GETTING CAPACITY RIGHT

HOW CURRENT METHODS OVERVALUE CONVENTIONAL POWER SOURCES

By Advanced Energy Economy

March 2022

ADVANCED ENERGY ECONOMY

1010 Vermont Ave. NW, Suite 1050, Washington, D.C. 20005
aee.net | powersuite.aee.net | @aeenet

ADVANCED ENERGY ECONOMY
Transforming Policy. Expanding Markets.

GETTING CAPACITY RIGHT: HOW CURRENT METHODS OVERVALUE CONVENTIONAL POWER SOURCES

Acceleration of the clean energy transition is dramatically shifting the types of electric generation technologies used to meet electricity demand and reliably operate the grid. Rapid cost declines in advanced energy technologies like wind, solar, and energy storage are making them increasingly competitive choices for new generation additions. The thriving clean energy market, combined with state policies and customer demand for such technologies, is causing these technologies to begin overtaking conventional generation sources like coal and natural gas that have traditionally been relied upon. This trend will accelerate as state clean energy targets, climate laws, and sustainability commitments by consumers and local governments call for their replacement.

These advanced energy technologies have different operating characteristics than the conventional power plant fleet. As a result, there has been considerable attention devoted to establishing the performance metrics and resource adequacy accreditation methods (e.g., determining their reliability value) applied to these new resource types, particularly renewables and energy storage. However, the methods used to evaluate the resource adequacy, or capacity, value of conventional thermal generating resources (including coal, natural gas, and oil-fired power plants) have not been formally reexamined or updated in decades.

In addition, recent extreme weather events have raised important questions about whether uncertainties in resource availability and correlated outage risks – those that affect multiple generators at the same time – are captured in current resource accreditation metrics. These events, which are increasing in frequency, have a significant impact on grid reliability. While methodologies recently adopted in some regions to determine the resource adequacy value of renewable resources and energy storage include such uncertainties and outage risks, the methodologies currently applied to conventional resources may not. Ensuring that the reliability contributions of all resources sufficiently take into account known reliability risks, and reflect them in their resource adequacy value determination, is critical to ensuring reliability and a level playing field in the markets.

With these factors in mind, Advanced Energy Economy (AEE) engaged Astrapé Consulting to conduct an analysis of the prevailing methodology for accrediting resource adequacy for thermal generating resources.[1] The report compared the methods applied to value the capacity of thermal power plants to their actual performance under various conditions.

[1] Accrediting Resource Adequacy Value to Thermal Generation, Astrapé Consulting, March 2022

The analysis shows that the traditional valuation method can overstate the capacity value of these resources by 2.7% to over 20% in winter and 4.6% to over 10% in summer, depending on regional conditions and other relevant factors These findings demonstrate that improvements in methodology are needed to accurately reflect the contributions to system reliability of these resources when determining their resource adequacy value and the amount of capacity they can bid into and receive revenues for in capacity markets. Putting in place methodologies that consider all types of outage risks would improve incentives for all generators to take steps to improve their accredited value, add new incentives for demand response and flexible load to enter the market, and send a signal for inefficient and poor performing thermal generators to retire, all of which can lower the total costs for capacity that customers pay to ensure reliability.

RESOURCE ADEQUACY AND CAPACITY MARKETS

Ensuring that electric power systems have sufficient resources available to reliably serve customers is accomplished through a combination of planning analyses to assess system needs, and procurement mechanisms that obtain the resources needed to meet those needs. Every system operator, regardless of whether it is a regional transmission organization (RTO) or a vertically integrated utility outside an RTO region, calculates a Planning Reserve Margin (PRM) that expresses the quantity of capacity needed to meet a system's peak demand. Planners typically use inputs such as expected demand growth, seasonal patterns in demand, historic and anticipated outages, and availability of supply to determine the required PRM.

