RESOURCE ADEQUACY IN ELECTRIC SYSTEMS

Prepared by:

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CONCENTRIC ENERGY ADVISORS

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Mark G. Karl, PE (Ret.), has over 42 years of diverse engineering, regulatory, wholesale markets, finance, and strategic planning experience in the regulated and deregulated electricity sectors.

Mr. Karl spent 23 years at ISO New England. For the past ten years, he served as Vice President of Market Development & Settlements, responsible for the design and development of the New England wholesale electricity markets. In that role, he oversaw the functions of Wholesale Market Design, Demand Resources Strategy, Market Settlements and Analysis, Market Operations Support Services, and the Chief Economist and his Economic Analysis Group.

In previous roles at ISO New England, Mr. Karl served as Senior Director of Resource Adequacy in the ISO's System Planning Department, where he was responsible for the operation of the Forward Capacity Auction, the development of the load forecast and installed capacity requirements, and the auction qualification process. He also held the position of Director of Market Development and Integration, designing markets and representing the ISO in stakeholder, regulatory, and legislative processes.

Before joining the ISO in 2000, Mr. Karl was at Duquesne Light Company in Pittsburgh for nearly 20 years. During his tenure there, he was a key figure in leading the company through Pennsylvania's transition to competitive markets, interacting extensively with state regulators and holding various roles—including engineer at fossil and nuclear plants—and other positions in finance and strategic planning, as well as regulatory and economic analysis.

After graduating from college in 1980, Mr. Karl's first position was as a Systems Engineer/ Analyst at Rockwell Space Systems Division, working on the design and configuration management of the Digital Flight Control System for NASA's space shuttle orbiters before transitioning to work on nuclear generation control systems.

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Key Takeaways

- **The traditional resource adequacy model faces significant challenges.**
- **A broader reliability paradigm is required beyond resource adequacy.**
- **Multiple policy and market solutions are under consideration, but no single solution prevails.**
- **A move to some form of central contracting may be required to ensure reliability at a reasonable cost.**

Traditionally, the responsibility to ensure electric system resource adequacy rested with the vertically integrated utilities, municipal systems, and electric co-ops, generally referred to as electric service providers (ESPs), that had the obligation to serve electric load in a defined territory. In most cases, these ESPs were regulated by the state or province in which they were located, and in exchange for assuming the obligation to serve load at a just and reasonable rate these organizations were compensated for the prudently incurred cost of providing that service.

With the advent of electric deregulation in the late 1990s, in many parts of the U.S., the responsibility for ensuring resource adequacy was turned over to the markets operated by FERC-regulated Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs). The generation and demand response assets are built, owned, and operated by a mix of merchant providers and ESPs with different rules and processes applied in each region.

For much of the past twenty years, this system has worked reasonably well. In an era of relatively stable low growth in demand, legacy fossil fueled resources slowly retired due to economic and environmental pressure, and were replaced by more efficient natural gas generators and low or zero carbon emitting renewable resources. Recently, that era of stability has ended with many states pursuing aggressive environmental goals and providing incentives or directly contracting with renewable resources. These resources tend to be smaller than legacy generation, they may be geographically dispersed and frequently operate intermittently.

In addition, ongoing electrification of transportation, space heating, and industrial loads has caused significant increases in electrical demand. By far, the biggest driver of electrical demand is the recent dramatic growth of data center load. Data centers provide data storage and compute power to train and host artificial intelligence, operate cloud storage and web services, and support crypto mining.

The retirement of legacy fossil resources, the entry of significant intermittent renewable resources, and the dramatic increase in data center load have created somewhat of a "perfect storm" in the electric industry, generating considerable concern around the concept of electric system resource adequacy. These concerns are not just a matter for industry insiders, but have been and continue to be discussed in general public media. In response, the FERC conducted a technical conference on resource adequacy on June 4-5, 2025. Advance comments were filed by numerous industry experts, the issues were discussed in the conference chaired by the FERC Commissioners, and a number of experts submitted follow up comments. This article will review some of the issues and potential approaches to dealing with electric system resource adequacy, but first it is helpful to consider what exactly is meant by the concept of resource adequacy, and what goals a resource adequacy process should achieve.

