High-Resolution Southeast Asia Wind Resource Data Set

High-fidelity, time series wind data for Southeast Asia is publicly available via RE Data Explorer

Figure 1. *Wind speed data over 9 years at a 3-km resolution, produced by GANs and used in the Southeast Asia Wind Resource Data Set.* (Image by Billy Roberts, NREL)

Informing Wind Decisions

Well informed decision-making is a key part of integrating variable renewable energy into the global energy marketplace. Stakeholders and country leaders need trusted, publicly available, comprehensive data to meet their ambitious renewable energy targets and put global power system decarbonization within reach.

Successful decarbonization strategies will optimize the use of wind energy. As Southeast Asia seeks to establish its clean energy economy, access to accurate wind data will be essential in planning new and ongoing wind energy projects. Considering Southeast Asia's increasing population and development needs, demand for clean energy will only grow, necessitating accurate data for decision-making.

The U.S. Agency for International Development (USAID) and the National Renewable Energy Laboratory (NREL) are supporting Southeast Asian nations through the Advanced Energy Partnership for Asia by providing a high-fidelity time-series wind resource data set to accelerate renewable energy integration and increase access to clean, affordable, and reliable energy throughout the region.

This data set, available through the USAID-NREL Partnership's Renewable Energy (RE) Data Explorer, provides access to fine spatial resolution wind data. Policymakers, technical advisors, project developers, researchers, and other stakeholders can use this data with modeling soft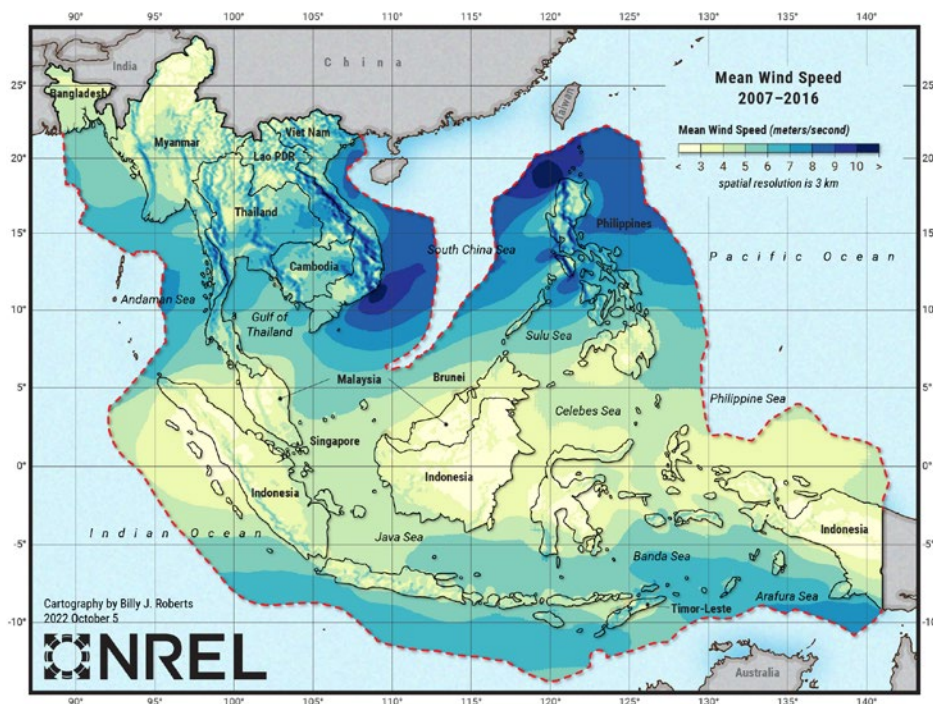ware to inform decisions regarding wind energy project development, long-term energy planning, and power system operations. **With a 3-km spatial and 15-minute temporal resolution and a 15-year record, this first-of-its-kind public data set supports the informed deployment of wind energy across Southeast Asia.**

Building on Prior Models

The fifth generation of the European reanalysis data set (ERA5) provided the initial atmospheric conditions across the globe needed to develop the wind resource data set. Using a combination of satellite data and ground measurements, ERA5 models global historical weather and climate conditions, including the atmospheric processes that impact wind resources. ERA5 has a spatial resolution of 30 km and a long-term record with hourly time steps; however, the local conditions that are important for wind energy production are not captured sufficiently at this spatial resolution.

