ESIG
ENERGY SYSTEMS INTEGRATION GROUP

ESIG REPORT

Ensuring Efficient Reliability

NEW DESIGN PRINCIPLES FOR CAPACITY ACCREDITATION

EXECUTIVE SUMMARY

As the power system changes due to increased renewables, coal and gas retirements, and the growing use of storage and load flexibility for reliability, new methods and principles are needed to measure each resource's contribution toward reliability. The ESIG Redefining Resource Adequacy Task Force developed this report to provide an overview of capacity accreditation: the measure of the contribution of individual resources toward meeting the system's resource adequacy.

The report details the ways that resources are accredited today, how those processes are evolving with a changing resource mix, and limitations inherent in these techniques, and provides suggestions on ways to simplify the approaches to ensure they can be used across all resource types in a more transparent manner. The report does not outline a single, one-size-fits-all approach to capacity accreditation; rather, it provides a framework and foundational pillars that can be used throughout the industry to improve accreditation processes and ensure resource adequacy in the future.

The key considerations from this work are twofold: (1) to ensure that capacity accreditation methods are applied to all resources, not just wind, solar, and battery storage, in a consistent, non-discriminatory manner, and (2) to ensure there is a linkage between resource accreditation and real-world operations.

See the full report: Ensuring Efficient Reliability: New Design Principles for Capacity Accreditation.

The Importance of Capacity Accreditation

While resource adequacy analysis assesses whether there are enough resources to serve load across the system, capacity accreditation measures the contribution of individual resources toward meeting that goal, both in terms of capacity and energy.

The power system's changing resource mix—shifting away from baseload fossil generation and toward a portfolio of wind, solar, storage, and load flexibility—has large implications for how the system ensures that reliability needs are met. Traditionally, these new resources were procured primarily to produce energy, displace fuel, and reduce emissions, but the next phase of the energy transition will increasingly look to them to ensure reliability.

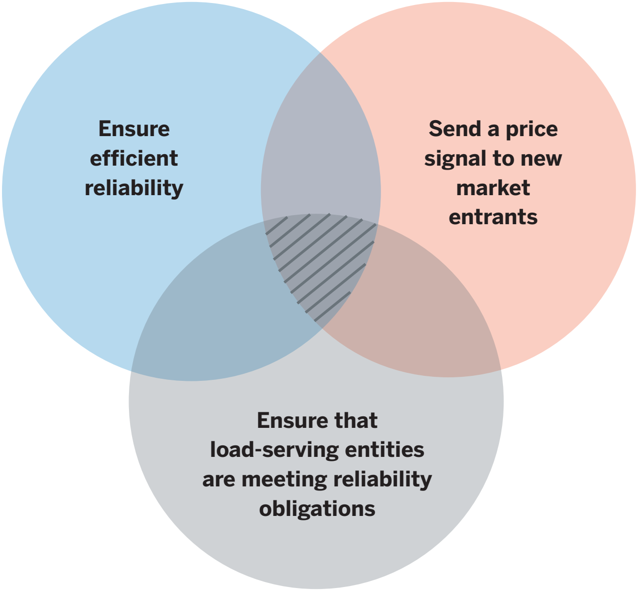
Capacity accreditation methods measure the ability of resources to be available during periods of tight supply. The outcome of accreditation methods—typically a capacity credit for each generator (the percentage of a generator's installed capacity that counts toward resource adequacy)—is used for capacity market offers or selection in competitive procurement processes. A MWh of *energy* on the grid is indistinguishable based on its source, but the same is not true for a MW of *capacity* for resource adequacy. When and where resources are able to provide electricity can differ a great deal, and some resources can provide more reliability benefits than others. The goal of capacity accreditation is to measure effective capacity contributions, in a technology-agnostic manner, and create a reliability-neutral way to allow for exchanging capacity between resources types while meeting resource adequacy needs.