Resource adequacy, the existence of resources to meet total demand, is essential to ensure an electric system is reliable but it is not sufficient. A broader definition fully addressing all aspects of system reliability might be referred to as "Reliability Adequacy."

What is Resource Adequacy

The traditional definition of resource adequacy in an electric system is to ensure sufficient resources are available to meet electric demand, plus maintain sufficient real-time ten and thirty-minute operating reserves. The ESP developed load forecasts and typically demonstrated adequacy by showing that at the system peak there was appropriate supply to meet the load and real-time reserve requirements plus a planning reserve intended to account for any planned or unplanned outages. The planning standard driving the planning reserve required a demonstration that the system meet a probabilistic reliability standard of one day of interruption in ten years. That standard, however, was not based on economics, with the implicit value of lost load in that standard far in excess of even emergency supply pricing.

While the resource adequacy process ensured there was sufficient total supply to meet electric demand, it did not address the other resource attributes needed to operate the system and did not address tradeoffs between generation supply and transmission. These other attributes were addressed through the choice of specific resources, frequently through a state reviewed Integrated Resource Planning Process (IRP), and a siting process that considered locational tradeoffs.

Essential elements of system reliability, such as fuel supply, the ability to dispatch and control output, the ability to provide voltage support, and inertia were addressed separately in the ESP planning process after the total supply requirement was determined. In short, the resource adequacy process determined how much supply was needed, and the remaining planning process determined what type of supply was needed and where it was needed. This process was successful because the ESP operated and planned the system and planned, built, or contracted for the specific resources required. With the deregulation of electricity supply, in much of the country these responsibilities were split, with traditional resource adequacy addressed by merchant resource owners in ISO/RTO markets and the other elements of system reliability not directly addressed or addressed through out-of-market actions.

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Reliability Adequacy: A New Paradigm

Resource adequacy, the existence of resources to meet total demand, is essential to ensure an electric system is reliable but it is not sufficient. A broader definition fully addressing all aspects of system reliability might be referred to as "Reliability Adequacy." A system that exhibits Reliability Adequacy would have sufficient resources with all the necessary secondary attributes to ensure reliable operation at all times throughout the year.

In addition to resources needed to meet peak total demand, the Reliability Adequate system would also have sufficient dispatchable or controllable resources, whether directly controllable or bundled with storage, to meet load ramps and accommodate changes in demand or variable renewable resource output. Such a system would have sufficient fuel security to reliably operate through the winter, and it would have sufficient resources capable of providing voltage support, rotating or synthetic inertia, and ensuring transmission stability and security. The acquisition of these attributes would be jointly optimized and would address tradeoffs between supply-side and transmission solutions.

The goals for an optimal Reliability Adequacy process would include ensuring system reliability, not just resource adequacy, and would address all aspects of supply-side sufficiency. It would achieve an optimal mix of supply-side, demand-side, and transmission resources, deliver affordable, just and reasonable pricing, and respond to public policy goals. This process would enable system planning and resource development through advanced indication of supply, transmission, and supporting infrastructure needs (such as fuel transportation) and would provide this indication with sufficient lead time for construction of this infrastructure.

Taken as a whole, the Reliability Adequacy process and the means of acquiring needed resources, whether through centralized markets or other methods, must provide a reasonable opportunity for project financing and investment recovery. These goals are not new; they are the same goals that ESPs have always had for their planning processes. But as described above, the entry of substantial intermittent supply with different operating characteristics and the dramatic growth in demand are substantially challenging the current processes, leading to concern as to whether the electric industry will meet these demands.