The Weather Research and Forecasting (WRF) model was then used to refine the resolutions of the ERA5 data set. WRF is a multidimensional model that predicts environmental variables (e.g., wind speed and direction, temperature) across space and time at multiple heights above the surface. It also models the lower atmosphere with higher
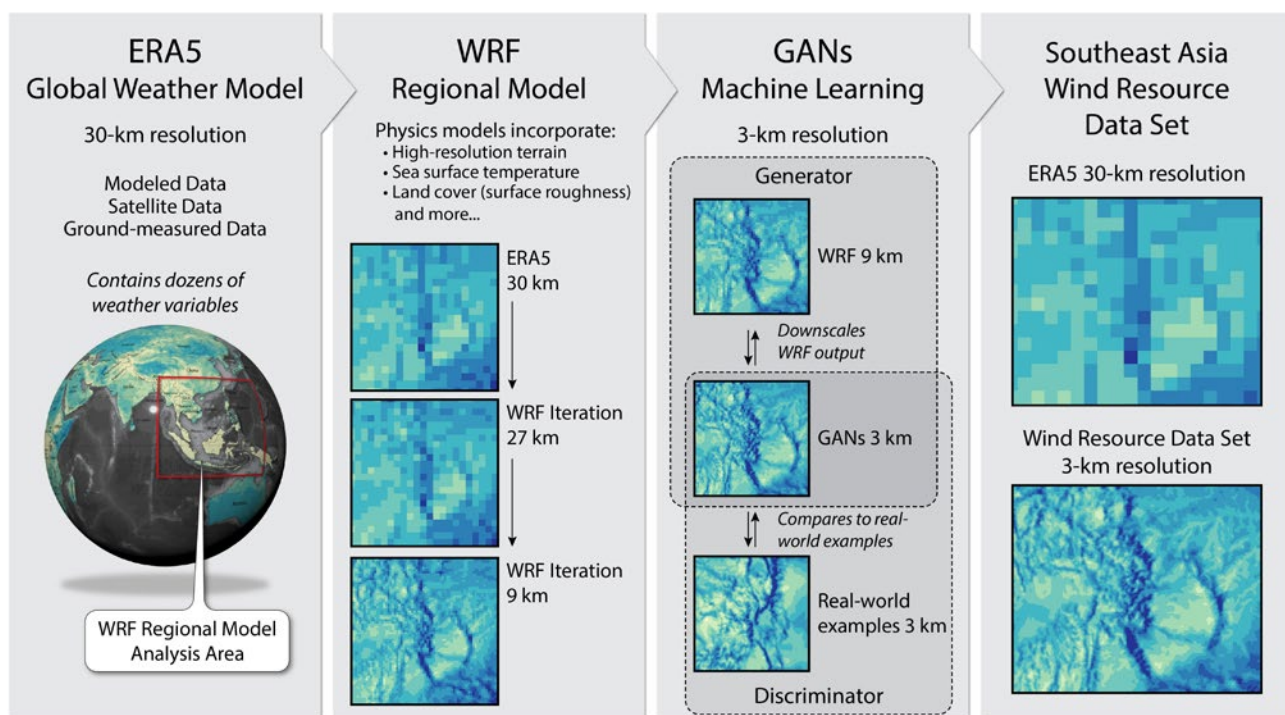
USAID FROM THE AMERICAN PEOPLE   NREL Transforming ENERGY

Figure 2. *The difference in resolution and other factors between models used for wind speed data generation. (Image by Billy Roberts, NREL)*

fidelity than ERA5, which is particularly important for wind energy applications. The WRF model iteratively refines that resolution for smaller and smaller spatial extents.

