WHITE PAPER

Rapid Response Power Solutions Enable Large Load Centers to Navigate Looming Power Crunch

By Kevin Fox and Justin Gruetzner

The race for megawatts is underway as new data centers, manufacturing plants, megascale transit charging stations and other industries electrify their processes. Projects that feature on-site, behind-the-meter or islanded power solutions have clear advantages in bypassing backlogged utility interconnection queues, greatly increasing the chances of getting to market sooner.

The critical issue of power supply is taking center stage as data centers and other large-scale industrial loads compete for a limited supply of grid electricity. In a dramatic change from years of flat growth in electrical demand, annual utility forecasts filed with the Federal Energy Regulatory Commission (FERC) now show dramatic growth in power demand across all regions of the country. By 2030, FERC forecasts that peak demand will grow by 60 gigawatts (GW). Further complicating this growth projection is another FERC forecast indicating that an additional 140 GW of capacity will be needed by 2030 to replace planned retirements of coal-fired and other baseload generation.

Other forecasts offer a similar outlook. According to a recent report by Goldman Sachs, U.S. load growth will see a 2.4% compounded annual growth rate through 2030, driven prominently by the rapid evolution of artificial intelligence (AI) and growth of cryptocurrency, translating to an expected 160% increase in power demand from data centers.

Another forecast from the Electric Power Research Institute (EPRI) aligns with those findings. According to EPRI, the growth in data center developments is expected to result in a total load of 35 GW by 2030, consuming approximately 9% of total U.S. power generating capacity. This represents a staggering rate of growth from the 4% of grid capacity consumed by data centers today.

Additional electricity demand growth is predicted to come as new manufacturing plants move back to the U.S., and as heavy industrial sectors like mining and oil and gas electrify equipment and processes. A number of large oil and gas producers with operations in the Electric Reliability Council of Texas (ERCOT) region are moving quickly to electrify critical operations either by requesting grid interconnections or by building their own on-site generation and distribution systems.

Hurry Up and Wait

With these unprecedented rates of projected growth, many major industries are confronting the reality of addressing their energy needs in light of highly constrained grid capacity. Those factors are cascading to other issues, such as extraordinarily long queues for approvals of grid interconnection applications and stresses in supply chains for critical electrical gear, components and equipment.

As of 2024, the interconnection approval queue for every regional transmission authority averaged eight times longer than in 2014. Lead times of 38 months are common in certain regions, while eight-year waits are now being seen in other, more congested regions.

Constructing transmission infrastructure is often at the heart of these extraordinary waiting periods. In 2024, U.S. investor-owned utilities reported a $92 billion backlog of transmission projects. More significantly, meeting all the requests currently in the interconnection approval queues would require approximately twice the transmission capacity currently available.

Further complicating lead times are extensive supply chain bottlenecks for essential transmission and substation equipment. Lead times for high-voltage transformers, breakers and switchgear needed in substations can be up to seven years.

This yields a significant problem for developers of new large-load facilities, as financial backers and others with vested interests clamor to begin operations and earn revenue as soon as possible.

Finding the Easy Button

Against this backdrop, power solutions for high-demand applications are needed within timelines unthinkable even a few years ago. On-site generating capacity along with behind-the-meter power distribution grids are being widely considered and are among the few solutions that offer a speed-to-market advantage.

Developers and owners are considering power solutions dictated somewhat by the equipment that is likely to be available the soonest — and in many cases that solution is to source high-speed reciprocating natural gas engines for power generation. With outputs ranging from 2 to 4 megawatts (MW), high-speed engines can be installed quickly in large yet flexible configurations that offer the ability to quickly ramp up or down in response to fluctuating loads. Medium-speed engines, offering maximum outputs ranging from 18 to 25 MW, also are being considered as options for large facilities that may have power demands of several hundred megawatts to 1 GW, though they are less tolerant to sudden load changes.

As renewable energy has attained a larger share of the grid's generation portfolio, many utilities have begun turning to reciprocating engines due to their ability to load-follow the intermittent output of wind or solar facilities. They are designed to accommodate frequent starts and stops with fast response times and flexibility to operate as peaking or baseload resources. But their true value lies in their ability to be engineered, procured and deployed to a site quickly.