Options for Achieving Reliability Adequacy

The FERC resource adequacy conference on June 4-5, 2025, discussed many of these issues and some possible improvements to existing resource adequacy processes. While there was general agreement regarding the challenges facing the industry, there was some disagreement as to how immediate the problems are and the magnitude of change needed. The first panel included representatives of the ISOs/ RTOs and while they agreed there are challenges, for the most part they referred to their resource interconnection queues, and aside from considering the need to speed up the interconnection processes, they all indicated substantial interest in the queues as proof that the current processes work. However, an examination of the resources in those queues suggests otherwise.

A recent breakdown of the PJM queue as of December 2024 showed nearly 221,000 MW of proposed projects; however, almost 211,000 MW of that queue was made up of wind, solar, or storage resources. As of October 2024 the interconnection queue of ISO New England shows in excess of 54% of the queue made up of wind and solar resources, with most of the remainder battery storage. The situation in the Midcontinent ISO (MISO) is similar, as of April 2024, with about 123,000 GW proposed, but more than 93% of the queue is made up of wind, solar, and battery storage.

Aside from this data indicating a shortfall in many of the other attributes of reliability, it must also be observed that the Trump administration has canceled many of the incentives that were driving these proposed projects, even going so far as to order construction halts at offshore wind sites. It is quite possible, if not probable, that many of these projects will be canceled, potentially leaving systems short of resource adequacy, as well as the other reliability attributes.

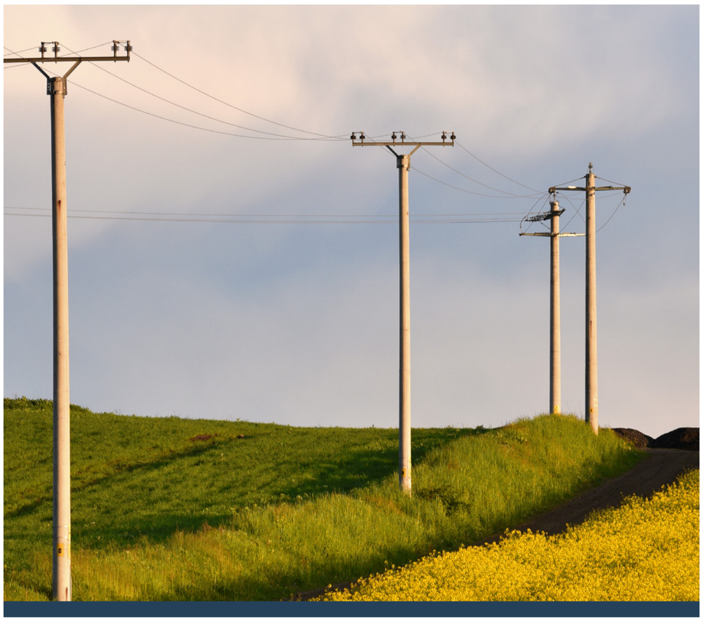
With that in mind the options discussed at the conference, plus a potential new proposal by PJM, can be simplified to the list below:

- Enhanced Status Quo
- Return of Capacity Markets to Residual Markets
- Mandatory “Bring Your Own Generation”
- “Non-Capacity Backed Load”
- Central Contracting

Enhanced Status Quo: The idea of enhancing the current resource adequacy processes was quite popular, with support from the ISOs/ RTOs as well as many of the other participants. These activities are already underway, with New England, New York, PJM, and MISO all working on “capacity accreditation” projects, using a planning analysis to assess the “Effective Load Carrying Capability” (ELCC) of capacity resources. This analysis better captures the ability of a resource to serve load throughout the year and may provide some second order incentives for fuel security and operating flexibility, but it stops well short of covering all the necessary reliability attributes.

Additionally, more region-specific changes were discussed, such as changing the New England and PJM forward capacity markets into a prompt seasonal format, and there was some discussion of the potential need for additional markets for other reliability attributes.

While additional markets could directly address some of the other system reliability needs, this would likely lead to incredibly complex pricing and clearing processes in an attempt to get to an optimum resource mix. Essentially, it would amount to an opaque integrated resource planning process by an optimization algorithm. Determining purchase quantities for these additional attributes, addressing locational issues, and mitigating market power for these attributes would also be challenging.



