



KEYS TO ENSURING GRID RELIABILITY IN AN ERA OF INCREASING VARIABLE ENERGY

Brattle Study: Diversity of Reliability Attributes – A Key Component of the Modern Grid

A detailed study commissioned by the American Petroleum Institute and conducted by the Brattle Group finds that as the U.S. electric industry continues to be transformed from a heavy reliance on coal and nuclear to more variable energy sources, grid operators should be focused on key reliability attributes.

As more variable energy supply comes on to the grid, driven by both economic and policy factors, the system potentially faces new reliability gaps in supporting these resources. As the trend continues, system reliability will increasingly depend on a fleet that is flexible, responsive and stable. As different fuels and technologies provide different levels of contributions to sustaining grid reliability, grid operators in both regulated and restructured markets need to increase their recognition of these reliability attributes in lock step with their growing importance. Operators should work within the market framework as much as possible, to send appropriate and transparent price signals to account for the economic benefits of reliability enabling services.

A new report, commissioned by the American Petroleum Institute and conducted by the Brattle Group, outlines some key reliability challenges and defines several crucial attributes on which grid operators should focus in maintaining and strengthening system reliability. In defining these attributes and scoring their applicability to different fuel types, the report highlights natural gas' unique ability to support grid operations across the board. Grid operators will need to fully recognize the tangible reliability benefits offered by flexible power sources, like natural gas, in offering these reliability attributes.

Key reliability attributes:

- 1. Generation capability;** No attribute is more fundamental to system requirements than the ability to generate electrical energy.
- 2. Dispatchability;** Dispatchable resources have the ability to change their output or consumption levels in response to an order by the system operator. While virtually all resources are dispatchable to some degree, some have greater capabilities than others and require shorter lead times.
- 3. Security of fuel supply;** Security of fuel supply measures the dependability of a resource's energy inputs, or fuel.
- 4. Start times and ramp rates;** Closely related to dispatchability, start times and ramp rates determine the speed at which resources can respond to system operators' orders to increase and decrease electricity delivered to the grid.
- 5. Inertia and frequency response capability;** Inertia and frequency response are attributes of resources that help the system meet the requirement to maintain frequency stability.
- 6. Reactive power capability;** The ability to provide reactive power is an attribute necessary for meeting the system's requirement to maintain voltage within certain limits to prevent generator operation malfunctions or, in the worst case, cascading blackouts.
- 7. Minimum load level;** A resource's minimum load level describes the lowest level of electrical output the resource can continuously send to the grid.
- 8. Black start capability;** Black start capability is the ability of a power plant to restart without relying on the transmission network to deliver power.
- 9. Storage capability;** Resources with the attribute of storing electricity help the system meet multiple requirements including meeting bulk demand, following load or net load, and maintaining frequency stability, but not all resources with the ability to store electricity contribute to meeting all of the requirements.
- 10. Proximity to load;** The ability to site resources close to load is an attribute that helps the system meet bulk demand and maintain voltages. Resources that are close to load that also have the ability to generate power, reduce transmission losses and transmission congestion.

Figure 1.

Legend

- Relatively Advantaged
- Relatively Disadvantaged
- Neutral
- N/A

	Nat Gas - CC/CT/RICE/ Aeroderivate	Coal	Nuclear	Wind	Solar	Pondage Hydro	Run of River Hydro	Demand Response	Storage
Generation	●	●	●	●	●	●	●	○	○
Dispatchability	●	●	●	●	●	●	●	●	●
Security of Fuel Supply	●	●	●	●	●	●	●	●	●
Start Times	●	●	●	○	○	●	○	●	●
Ramp Rates	●	●	●	○	○	●	○	●	●
Inertia	●	●	●	●	●	●	●	●	●
Frequency Response	●	●	●	●	●	●	●	●	●
Reactive Power	●	●	●	●	●	●	●	○	○
Minimum Load Level	●	●	●	○	○	●	○	●	●
Black Start Capability	●	○	○	●	●	●	●	○	●
Storage Capability	○	○	○	○	○	●	○	○	●
Proximity to Load	●	●	●	●	●	●	●	●	●