ESIG
ENERGY SYSTEMS INTEGRATION GROUP

# Keeping the Lights On

## Redefining Resource Adequacy for Modern Power Systems

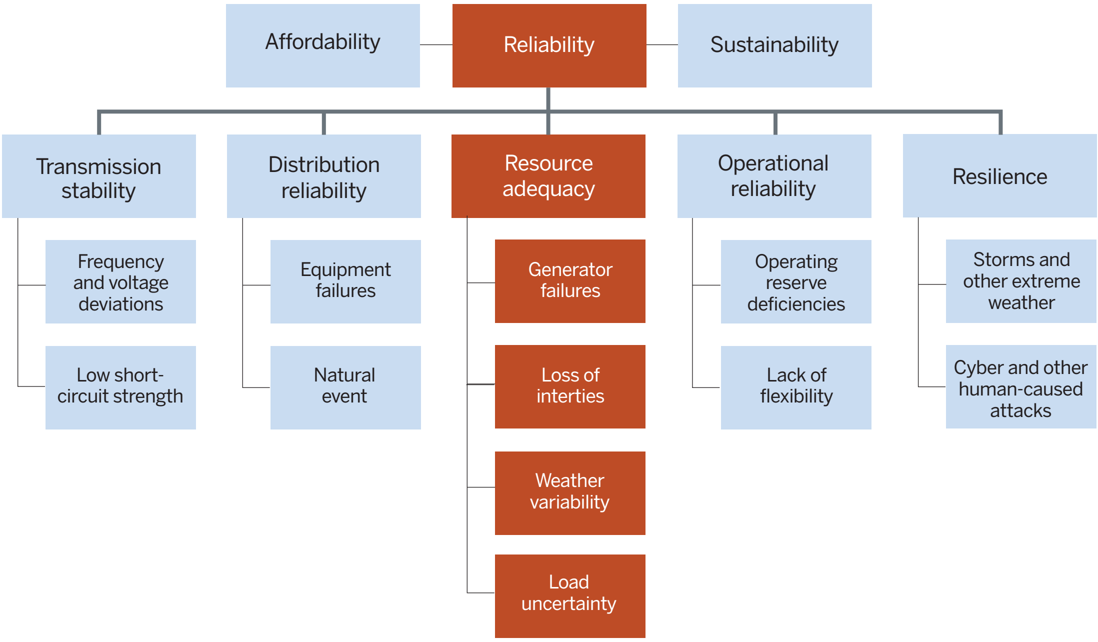
**FACT SHEET**

As grids around the world continue to decarbonize and levels of renewables rise, power system planners, policymakers, and regulators continue to balance three pillars of power system planning: affordability, sustainability, and reliability (Figure 1). To ensure that reliability remains a fixture of our power system, modern resource adequacy analysis must evolve as the grid's power mix changes. Resource adequacy methodologies use statistical analysis and specific metrics to assess whether or when the resources available to the bulk power system may be insufficient to serve load. Ultimately, this analysis determines when—and where—additional investment in new resources is needed and which resources can retire.

## Revamping Long-term Resource Planning

At its core, the challenge with resource adequacy analysis is that the methods and metrics used by the industry today, but originating decades ago during the second half of the 20th century, have been improved only incrementally, as the resource mix has transitioned appreciably. Traditional methods evaluated only the peak load hour and made a simplifying assumption that reliability events were due to mechanical failures of generating equipment and that they occurred at random. The probability of multiple failures happening simultaneously was assumed to be low.

FIGURE 1
The Elements of Grid Reliability

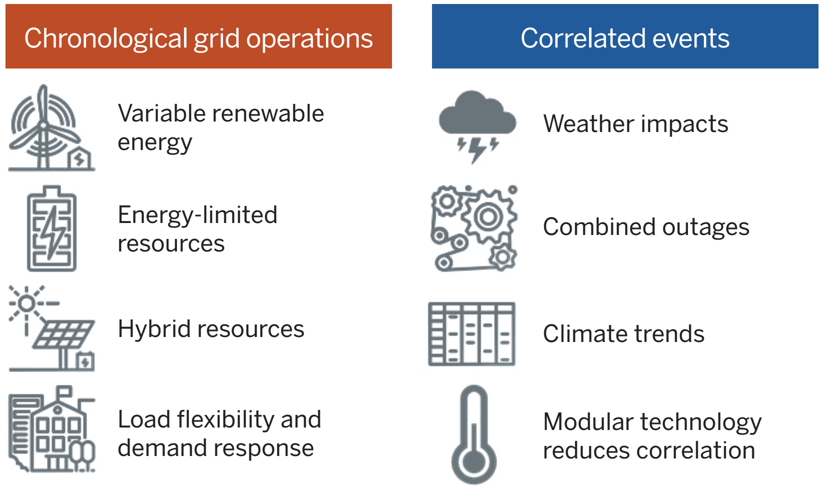



Source: Energy Systems Integration Group.

**This fact sheet is adapted from ESIG's report Redefining Resource Adequacy for Modern Power Systems.**

However, for today's grid with high levels of renewables, energy storage, and load flexibility, reliability is strongly affected by the nature of hour-to-hour operations, and reliability failures increasingly have a common cause—the weather. Today, reliability risks are less about peak load and more about the daily setting of the sun, extended cloud cover, wind speeds, cold snaps, and heat waves. The peak load hour may no longer be the riskiest, as the supply mix and generator availability vary continuously and demand is increasingly flexible. In addition, key resources are time-sensitive, as batteries need time to recharge and electricity customers can only be asked to provide demand response for just so long.