Procuring resources needed to meet the PRM requires the application of methods to accredit (i.e., calculate) the capacity value of particular generating units, taking into account the amount of time they are expected to be available to produce energy. No generating resource is available 100% of the time to achieve its maximum potential output; these methods determine the "discount" from a generating unit's nameplate capacity to determine how much value it provides toward meeting resource adequacy needs. The RTOs in the Northeast (namely PJM Interconnection, ISO New England, and New York Independent System Operator) operate centralized capacity markets where generators compete to sell capacity needed to meet the RTO's PRM. In those regions, capacity accreditation methods are important because they determine the amount of capacity generators can sell into the market.

To accredit the capacity value of thermal generators, these regions generally apply a methodology called Equivalent Forced Outage Rate Demand (EFORd), which considers a unit's historical forced outage rate during periods the unit was in demand. EFORd assumes that a generating unit's performance is independent of other similar resources (i.e., outages are not correlated).

This is very different from how the capacity of advanced energy resources like wind, solar, and energy storage are now assessed in PJM and other regions using an Effective Load Carrying Capability (ELCC) methodology. ELCC is a probabilistic method that determines the capacity value of these resources by evaluating their contribution to meeting the reliability objective of no more than one day of outage in 10 years. ELCC capacity values are determined for groups (or classes) of resources based on their characteristics and output profiles; unlike EFORd, this grouping captures the potential for correlated periods of unavailability among similar resources and assigns capacity value accordingly. ELCCs have not typically been quantified for thermal resources since they are dispatchable and presumed to not have energy constraints. The only reduction in the reliability contribution of these resources would be due to unplanned outages.

	PJM	CAISO	MISO	SPP	ERCOT
Onshore Wind	15.0%	16.3%	16.6%	16.8%	21.0%
Offshore Wind	40.0%	N/A	N/A	N/A	31.0%
Solar Fixed	38.0%	8.7%	50.0%	85.1%	74.0%
Solar Tracking	54.0%	11.0%	50.0%	85.1%	74.0%
4-Hr Battery	83.0%	90.6%	100.0%	N/A	N/A

In PJM, EFORd continues to be used for conventional thermal resources, while ELCC is now in place for renewables, energy storage, hydro, and similar variable or limited duration resources. This difference in treatment of resources has been identified by market participants and at least one FERC commissioner[2] as problematic. PJM is now considering revisiting conventional thermal resource accreditation. Other regions are in various stages of moving to an ELCC methodology (for some or all resources) to determine capacity value as they anticipate expected increases in the development of renewables and storage putting pressure on conventional generation, and in response to recent extreme weather events like Winter Storm Uri, which raise new questions about outage risks facing the generation fleet.

ACCOUNTING FOR KNOWN OUTAGE RISKS OF THERMAL GENERATORS

In the report, Astrapé assesses the extent to which the existing EFORd methodology adequately accounts for the actual risks of outages of thermal resources that were observed in prior extreme weather events, and whether EFORd appropriately values capacity in light of those outage risks. To perform this assessment, Astrapé constructed a model based on the demand and generation resource profile of the PJM South region. Incorporating historic extreme weather events and publicly available data, the model ran different simulations

[2] Commissioner Christie's Dissent from Order Concerning PJM's proposed ELCC, Federal Energy Regulatory Commission, July 20, 2021.

weighing thousands of simulated years of outages (including both winter and summer) to compare how the EFORd methodology performs in accounting for these uncertainties when compared to an ELCC-equivalent methodology.

Based on this modeling, Astrapé determined that the existing EFORd accreditation methodology does not fully account for these risks when assigning capacity value to thermal generation resources. Specifically, the report describes four categories of outage uncertainty and risk that the EFORd methodology fails to fully capture when compared to an ELCC-equivalent:

1. Outage variability: Existing EFORd and Unforced Capacity (UCAP) determination methodologies implicitly presume an annual average rate of outages, but Astrapé's modeling shows that at any given time actual outages will vary and often can exceed those averages. Using an annual average masks these higher outage rates and results in a higher capacity accreditation than is justified.
2. Common mode failures: Existing methodologies like EFORd generally assume that generator outages are independent from one another. However, modeling shows correlated outages of multiple resources can occur in certain instances, such as when they share equipment like a step-up transformer.
3. Weather-dependent outages: The modeling further showed that thermal generation resources can suffer correlated outages due to the acute impacts of extreme weather, such as frozen equipment or heat stress, causing them to perform below their EFORd-based rating in a statistically significant manner.
4. Fuel availability: Modeling and anecdotal evidence reviewed by Astrapé showed that cold weather events can impact availability of fuel supply itself (such as natural gas) independent of particular acute impacts on generation resources themselves and result in correlated outages that may not be captured in the EFORd average availability calculation.