In addition to the shifting resource mix, the timing, location, and causes of reliability risk and tight supply conditions are also changing. In the past, peak risk and tight supply conditions occurred when load was highest. But risk is shifting out of these peak load periods and into periods when load is lower but resource availability is also lower, due to weather (periods of low wind and solar generation) or correlated outages due to extreme weather and fuel supply disruptions. Load profiles are also changing due to increased electrification, climate change, and structural changes in the economy. These changes to both the resource mix and the load profile are shifting risk away from the conventional risk periods (e.g., summer afternoon peak in much of the United States) and toward new periods, underscoring the importance of understanding the resource adequacy contributions of different resources.

The two key considerations from this work are the importance of (1) ensuring that capacity accreditation methods are applied to all resources, not just wind, solar, and battery storage, in a consistent, non-discriminatory manner, and (2) ensuring there is a linkage between resource accreditation and real-world operations.

A robust capacity accreditation framework accomplishes three goals of planning: to secure reliability in an economically efficient manner, send a price signal to new market entrants, and ensure that load-serving entities are equitably meeting their obligations to reliably serve load (Figure ES-1).

FIGURE ES-1
The Nexus of Capacity Accreditation



Source: Energy Systems Integration Group.

Ways That Capacity Accreditation Is Done Today

Today, accreditation methods can be characterized by three overarching elements that need to be considered when evaluating a capacity accreditation technique:

- **Deterministic or probabilistic:** Deterministic metrics use a single-point estimate, often based on historical performance. Probabilistic metrics use analytical simulations across hundreds or thousands of potential future conditions.
- **Prospective or retrospective:** Prospective (forward-looking) methods are often used in the planning and investment time frame to help understand the incremental benefits of future resources. Retrospective (historical) approaches include the use of historical operating conditions to inform resource accreditation.
- **Marginal or average contribution of a resource:** Marginal approaches accredit the entire cohort of a resource type based on the reliability contribution of incremental additions to that resource type, whereas average approaches accredit the entire cohort based on the contribution of the entire fleet.

None of these elements is perfect and there is no right answer; a lot depends on the methodology of implementing each technique and the assumptions used. When redesigning accreditation frameworks, it is important that planners and market designers make clear and intentional choices in these three properties.

Gaps in Current Accreditation Methods

Complexity and lack of transparency. Today's capacity accreditation methods have several limitations, which are leading planners to adjust their process or accreditation rules. First and foremost, methods in use today are complex and, as a result, lack transparency for many industry stakeholders. While the discipline of probabilistic analysis and power system modeling is improving in accuracy, it is also growing more complex. It is necessary to ensure that accreditation processes are understood across a broad range of stakeholders—and not just the modeling community. Simpler heuristics, though perhaps not as precise, may provide a valuable alternative and beneficial trade-off.

Sensitivity to modeling assumptions. Accreditation techniques are also sensitive to modeling assumptions, potentially leading to significant changes in capacity payments or a system's portfolio due to modeling decisions. Capacity credits derived from modeling are only as good as the input assumptions and underlying modeling. Any limitations, oversights, or failures in the probabilistic modeling will also flow through to a resource's capacity credits and payments. In practice, capacity credits are the one area of power markets where a resource is compensated based on expected—or modeled—performance rather than actual performance.

Heterogeneity and unique aspects of resources. Another limitation in current accreditation processes is the difficulty of differentiating resources based on their unique configurations, locations, or operations. Capacity accreditation is intended to measure a resource's contribution to resource adequacy and its ability to reduce system risk. While in theory, this process should be done at the individual unit level, in practice it is often done for aggregated resource classes, which can encompass a great deal of heterogeneity among generators even within the same resource type. (For example, they may have different patterns of generation or plant configurations (e.g., turbine sizes or hub heights for wind, presence of tracking systems or inverter-loading ratios for solar).) This miscorrelation can lead to a wind or solar resource in one region having a higher capacity credit even if it is a lower energy yield. At a minimum, capacity accreditation should evaluate groups of similar resources, but with enough resolution to notice different timing of generation or miscorrelation between resource groups. The objective is for accreditation to result in

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each individual resource receiving the capacity credit commensurate with its reliability contribution.

