

# Methodology for Indonesia Renewable Profiles

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## Overview

This document outlines the methodology for generating Indonesia renewable profiles.

This analysis identifies candidate sites for captive (behind-the-meter) renewable generation co-located with heavy industrial facilities in Indonesia. For each facility, it conducts a solar and wind resource assessment within a 10-km buffer radius of the site, then constrains the resulting capacity-factor surfaces to land that is physically and environmentally suitable for development. The grid-level renewable resource assessment follows the resource potential evaluated by MEMR in the Rencana Usaha Energi Nasional (RUEN); the captive assessment narrows this to the facility neighborhood.

We developed a notebook to implement the steps below using the open-source [geodata](#) package, which converts ERA5 reanalysis data into renewable capacity factors and provides the masking and shape-extraction primitives used for siting.

## Data Fields

| Field                        | Description                                                                          |
|------------------------------|--------------------------------------------------------------------------------------|
| <code>time</code>            | Timestamp of the data point (hourly)                                                 |
| <code>y</code>               | Grid index in the y-direction                                                        |
| <code>x</code>               | Grid index in the x-direction                                                        |
| <code>lat</code>             | Latitude of the grid cell center                                                     |
| <code>lon</code>             | Longitude of the grid cell center                                                    |
| <code>capacity_factor</code> | Renewable energy capacity factor (ratio of actual output to maximum possible output) |

## Workflow Overview

1. Download ERA5 surface and wind data for the Indonesian bounding box and build a geodata cutout for the analysis year.
2. Convert the cutout to solar and wind capacity-factor surfaces.

3. Build a suitability mask from the KLHK land-cover layer and the USGS slope layer, then merge them.
4. Buffer each industrial facility by 10 km and extract the merged suitability mask within each buffer.
5. Overlay the capacity-factor surfaces on the per-facility suitable area to estimate deployable potential.

## Renewable Resource Assessment

Solar and wind capacity factors (CF) are estimated per grid cell on an hourly basis over a representative year using the ERA5 reanalysis product from the Copernicus Climate Data Store. ERA5 provides global hourly climate variables on a  $0.25^\circ \times 0.25^\circ$  (~30 km) grid. In geodata, these variables are downloaded with the `wind_solar_hourly` configuration and assembled into a *cutout* — a subset of the data bounded by a region and time range — which is then converted to physical power and capacity factors.

Solar PV generation is computed using a fixed-tilt KANEKA panel at latitude-optimal orientation. Wind generation is computed using an onshore turbine power curve at a 90 m hub height. CF is the ratio of generated energy to the theoretical maximum at full capacity. Key parameters are summarized in Table 1.

| Parameter                | Solar                                   | Wind                                     |
|--------------------------|-----------------------------------------|------------------------------------------|
| Reanalysis source        | ERA5 (single-levels, hourly)            | ERA5 (single-levels, hourly)             |
| geodata config           | <code>wind_solar_hourly</code>          | <code>wind_solar_hourly</code>           |
| Native grid              | $0.25^\circ \times 0.25^\circ$ (~30 km) | $0.25^\circ \times 0.25^\circ$ (~30 km)  |
| Conversion call          | <code>cutout.pv()</code>                | <code>cutout.wind()</code>               |
| Technology               | Fixed-tilt PV (KANEKA panel)            | Onshore turbine (Siemens SWT-107 3.6 MW) |
| Orientation / hub height | latitude-optimal tilt                   | 90 m hub height                          |
| Slope exclusion          | > 5%                                    | > 20%                                    |

**Table 1.** *Parameters used in the solar and wind capacity-factor estimates. Panel and turbine choices mirror the geodata resource library; slope thresholds follow standard siting practice.*

## Candidate Site Definition

Captive renewables must be sited close to the industrial load they serve. Candidate areas are therefore restricted to a 10-km buffer radius around each facility. Facility coordinates are read into a geopandas frame; each point is buffered by 10 km in a metric CRS and passed to the masking step.

## Geospatial Suitability Masking

The availability of land is a key constraint on deployable capacity. A suitability mask is assembled in geodata from two raster layers:

- **Land use** — obtained from the Ministry of Environment and Forestry (KLHK) database. Critical land elements such as forest and residential areas are identified and excluded from the assessment.
- **Slope** — obtained from EarthExplorer (USGS). Areas exceeding the slope thresholds in Table 1 (5% for solar, 20% for wind) are excluded.

Each layer is added and filtered to a binary suitable/unsuitable surface, and combined so that a grid cell is retained only where every constraint is satisfied. The merged mask is then extracted within each facility buffer and overlaid on the solar and wind CF surfaces to yield the suitable, resource-weighted area available for captive deployment at each site.

### Note on Geothermal

Geothermal resources at captive sites are assessed separately from this geodata workflow. Heat-flow point data from the IHFC Global Heat Flow Database are interpolated by ordinary kriging onto a 500 m grid, and a suitability mask retains only areas within each facility buffer exhibiting heat flow of at least 80 mW/m<sup>2</sup>.