a given year improves as more enterprises enter the reporting sample, which has two consequences:

- Reported levels are understated, most severely for solar: distributed installations are largely absent from the statistics, and small enterprises are more common in the wind and solar industries.
- Reported year-on-year growth rates are calculated on a more complete sample than the previously published levels, so levels and growth rates are mutually inconsistent.

We correct for this as follows:

- Earlier years are revised by back-calculating from the following year's reported level and year-on-year growth rate.
- The most recent year, where no back-calculation is possible, is scaled using the average historical correction factor for each fuel.

NBS does not publish a January figure, and reports February as a combined January-February total. We estimate the split by interpolating between December and March and rescaling so that the two months sum to the reported total. For thermal generation, the split is taken from Carbon Monitor data, which captures the drop in generation around Lunar New Year.

Hydro and nuclear generation are taken directly from the corrected NBS data.

Wind, solar and bioenergy

Even after the corrections above, NBS wind and solar generation remain underestimated. We use the corrected NBS series to provide the month-to-month shape, and use Denton proportional benchmarking to scale them to sources with fuller coverage:

- NEA quarterly generation data, which includes distributed solar. NEA figures are preliminary, so complete years are scaled to match annual totals.
- EI annual totals.

Bioenergy is estimated entirely from the NEA quarterly and EI annual data.

For the most recent months, where quarterly and annual benchmarks are not yet available, correction factors are projected forwards based on recent years. Months based on projected

factors are then aligned with the CEC's monthly new energy generation index, with differences assigned to solar.

Thermal generation by fuel

NBS reports thermal generation as a single total. We disaggregate this into coal, gas, other fossil and bioenergy:

- Monthly fuel shares of thermal generation are taken from Carbon Monitor, after rescaling Carbon Monitor so that its annual totals for each fuel match our annual series, and smoothing out implausible month-to-month jumps in the shares.
- These shares are applied to the NBS thermal total. For recent months not yet covered by Carbon Monitor, shares are estimated by carrying forward each fuel's year-on-year share change.
- Before 2019, the first year covered by Carbon Monitor, monthly shares are estimated by combining Carbon Monitor's average seasonal profile with EI's annual fuel shares, with coal calculated as the residual.
- The small remainder of thermal generation that cannot be attributed to a specific fossil fuel is split between other fossil and bioenergy, keeping other fossil generation within a plausible range and keeping bioenergy consistent with the estimate described above.

National annual generation

- Annual generation is taken from EI. For China, EI reports pumped storage output within other fossil generation; we therefore estimate pumped storage output as the difference between NBS and EI annual hydro data, and remove it from other fossil.
- For years not yet covered by EI, values are estimated by applying year-on-year changes from our annualised monthly data to the latest annual values, following the approach described in our main methodology.

As for most countries in our dataset, summing our monthly values will not exactly reproduce our annual values, as annual data has fuller coverage.

Provincial monthly generation

We produce monthly generation by fuel for 31 provinces. Provincial values are estimated to be consistent with the national series: for each month and fuel, provincial values sum to the national total.

NBS provincial data is corrected in the same way as the national data. Because provincial correction factors are noisy, particularly for small generation bases, each province's

correction factor is shrunk towards the national average, with more weight given to the province's own factor where its generation is larger.

Solar

Provincial solar generation requires the most estimation, as the generation missing from NBS reporting is not evenly spread across provinces. We build a physical model of provincial solar output:

- Provincial capacity, split between utility-scale, distributed, and residential installations, is taken from NEA quarterly reporting and interpolated to monthly values.
- Hourly output per unit of capacity is simulated from ERA5 weather data: at known plant locations (from GEM) for utility-scale solar, and weighted by population density for distributed and residential solar.
- Output is adjusted for curtailment using provincial monthly utilisation rates.

The gap between national solar generation and the sum of NBS provincial reporting is allocated across provinces in proportion to modelled output. The allocation is weighted towards output from smaller installations, which drive the under-reporting, and calibrated against each province's under-reporting observed in annual benchmarks. NBS monthly reporting is used as a minimum for each province, and provincial values are rescaled to sum exactly to the national total.

Annual benchmarks are taken from CEC provincial data up to the most recent year available and derived from NBS annual statistics for later years. Because the NBS annual statistics have full coverage, solar can be calculated as the residual after subtracting thermal, hydro, nuclear and wind from the provincial total, with nuclear and wind taken from our monthly series. NBS publishes provincial thermal and hydro one year behind provincial totals, so for the most recent year these are estimated from our monthly data and scaled to match published national totals. In provinces where this estimate seems unreliable, we instead use an earlier year as the most recent benchmark.

Beyond the most recent year of available annual data, calibration factors are projected forward using ridge regression.

Wind

The gap between national wind generation and the sum of NBS provincial reporting is allocated across provinces according to each province's historical share of the difference between CEC annual provincial data and NBS reporting. Provincial values are rescaled each month to sum exactly to the national total.

Thermal generation by fuel

Provincial thermal generation totals are taken from the corrected NBS data, and the split into coal, gas, other fossil and bioenergy is estimated using iterative proportional fitting: starting from each province's capacity mix (from GEM), values are repeatedly scaled to match both the national total for each fuel and each province's total thermal generation.

Hydro and nuclear

Hydro and nuclear generation are taken directly from the corrected NBS provincial data.

Provincial annual generation

- From 2011, annual provincial generation by fuel is taken from the CEC, with thermal generation split into coal, gas, other fossil and bioenergy using the same capacity-based fitting approach as the monthly data.
- For years fully covered by our monthly provincial data (2016 onwards), annual values are the sum of the monthly estimates.
- National values in the provincial dataset are taken from our national annual series. Because the national annual series is based on annual sources with more complete coverage, the sum of provinces can differ slightly from the national total in this dataset.

Caveats

- **January and February:** NBS reports January and February together, and for most fuels we interpolate the split between the two months. This does not capture the reduction in generation around Lunar New Year, except for thermal generation, where daily data is available.
- **Distributed solar:** A large share of China's solar generation comes from distributed installations that are not directly captured in the statistics we use. Provincial solar figures therefore include significant estimation.
- **Pumped storage:** Pumped storage output is excluded from annual national generation by fuel, but may be included in other series. We will correct this issue in future.