In short, while enhancing the existing resource adequacy processes and improving the interconnection queues is probably a no-regrets option, it is not likely to fully address the identified goals of a Reliability Adequacy process.

Capacity Market Returned to Residual/ Mandatory Contracting: Most conference participants agreed that more long-term contracting for supply resources would be beneficial, but there was disagreement as to how that might be accomplished. There were suggestions that the ISOs/ RTOs or regulators might act to encourage or facilitate bilateral transactions. Other suggestions, not widely supported, were to require mandatory contracting, potentially by assigning resource adequacy requirements to retail load serving entities. Most of this discussion focused on resource adequacy, but could be extended to the other attributes of reliability as well.

However, none of the discussions truly addressed the reasons why parties may be relying primarily on short-term capacity markets or short-term bilateral contracts for adequacy needs. In the regions with deregulated supply and retail choice, no party in the market has long-term responsibility for load. While marketers in some regions may offer five-year contracts, most retail choice contracts are two to three years at most.

The retail environment is further disrupted by the "standard offer" or "default service" requirements mandated by states. Unlike the deregulation of long-distance telephone service where retail customers were required to choose a marketer or have one assigned, most electric deregulation provisions allow customers to decline to choose. In that case, they are supplied by their local utility through a periodic state mandated auction process, with auctions conducted every two to three years or less.

Merchant suppliers compete to win these auction awards, but given that load serving responsibility can change dramatically with each auction cycle, this process serves as a disincentive for longer term contracting. Compounding this disincentive is the risk created by fuel cost and supply uncertainty and regulatory churn through frequent market rule changes by the ISOs/ RTOs. These risks increase over time, making longer term supply contracts more expensive. It is not likely that contracting incentives or facilitation will have much influence until load serving responsibility is clarified and rule stability is achieved.

Mandatory "Bring Your Own Generation": Bring Your Own Generation (BYOG) is a concept where new large load is required to effectively self-supply its electricity needs. In this case, existing load is insulated from the price and reliability impact of incremental load, with that incremental load bearing the cost. While this sounds simple in concept, it would quickly become incredibly complex.

During a discussion at the FERC conference, the idea seemed to target new data center load. But what then is a "data center"? Is it defined by size, greater than some megawatt threshold, and if so, why would that threshold not apply to incremental industrial load? Is a data center defined by its function, such as artificial intelligence training, cloud hosting, or crypto mining? Would it include a university supercomputing center, a bank billing site, or an Amazon fulfillment center? Would the BYOG be required to be incremental new generation or could the data center contract with existing generation? How would reactivation of retired generation or incremental generation at an existing site be treated?

All these questions and more would need to be addressed, and then likely litigated. In addition to litigating, these qualification questions raise the issue of discrimination and will need to be addressed. Existing data centers would be advantaged as compared to new data centers, since existing data centers are not required to build or contract for generation.

If this requirement is only applied to data centers, however they may be defined, it disfavors data center load while favoring other new large loads, and discriminates against new data center load in favor of similar existing load. This proposal also raises questions regarding the treatment of the expansion of an existing data center which would then be partly new and partly existing. While some data center developers may be willing to voluntarily build incremental supply to speed interconnection, and that action should certainly be accommodated, mandatory BYOG seems incredibly hard to implement in practice.

Non-Capacity Backed Load: This is a recent proposal by PJM, subsequent to the June FERC Conference. At this point, it is a preliminary proposal and has been the subject of just several stakeholder discussions. While many details of this proposal have not yet been developed, sufficient information is available to consider here. Most of the other resource adequacy proposals focus on ways to increase supply resources or to modify interconnection processes to accommodate additional supply. In contrast, this proposal focuses on the demand side of the equation and seeks to reduce demand by treating data center load as interruptible.

