

Methodology for China Renewable Profiles

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Overview

To conduct a technical assessment of VRE resources, we first obtain hourly simulation records of atmospheric properties, including temperature, wind speeds, and solar irradiance in 2015 at a spatial resolution of 0.3125° longitude by 0.25° latitude (approximately 30 by 28 km per grid cell at mid-latitudes) from the Goddard Earth Observing System (GEOS-5).

Using the technical parameters of General Electric 2.5-MW and Vestas 8.0-MW turbines, we estimate hourly capacity factors (CF) at 100-m hub height for onshore and offshore wind, respectively. Similarly, using the technical parameters of a fixed-tilt solar module (e.g., 19.9% module conversion efficiency, and 83.2% system performance coefficient) in addition to the GEOS-5 records, we estimate hourly capacity factors at 2 m above the displacement height for both utility-scale and distributed solar. We use the observed records from the Global Solar Atlas to adjust the calculated capacity factors. Detailed procedures are provided in our previous work [1].

To calculate the maximum deployment potential per grid cell, we first calculate the suitable areas per grid cell for renewable deployment based on land use data in 2018 at a 30-m spatial resolution. In this procedure, we consider a wide range of land suitability assumptions, such as preferences for low slopes and altitudes and for certain land types with fewer competing uses. For example, the National Energy Administration and other ministries have issued land use regulations that restrict solar deployment on productive agricultural lands, where we assume only a small fraction (2-20%) is available for solar, while wind can be deployed on most (80-100%) of the croplands, grasslands, shrublands, and barren lands. Detailed land use assumptions are provided in our previous work [1].

Then, we assume that each wind turbine requires an area of 10 rotor diameters in the downstream direction and 5 rotor diameters in the crosswind direction to calculate the deployment potential in MW per grid cell for both onshore and offshore wind. For utility-scale solar, we assume each square kilometer area can deploy 161.9 MW of solar and discount the deployment potential by packing factors as a function of latitude. For distributed solar, we first estimate the built-up area per grid cell using NASA's Moderate-Resolution Imaging Spectroradiometer (MODIS) land cover data. Then, we assume 15% of the built-up areas are buildings and 50% of their rooftop areas are available for deploying distributed solar.

We adopt a levelized-cost-of-electricity (LCOE) method to conduct an economic assessment for each 0.3125° by 0.25° grid cell. Total lifetime costs of wind and solar include generation (i.e.,

capital, maintenance, and operations) and grid connection costs. The generation component is estimated based on the input assumptions of renewable costs, considering percentage decreases in each simulation period. The grid connection component refers to the costs of connecting wind and solar resources in each grid cell to the nearest major node on the transmission network. Specifically, spur lines are used to connect cells to substations, and trunk lines are used to further connect substations to the nearest major nodes. In this approach, we simultaneously determine the capacities of spur and trunk lines, and wind and solar capacities in each grid cell. Lastly, we use the total lifetime costs and the estimated capacity factors to calculate cell-level LCOEs. Note that we do not consider distribution network details.

Data Format

The dataset is provided in **CSV format, compressed as a ZIP file**.

Each row represents a **renewable energy grid cell with estimated deployment potential and capacity factor time series data**.

Field	Description
<code>index</code>	Grid cell ID
<code>latitude</code>	Latitude of the grid cell center
<code>longitude</code>	Longitude of the grid cell center
<code>province</code>	Province where the grid cell is located
<code>capacity_GW</code>	Maximum deployable renewable capacity in gigawatts (GW)
<code>h1 ... h8760</code>	Estimated capacity factor for each of the 8,760 hours of 2015, one column per hour, rounded to four decimal places

References

[1] Zhang D, Zhu Z, Chen S, Zhang C, Lu X, Zhang X, Zhang X, Davidson MR. Spatially resolved land and grid model of carbon neutrality in China. *Proc Natl Acad Sci* 2024;121(10). <http://dx.doi.org/10.1073/pnas.2306517121>.