Simple-cycle gas turbine power plants are another option for behind-the-meter rapid power deployment. Commonly utilized by utilities for baseload power, simple-cycle turbines can operate efficiently year-round with high capacity factors, while also offering the flexibility to be coupled with a heat recovery steam generator to capture waste heat and improve plant efficiency while generating additional electricity. Operating either as a simple- or combined-cycle unit, gas turbines provide another attractive option for owners seeking to deploy a generation solution quickly.

Facility load ramps may dictate that a combination of technologies of mixed sizes be deployed, in order to provide the desired resiliency throughout a facility's operating cycle.

Waiting For Interconnection Approvals

Projects that include on-site power generation to serve at least a part of their load, or for the initial phase of a multistage buildout, can proceed with assurance that they can start quickly and operate for an extended period of time until a grid interconnection is available and approved.

While construction of behind-the-meter power solutions that have no initial grid tie may be the fastest path to become operational, many operators will want to remain in the approval queue for grid interconnection later. Once approved, the on-site power facility can run as a microgrid in island mode when needed to provide operational security and resilience while functioning as a dispatchable resource for regional grid operators to deliver ancillary resilience and reliability services for the overall grid. Careful consideration during the design of the original facility is required to provide a solution that can meet the future use case desired by the facility.

Some new high-demand facilities, such as those powering cryptocurrency, can have the autonomy and flexibility to curtail operations in order to dispatch power to the grid and take advantage of power arbitrage opportunities.

Whether it's a data center, manufacturing plant or oilfield electrification project, developers must carefully weigh the advantages and disadvantages of islanded versus grid-tied power

supply. For example, power facilities that both serve a facility and export power to the regional grid must comply with critical infrastructure protection (CIP) rules mandated by the North American Electric Reliability Corporation (NERC). In addition, facilities with no backup generating capacity also face exposure to widespread outages or other weather-related events that could lead to electricity curtailment by grid operators. For those reasons, many developers are considering options featuring behind-the-meter power solutions that provide the ability to operate in island mode or to dispatch power to the grid in response to grid emergencies.

Long Poles in The Tent

With speed-to-market increasingly vital for many large new facilities, anything that can reduce the lead times required to get up and running is of great value.

Given the reality that it may be many years before a facility's grid interconnection request is approved, supply chain lead times for critical equipment like generators, transformers, breakers and switchgear are another important schedule consideration. In addition, securing the fuel supply for on-site generation solutions can lie on the critical path, and availability may dictate technology considerations.

Determining how to power a high-demand facility requires consideration of multiple critical-path activities. For example, environmental permitting will still be required for both grid-tied or behind-the-meter solutions and also may take considerable time for the completion of needed studies and other necessary reviews.

Compliance with increasingly stringent air quality requirements is becoming the proverbial long pole in the tent due to extensive data that must be submitted for facilities located in nonattainment areas set by the EPA. In those areas, developers are likely to see requirements to include selective catalytic reduction (SCR) and other abatement equipment to control nitrogen and sulfur oxide emissions. Noise permits or sound abatement may also be needed for power generating equipment located in areas with strict noise ordinances. The potential for negative public opinion related to carbon emissions from sites that use fossil fuel for generation equipment also may be impactful for a project and could warrant carbon capture in some instances.

Optimizing The Process

There is no question that the power industry has entered a challenging era with many issues that impact the development and deployment of much-needed new generation and transmission capacity. For high-demand facilities and industries seeking to cut costs, reduce emissions and generally create more efficiencies by electrifying operations, upfront planning revolving around proven engineer-procure-construct (EPC) contract delivery processes is a means to meet these challenges.

EPC contractors often have insider knowledge of multiple downstream factors impacting supply chains for critical electrical gear and components and can help developers and owners explore options that fit with a customer's often-unique business cases.

Robust project preplanning can address questions such as:

- What is the right power generation solution for my facility's demands?
- How does the business case drive resiliency requirements?
- How do we deploy power generation solutions and navigate the utility interconnection process and accelerate reaching operation quickly?
- Can we optimize resiliency requirements in conceptual designs for unique power solutions?
- How do we navigate the equipment supply chain challenges inherent with a power generation project? Can we advance prepurchase agreements within the EPC framework?
- How do we plan a system that meets both Day 1 and Day 2 needs, maximizing the asset's return?
- Can we advance prepurchase agreements within the EPC framework?

Successfully addressing these and a host of other questions through the collaboration afforded under an EPC approach can accelerate deployment of power solutions by many months.

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