**FIGURE 2**
Two Driving Factors That Require New Approaches to Resource Adequacy




Source: Energy Systems Integration Group.

Chronology (for battery recharging and load flexibility) and correlation (with weather causing reduced generation and spikes in load at the same time) are two driving factors requiring the industry to modernize frameworks for resource adequacy analysis (Figure 2).

## Redesigning Resource Adequacy Analysis

Our use of risk metrics must evolve. A set of guiding principles for the redesign of resource adequacy analysis can support the sharing of insights and best practices, interregional resource coordination, and a smoother regulatory process for resource procurement. The six principles described below are designed for use by system planners, regulators, and others as they bring their analytical methods in line with the realities of tomorrow's grid.

### PRINCIPLE 1
### Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions.

Current metrics, like loss of load expectation (LOLE), are inadequate to capture the magnitude, duration, and distribution of shortfalls, failing to differentiate between events with very different impacts on consumers and requiring different mitigation options. Planners need to extract more information and detail from existing metrics. Future resource adequacy analysis should move beyond averages and provide information on the distribution of individual events, including high impact, low probability tail events.

### PRINCIPLE 2
### Chronological operations must be modeled across many weather years.

Many years of synchronized hourly weather and load data are necessary to understand correlations between year-to-year variability in wind and solar generation, system outages, and load. Data on chronological operations and scheduling will help to ensure that energy-limited resources—such as storage and demand response—can effectively support the system through reliability challenges.

### PRINCIPLE 3
### There is no such thing as perfect capacity.

Natural gas combustion turbines have traditionally been seen as a near-perfect capacity resource, a one-size-fits-all approach. However, this assumes that combustion turbines and similar fossil technologies are available on demand, when in fact drought, extreme temperatures, and other conditions can force reduced operations. Future resource adequacy analysis should explicitly recognize that all resources have limitations based on weather-dependence, potential for outages, flexibility constraints, and common points of failure. Likewise, different resources offer distinct contributions to reliability, whether battery storage, load flexibility, load-shed demand response programs, fossil generation, long-duration storage, or coordination with neighboring grids.

### PRINCIPLE 4

Load participation fundamentally changes the resource adequacy construct.

Traditionally, load has been treated as static, rather than increasingly flexible, price responsive, and intelligent. The proliferation of energy storage, demand response, electric vehicles, and dynamic rate design bring with them new options for load flexibility, and these flexible loads should be evaluated in a similar context as generation resources.

### PRINCIPLE 5

Neighboring grids and transmission should be modeled as capacity resources.

The prevailing orientation toward self-reliance can lead to a potentially large, expensive overbuild of capacity. Resource-sharing, in contrast, offers an important low-cost alternative to procuring new resources. The benefits of sharing between neighboring grids include staggered peak demand, more consistent renewable generation, less chance of simultaneous outages, and less chance of outages caused by fuel shortages. Transmission is key to unlocking this economic opportunity and its benefits for resource adequacy should be clearly identified in long-term planning.

### PRINCIPLE 6

Reliability criteria should be transparent and economic.

Traditional resource adequacy analysis typically has not assessed the cost of achieving a given level of reliability. However, the current lack of transparency around the costs of different approaches to reliability makes it impossible to perform a rigorous cost-benefit analysis. Grid planners and regulators need a clear understanding of the costs associated with achieving different reliability targets in different ways, to ensure that the value provided to the customer is worth the cost of a given investment.

## Putting the Principles into Practice

While considerable work is needed to fully define what robust resource adequacy looks like going forward, some basic first steps can lead to improved resource adequacy analysis now. These steps include applying these six principles to specific systems; making the resource adequacy analysis public and easily accessible; creating a set of case studies from regions around the world with different resource mixes, load profiles, and characteristics of system risk; collecting as much chronological and correlated hourly historical weather and load data as possible; reporting a broader set of resource adequacy metrics; and developing detailed statistics on the shortfall events in order to better characterize the size, frequency, duration, and timing of events and allow mitigation measures to be properly sized.

Consistency in analysis and reporting will provide the necessary data and better insight into what shortfall events look like across many systems, helping the industry better understand how resource adequacy risk shifts with changes in the underlying resource mix of modern power systems.

The consequences of inaction are significant. Not only would a resource adequacy shortfall (and potentially rolling blackouts) be disruptive to many customers, it could also jeopardize the long-term transition of our power grids, as reliability failures become increasingly politicized. A top priority in decarbonizing our energy mix must be to get long-term resource planning right.

Adapted from *Redefining Resource Adequacy for Modern Power Systems*, a report by the Energy Systems Integration Group's Redefining Resource Adequacy Task Force. This fact sheet and the full report are available at https://www.esig.energy/reports-briefs.

To learn more about the recommendations described here, please send an email to resourceadequacy@esig.energy.



The Energy Systems Integration Group is a nonprofit organization that marshals the expertise of the electricity industry's technical community to support grid transformation and energy systems integration and operation, particularly with respect to clean energy. Additional information is available at https://www.esig.energy and info@esig.energy.