Difficulty of disentangling portfolio effects. The reliability contributions of a resource are also linked to the availability or performance of other resources and load throughout the system. Portfolio effects arise because the capacity value of any resource is dependent on what the rest of the system's resource mix looks like. For example, battery storage capacity credit may depend on the amount of solar energy available earlier in the day for charging, because high levels of solar provide surplus energy to charge the storage and create narrower (shorter) periods of peak evening net loads, making storage duration more effective. In addition, a system with high levels of solar may shift risk to the evening or overnight hours or to the winter season. Disentangling these types of synergistic portfolio effects is difficult, and often an arbitrary decision of the modeler.

Circularity and ex ante challenges. These challenges also introduce circularity and ex-ante challenges. The capacity credit of any resource is dependent on the existing system portfolio and the amount of each accredited resource on the system. Therefore, evaluating the capacity contribution of a resource in isolation is highly dependent on the assumptions made for the rest of the system. While these assumptions can be forecasted, they will change over time, partly due to the capacity accreditation afforded to the resource. This ex-ante challenge—where the result of the capacity expansion or capacity auctions affects the capacity credits—requires additional modeling and analysis.

Pillars of Capacity Accreditation

Today, there is no uniform set of best practices for capacity accreditation. Given different market structures and regional resources, uniformity may not be desirable or feasible, but foundational pillars can be applied.

Despite the array of resource adequacy and accreditation methods, there are foundational elements that should be consistent across accreditation techniques. These can be used as guidelines for planners, regulators, and other stakeholders to evaluate accreditation options in new market designs or integrated resource planning processes. The ESIG Redefining Resource Adequacy Task Force developed five pillars of resource accreditation to serve as foundational elements that can be applied to all accreditation methods (Figure ES-2, p. 5).

Capacity Accreditation for All Resources

The first pillar highlights the importance of non-discriminatory capacity accreditation methods. If specific capacity accreditation methods are applied to some resources, they should be applied to all resources in a consistent manner, with the same calculations and methodologies.

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Today, capacity accreditation techniques are applied to variable renewable resources and energy-limited resources (storage and load flexibility), while fossil fuel generation often receives either a perfect capacity credit or unforced capacity (UCAP) credit equal to its capacity minus a forced outage rate. This approach inherently misses risk

FIGURE ES-2

Five Pillars of Resource Accreditation

Non-Discriminatory	Robust	Transparent	Reliable	Predictable
Accreditation is applied to all resources using a similar methodology.	Accreditation continues to work as the resource mix, load patterns, and system risk change over time.	Accreditation can be effectively communicated to stakeholders, and data are readily available for decisionmaking.	Accreditation accurately measures performance during real scarcity events.	The process is repeatable and consistent. It does not yield volatile or unexplained changes year to year.

Source: Energy Systems Integration Group.

and overstates the capacity contribution of conventional resources. In addition, other resources, like transmission, can significantly improve resource adequacy, but are often excluded from capacity accreditation techniques.

Correlated outages—such as extreme weather and fuel supply disruptions—can create situations where large portions of capacity are removed from service simultaneously. While this is typically embedded in the renewable generation profiles used in accreditation, the same details are often not applied to thermal generators. Recent winter weather events during Winter Storm Uri (February 2021) and Winter Storm Elliott (December 2022) have shown unique vulnerabilities to thermal resources and the impacts of correlated outages on resource adequacy.

In order to ensure that capacity accreditation is done in a non-discriminatory manner for different resource types, capacity accreditation should be applied to all resources in a consistent manner.

Linking Accreditation to Operations

A key concern regarding capacity accreditation approaches is that imperfect economic signals during a high-risk event might mean that accredited capacity will not deliver during the event. A perfect accreditation calculation can still result in a resource not showing up, even if it was capable of producing power. Accreditation approaches need to be linked to operations in order to ensure that resources deliver in the moment.

