

Wind Energy Grid Services: A Primer

System operators and governing bodies across North America are focused on the expansion of renewable energy. Advancements are ongoing as the various markets adjust and adapt to this new paradigm. This document provides insights about successes in variable generation integration, the key capabilities of wind power generation facilities, and market considerations to encourage future success.

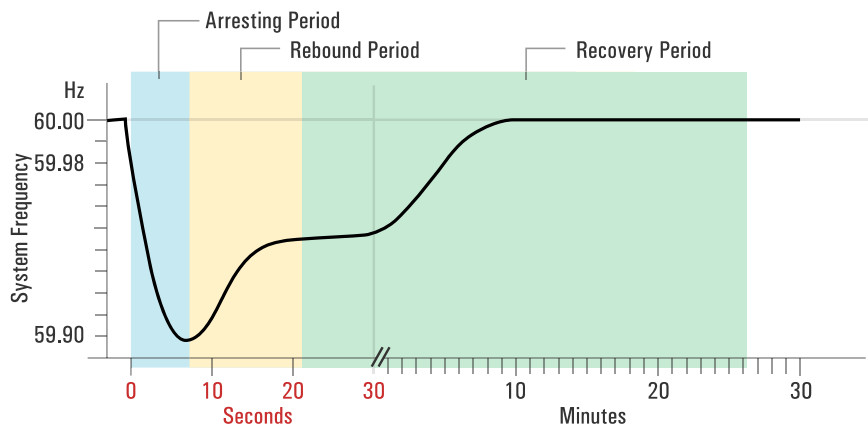
Wind energy facilities are capable of supporting grid reliability through all critical areas of operation at a competitive price. The broad range of grid services can be summarized in three general areas:

1. Regulation

Wind power offers increased flexibility over many other forms of electricity generation. Fast ramping, automatic and manual signal-following and de-centralized generation support a reliable grid. The variability of the fuel source (wind) should be considered relative to the cost of the fuel source (free) and can be accommodated for through the ability to accurately follow short timescale signals from the operator. Wind power regulation reserves are possible within a market structure that appropriately values these services and have the added benefit of being distributed across transmission and distribution networks.

2. Primary Frequency Response (PFR) and Ride Through

As a fast-acting generation source (sub-10 seconds) utilizing advanced power electronics, modern wind power facilities can provide PFR during arresting and rebound periods as well as voltage and frequency ride through support. Compensating for reduced synchronous inertia is accomplished through inverter-based technology, kinetic energy in the wind and momentum in the large wind turbine rotor.



Source: North American Electric Reliability Corporation (NERC)

3. Contingency

With the right market structure and time scale considerations, wind energy is capable of providing contingency reserves from primary to secondary to tertiary operating reserve (manual and automatic). Within markets that value these reserves, wind power can maintain a set reserve level through delta-control schemes that accommodate for wind fluctuations or simple capacity commitments based on accurate forecasting. The nature of the fuel source requires time scale considerations because forecast accuracies improve closer to real-time production. The advanced controls and shorter response times as noted above are capable of accommodating for shorter time scale demands providing the flexibility needed to operate within this dynamic.

Key Capabilities

Wind power plants are fast-acting, flexible and diverse facilities utilizing advanced hardware and control systems that can bring reliability services to the grid at a competitive price. An effective market structure and time scale considerations are required to unlock the full potential of wind energy grid services allowing for higher levels of renewable energy penetration.

What does an electricity market that takes advantage of the full potential of wind energy look like?

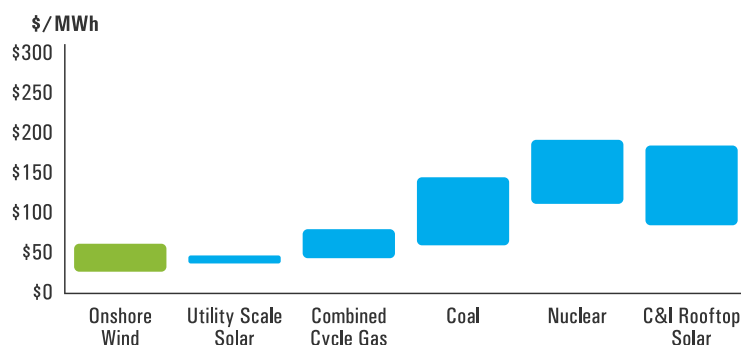
Elements

The following elements are identified as markets in which system operators are encouraged to allow wind power to contribute:

- Energy
- Capacity
- Flexibility and Ancillary Services
- Clean Energy Attributes

Exclusion from one or more of these markets restricts the potential of wind power to participate in useful and valuable ways. Wind

has proven that it can effectively compete within open, technology-agnostic markets. An approach that includes all market products is possible to prevent under-utilization of non-emitting resources. For example, compensation of wind power by a renewable energy program may result in unnecessary restriction of wind's participation in a capacity market. This may be a short-sighted policy decision to allow for comparable treatment of emitting resources that are prevented from participation in renewable energy programs due to their inability to contribute to emission reductions. This is a disparity that limits the ability of a system operator to utilize installed capacity represented by wind energy simply because it offers added clean energy attributes.



Wind energy is the lowest cost option for new electricity supply, without subsidies (Lazard 12.0)

Value

Electricity markets that unlock the potential of wind energy place a value on the services offered by these generation facilities. This incentivizes the provision of key reliability services. As attempts are made to transition the grid from fossil fuel-based production to higher penetrations of non-emitting resources, particularly wind and solar, conventional ancillary services will need to be reconsidered. The low cost and variability of wind resources may make it less economic to supply some conventional ancillary services associated with synchronous generators. However, many reliability services can be offered by wind power, often more quickly and accurately, if wind energy is not required to conform to the narrowly defined qualifiers of synchronous machines. Opening the ancillary services markets to new definitions will allow renewable energy generators to show their value in many ways through a variety of services in regulation, PFR, ride-through and contingency reserves. This also allows system operators to realize financial advantages by compensating for valuable services rather than for added infrastructure.

Time scale

Although fossil fuel prices and availability are subject to fluctuations, electricity markets have been established to accommodate for the time scale of fuel stockpiling. This has allowed system operators to be flexible enough with capacity and energy commitments to allow for variabilities in the supply chain on a day-ahead or longer time scale. Recent advancements in computation capabilities and flexibility from renewable energy sources allow for system operations that are closer to real time. Exploitation of these new opportunities can compensate for the variability of renewable energy sources. Unless control strategies are adjusted to move from conventional power generation to renewable energy, the full potential of an advanced grid with low levels of carbon emissions will be restricted.