It is possible that loads may opt in for this treatment, or it could be mandatory for certain classes of load. In its recent presentation, PJM conceded this proposal would likely work as an incentive for BYOG, since most data centers are unlikely to operate as interruptible loads over the long-term. Much like the issues with BYOG if this proposal is

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optional, where a data center (however defined) could opt in for this treatment perhaps while its accompanying generation is under construction, such an option should be accommodated. It would allow the incremental load to interconnect more quickly and would operate much like the ERCOT "connect and manage" generation interconnection process only applied to load in this instance. However, if this treatment is mandated, all the challenges with qualification definition and discriminatory treatment identified with BYOG would apply here as well.

Central Contracting: At the FERC Conference, numerous conference participants suggested that a return to some form of central contracting for resources may be necessary to achieve resource adequacy, given the multiple challenges facing the industry. In addition, while commenters did not explicitly use the term Reliability Adequacy, the concerns they expressed, in addition to simple resource adequacy, are the same as would be considered in the more comprehensive Reliability Adequacy concept.

In central contracting, a single entity is assigned responsibility for ensuring sufficient resources are available to serve electric system load at all times. The most familiar form of central contracting would be a return to vertical integration of the electric industry with cost-of-service compensation for the re-integrated utility. However, at the FERC conference the idea of a return to full cost-of-service compensation saw considerable resistance, with the ISOs/ RTOs and others offering defense of markets and claims of billions of dollars in savings due to markets.

But a move to central contracting need not result in the abandonment of wholesale electricity markets. There are a number of possible structures that could be explored where central procurement and markets would coexist. For many years, PJM operated as a central pool where vertically integrated utilities built resources to ensure reliable operation of the system while benefiting from the economic exchange of power within the pool. The New England power pool did the same, while the Long Island and New York Power Authorities continue to own and operate resources within the New York ISO markets. Both the state of California and the Midcontinent ISO use elements of central procurement with a mix of merchant resources and markets.

Creation of a central contracting entity would address the lack of long-term responsibility for load, which is likely a reason why long-term contracting has become less common. Looking at an extreme, many commenters suggested the growth of data center load, coupled with concern for carbon emissions, could be accommodated with the construction of new nuclear generating capacity. While merchant operators are likely willing to build and operate nuclear capacity they are unlikely to do so absent long-term credible contracts. As an example, just this past June, Governor Hochul of New York ordered the New York Power Authority to develop and construct an advanced nuclear plant which will operate within the New York ISO markets.

Central contracting could be conducted by a Power Authority as in New York, the contracting responsibility could be assigned to a load serving utility or a transmission operator, or it could be assumed directly by a state, perhaps in conjunction with an ISO/RTO. Merchant resources could still operate within the electric system with the contracting agency contracting with merchants. The contracting agency could allow for utility proposals to serve as a "price to beat," utilities could be restricted to build certain technologies not as attractive to merchant developers such as baseload, nuclear, or hydro, or they could serve as the backstop builder of last resort. Whatever the specific contracting structure, a central contracting party is probably best suited to optimize tradeoffs between transmission and generation, and to ensure an optimized mix of resources, with the needed characteristics available to ensure Reliability Adequacy.

Conclusion

Much of the discussion regarding resource adequacy, or Reliability Adequacy is taking place in the regions with fully deregulated markets and some degree of retail choice, coupled with rapid load growth and entry of intermittent renewable resources. In these regions, no entity really has long-term responsibility for serving load, and this, coupled with the large periodic standard offer/default service auctions for short-term supply, disrupts the incentives for long-term contracting. The regions in the U.S. with continued utility ownership of supply or that have some level of central contracting, such as Texas, California, or the Southeast U.S., seem to have fewer concerns.

Without clear long-term load responsibility in the wholesale markets, some form of central contracting seems to be essential and may be the only realistic way to maintain an optimal resource mix capable of ensuring Reliability Adequacy. This need not represent an abandonment of markets, since any number of hybrid utility-merchant structures could work. It is also essential to ensure that merchants in any hybrid structure still have a reasonable expectation of investment recovery through contracting or markets.