Relying exclusively on modeled performance disregards the reality of actual plant performance. There is a need to better link forward-looking capacity accreditation with retrospective operations to ensure that resources actually show up when needed. A performance-based accreditation methodology for individual resources could avoid many of these risks while offering a lower level of complexity, because accreditation is based on actual performance rather than simulations.

Accreditation approaches need to be linked to operations in order to ensure that resources deliver in the moment.

Because prospective and retrospective accreditation approaches consider different drivers of system risk, a blended approach that accredits resources based on historical scarcity hours and simulated loss-of-load events may balance the alignment of incentives and operations in an energy-only market with the uncertainty of future risks evaluated using modeled accreditation techniques (Figure ES-3, p. 6).

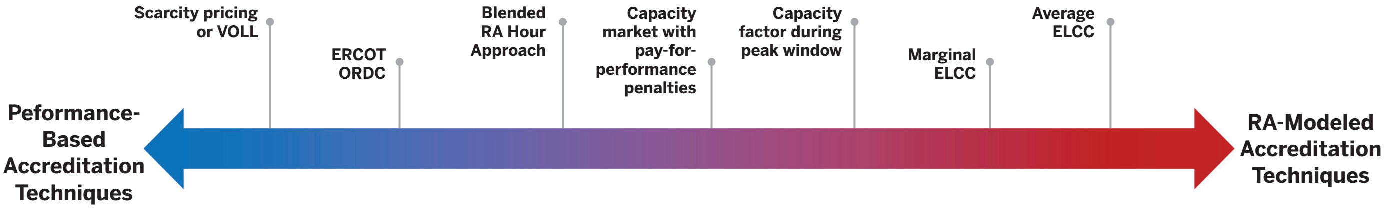
Regardless of the approach chosen, decisionmakers will want to ensure that incentives or governing rules—including accreditation or capacity market revenues—are aligned so that generators will supply power during times when it is needed.

Recommendations

This report focuses attention on two key considerations. First, accreditation methods should be expanded and applied to all resource types, not just wind, solar, and battery storage. This includes considering the reliability

FIGURE ES-3

Performance-Based vs. RA-Modeled Accreditation Techniques



Notes: VOLL = value of lost load; ERCOT = Electric Reliability Council of Texas; ORDC = Operating Reserve Demand Curve; RA = resource adequacy; ELCC = effective load-carrying capability.

Source: Energy Systems Integration Group.

implications of correlated outages on thermal resources, the benefits of interregional transmission, and the details of load flexibility. Second, given that power system modeling is never perfect and there are inherent risks with accrediting resources solely based on models reliant on the underlying assumptions chosen, there is a need to link simulated accreditation with actual operations.

The ESIG Redefining Resource Adequacy Task Force offers the following recommendations to improve how accreditation is currently practiced and help ensure efficient reliability of the power system.

Recommendation 1

Ensure that the foundational pillars are clearly communicated to stakeholders.

Recommendation 2

Be cautious if using capacity credits—in isolation—as the basis for ensuring reliability.

Recommendation 3

Consider accreditation methods that evaluate not only a resource's capacity, but also energy available during periods of high risk.

Recommendation 4

Accredit all resource types using similar metrics and methods.

Recommendation 5

Align incentives in capacity accreditation and real-time performance, in order to not only simulate availability during typical risk periods but ensure performance during actual scarcity events.

Recommendation 6

Evaluate methods to simplify and streamline accreditation calculation techniques.

Ensuring Efficient Reliability: New Design Principles for Capacity Accreditation, by the Energy Systems Integration Group's Redefining Resource Adequacy Task Force, and the accompanying fact sheets are available at https://www.esig.energy/new-design-principles-for-capacity-accreditation.

To learn more about the recommendations described here, please send an email to info@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. Additional information is available at https://www.esig.energy.