While this process increases the resolution and fidelity in each iteration, it does so with increased computational expense. Beyond 9-km hourly data, the WRF model was too computationally intensive to efficiently produce a long-term, high-resolution data set covering Southeast Asia. To meet the data needs of stakeholders, modelers, and decision makers, a more efficient solution for producing wind resource data was needed.
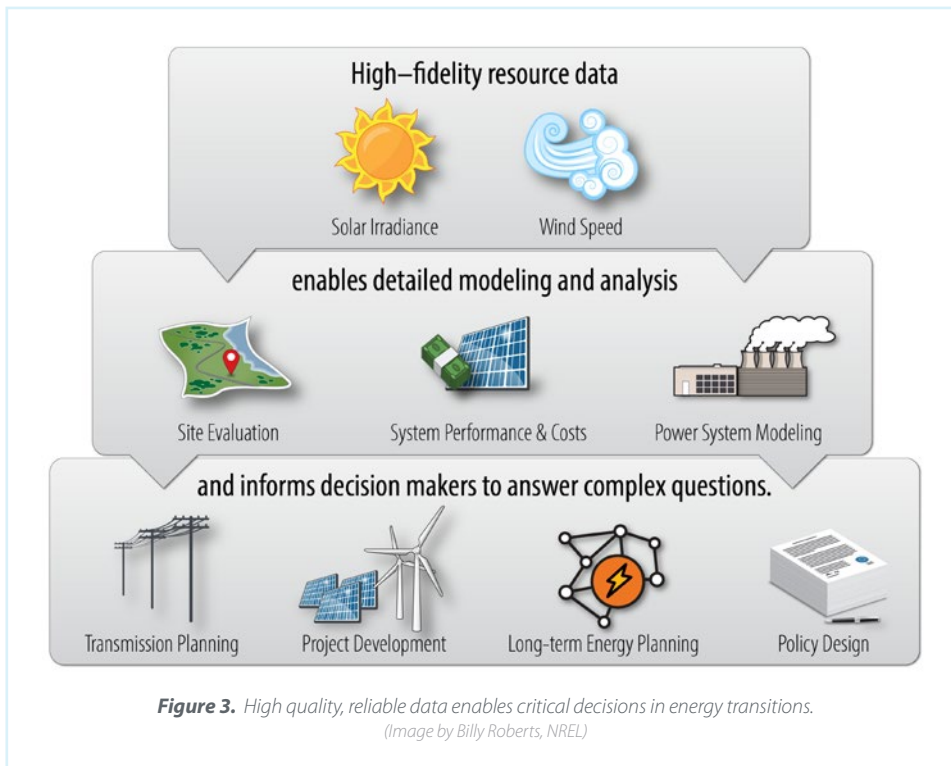
Introducing Machine Learning

The Southeast Asia Wind Resource Data Set solves these challenges. Understanding the computational constraints of WRF, machine learning was used to make data production more efficient while ensuring similar levels of accuracy. Using a method called Generative Adversarial Networks (GANs), researchers trained physics-based deep learning models to refine the atmospheric processes in the WRF outputs. The approach uses two models, the "generator" and the "discriminator" which work together to iteratively increase the spatial and temporal resolutions while capturing the important atmospheric processes for wind energy applications. After learning these natural patterns, the approach can produce a time series of wind resource data (including wind speed, direction, temperature, and air pressure).

Before this approach, creating regional data sets with traditional models was prohibitively time-consuming and expensive. But by using GANs, researchers produced a 3-km, 15-minute, and 15-year data set covering Southeast Asia with 16 times better computational efficiency than WRF alone.

Accessing through RE Data Explorer

The Southeast Asia Wind Resource Data Set is available at no cost to the public through the USAID-NREL Partnership's RE Data Explorer tool, as well as through APIs and highly scalable data services, where it can be accessed through Python or other scripting languages. It is also compatible with NREL's System Advisor Model (SAM) to evaluate system performance and estimate project costs. By making the data set accessible in SAM, developers can use it to model potential wind farm sites, develop project plans, determine risk, and pursue financing. Policymakers and advisors can also model the resource potential at regional and national scales, allowing them to develop energy deployment targets and commission national grid integration studies.

In combination with other data available through RE Data Explorer, like the high-fidelity solar irradiance data for Southeast Asia, stakeholders are empowered to site wind and solar photovoltaic (PV) farms in efficient locations and illustrate the reliability of their projects to potential funders.

Figure 3. *High quality, reliable data enables critical decisions in energy transitions.*
(Image by Billy Roberts, NREL)

Looking Toward the Future

To achieve regional-and national-level objectives, Southeast Asia's energy sector requires high-quality, public data for power system modeling, renewable energy target-setting, integrated PV-wind planning, and prefeasibility assessments.

By developing a novel approach to accurately modeling wind resources across Southeast Asia, the Advanced Energy Partnership for Asia is expanding access to the resource data needed to scale renewable energy integration and accelerate Southeast Asia's net-zero transition. The Southeast Asia Wind Resource Data Set will help ensure regional growth and development are informed by high-quality data.

The Advanced Energy Partnership for Asia is proud to launch the Southeast Asia Wind Resource Data Set for public use.

High-Fidelity Resource Data is Integral to Smart Decision-Making

RE Data Explorer is a user-friendly, publicly accessible geospatial application that hosts a wide variety of renewable energy data to support renewable energy analysis, modeling, and decision-making around the world. Access to the Southeast Asia Wind Resource Data Set enables a variety of stakeholders to participate in modeling and analysis and answer complex questions related to project development, energy planning, and more. RE Data Explorer:

- **Provides best-in-class data from around the world**
- **Offers intuitive and user-driven analysis capabilities**
- **Contains a breadth of renewable energy resources and technologies for analysis**
- **Integrates with complementary tools and models such as SAM**
- **Creates links between data, analysis, and decisions.**

RE Data Explorer enables vital renewable energy investment and deployment decisions around the world.

Visit **www.re-explorer.org**.