Based on these findings, the report presents an illustrative range of the downward adjustments to EFORd-based accreditations that could be made to account for these risks. While precise adjustments to capacity accreditation require further study and analysis, the range presented in the report illustrates the potential magnitude by which the existing EFORd-based methodology overstates the capacity value of thermal resources. The table below summarizes illustrative adjustments from model simulations, showing potential downward adjustments of 2.7% to over 20% in winter and 4.6% to over 10% in summer.

Thermal Generator SUMMER	Outage Factor	Accreditation Impact (Incremental)	Capacity Credit (Cumulative)
Standard Practice	Forced Outage Rate	5.0%	95.0%
Proposed Additional Factors	Outage Variability	4.6%	90.4%
	Common Mode Outage	N/A	
	Weather Dependent Outage	5.6%	84.7%
	Fuel Supply Outages	N/A	
Adjusted Summer Thermal Capacity Credit:		**84.7%**	

Thermal Generator WINTER	Outage Factor	Accreditation Impact (Incremental)	Capacity Credit (Cumulative)
Standard Practice	Forced Outage Rate	5.0%	95.0%
Proposed Additional Factors	Outage Variability	2.7%	92.3%
	Common Mode Outage	2.3%	90.0%
	Weather Dependent Outage	10.0%	82.3%
	Fuel Supply Outages	6.2%	76.1
Adjusted Winter Thermal Capacity Credit:		**76.1%**	

IMPLICATIONS FOR REGIONAL MARKET OPERATORS AND REGULATORS

The report findings suggest that existing EFORd-based resource adequacy and capacity accreditation methodologies should be carefully reviewed and revised to ensure that they adequately consider all relevant uncertainties. To the extent these methodologies do not account for these outage uncertainties, they may be over-accrediting capacity value to thermal resources and requiring consumers to pay for capacity contributions to reliability they are not actually receiving. Further, given that ELCC-based methodologies now applied to renewables, energy storage, and similar technologies in PJM already account for correlated unavailability, failure to revisit existing EFORd-based methodologies applied to thermal resources may result in undue discrimination among resources within RTO centralized capacity markets.

The modeling results in the report do not necessarily imply that PRM requirements should be increased. Some of these risks are already accounted for when setting the reserve margin requirement but they are not considered in the capacity values of generation resources using

EFORd. This essentially shifts the cost of these risks to customers (who pay the costs of all capacity acquired to meet the PRM), rather than assigning those risks to generators by adjusting the amount of capacity they can sell. Other unaccounted for risks may be offset by other conservative assumptions.

Putting that risk back on the generators, where it belongs, would improve incentives for generators to take steps to improve their accredited value (adding storage, improving weatherizing, obtaining firm fuel supply, etc.), add new incentives for demand response and flexible load to enter the market, and send a signal for inefficient and poor performing thermal generators to retire, all of which can in turn lower the total costs customers must pay for capacity to meet PRM requirements.

While the report presents a range of illustrative downward adjustments to EFORd-based thermal capacity accreditations, further analysis is necessary to translate the results of the modeling into a fair accreditation and valuation methodology for use in markets.

To arrive at a new methodology, regional market operators should consider, among other things, how to account for and adjust outage assumptions based on individual unit size, age, and performance characteristics (including fuel supply arrangements or other technical specifications). Seasonal impacts on outage risks may also need to be addressed.

A methodology that fairly quantifies the capacity value of traditional energy sources becomes increasingly important as the transition to advanced energy technologies like solar, wind, and energy storage accelerates and these technologies replace thermal generation resources. A clear understanding of the true load-carrying capability of all resources is necessary to ground conversations about the potential reliability implications of this shift and solutions to identified reliability challenges.