GRID INTEGRATION STUDIES: DATA REQUIREMENTS

GREENING THE GRID

Grid integration studies require a variety of inputs, including data on renewable resource availability. *Photo by Warren Gretz, NREL 00215*

A grid integration study is an analytical framework used to evaluate a power system with high penetration levels of variable renewable energy (VRE). A grid integration study simulates the operation of the power system under different VRE scenarios, identifying reliability constraints and evaluating the cost of actions to alleviate those constraints. These VRE scenarios establish where, how much, and over what timeframe to build generation and transmission capacity, ideally capturing the spatial diversity benefits of wind and solar resources. The results help build confidence among policymakers, system operators, and investors to move forward with plans to increase the amount of VRE on the grid. High quality data are critical to robust and reliable grid integration studies.

WHAT KIND OF DATA INFORM EFFECTIVE GRID INTEGRATION STUDIES?

Grid integration studies usually include several interrelated analyses (see Table 1). Input data for integration studies may include the following:

Renewable energy resource data provide the basis for estimating solar and wind generation potential, characterizing variability and uncertainty, and identifying the best locations for new renewable energy generators. Resource data describe the quantity and type of fuel (e.g., solar radiation and wind) available at a specific location and time to power renewable energy systems. Data sources include direct measurements from existing solar or wind generators, meteorological towers, and other field-based devices, or simulations based on satellite measurements (for solar) and mesoscale numerical weather prediction models (for wind) [1]. Wherever possible, modeled resource data should be calibrated using historic patterns and validated using on-the-ground measurements [2]. At a minimum, integration studies require one year of resource data for locations under consideration for renewable energy generation; multiple years of historical data will better support estimation of inter-annual variability and capture extreme events.

Load data are essential for understanding when and where electricity supply is needed within the power system and how quickly electricity demand changes. Load data provide information about the magnitude, location, and timing of electricity demand. Like solar and wind resource data, load data can be measured directly or simulated using models. In either case, load data is most useful when it is time *synchronous* with wind and solar data: the time-steps (year, day, hour, etc.) should align chronologically among the datasets so that planners can understand correlations and major trends with respect to the variability and magnitude of both electricity demand and VRE resource availability.

Forecast and forecast error data, allow power system planners to estimate generation and reserve requirements and are a key input to unit commitment and dispatch models [1,3]. Forecast data predict future electricity demand and renewable energy resource availability over a certain time horizon (e.g., hour- or day-ahead). To allow power system models to mimic the uncertainty present in power system operations, grid integration studies also require data on operational forecast errors, e.g., the difference between actual and predicted wind and solar resource and/or demand on an hourly or shorter timescale. Operational forecast errors can be simulated or derived from actual historic forecast error

IMPROVING DATA

The following measures can help improve input data in many power systems:

- Include requirements for independent power producers and self-generators to provide data on forecasts, real-time generation, meteorological conditions, forced outages, etc., into interconnection and power purchase agreements. This practice provides data to inform centralized forecasting, grid integration scenario development, and resource modeling by grid operators.
- Archive operational forecast errors for demand and VRE resources into a centralized database.
- Arrange nondisclosure agreements or other mechanisms to use proprietary data (e.g., resource data measured by project developers and power-plant specific characteristics and emission rates) for grid integration model development and calibration.
- Collect and archive sub-hourly data where possible.
- Monitor and incorporate best practices in forecasting methodologies. The international Utility Variable-Generation Integration Group (UVIG) hosts an annual forecasting workshop that can be a source of information on the evolution of solar and wind forecast methodologies.