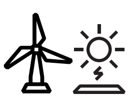
WHITE PAPER

Utilities must focus on key energy transition technology gaps to support grid stability

Meeting infrastructure, intermittency and storage challenges are the main obstacles on the path to integrating renewable energy resources and achieving sustainability goals.



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The energy transition is well underway, with 80%–85% of new generation capacity coming from wind and solar. Utilities in the U.S. and around the world are taking decisive action to reduce greenhouse gas emissions. The transformational shift from carbon-based fossil fuels to greener, cleaner renewable sources creates a growing reliance on distributed energy resources (DER), placing new challenges on what is already an aging power grid.

According to data from the U.S. Energy Information Administration, 20.1% of utility-scale electricity generation in the U.S. in 2021 was from renewables.

Industry data shows that global wind turbine deployment tripled during the last decade, while it is expected that between 2021 and 2025, 865 GW of PV solar will be installed. Meeting growing energy needs and securing a carbon-neutral future are pushing renewables further to the forefront.

New renewable generation capacity is important as utilities retire existing coal plants. But often these new solar and wind resources are far from urban or industrial centers where the energy is needed, presenting transmission and distribution challenges. Utilities must find reliable methods to incorporate the energy mix from these green energy sources and maintain grid flexibility, while balancing supply and demand.

Utilities face the reality that the two largest renewable energy sources—wind and solar—also have the highest intermittency. Energy producers must pass the infrastructure, intermittency and storage tests that come with these renewables.

Infrastructure planning

EVs are boosting the demand for electricity, with $5 billion in government funds earmarked to support the creation of EV charging corridors nationwide.

Absorbing the supply shift from fossil fuels to renewables requires a new approach, including transmission and distribution strategies that focus on digital solutions. The ability to remotely control, monitor and troubleshoot the grid builds a stronger, more resilient system.

Utilities are deploying smart components using advanced sensors to not only detect issues, but also allow operators to do everything from remotely performing routine maintenance to safely disengaging DER generators from the grid until repairs can be completed.

Circuit breakers acting as power managers can measure key points such as voltage frequency and phase, while determining when to send a signal to switch a unit on or off. These devices can detect potential problems, so a decision can be made to shut the generator down or allow it to run until a scheduled maintenance period.

The infrastructure challenge for utilities also comes from the electrification of new segments of society. The transportation sector shift to electric vehicles (EV) to reduce carbon emissions is placing demands on generation capacity, while also stressing transmission and distribution resources. The situation is further complicated by the fact EV adoption is uneven, often placing demands on the grid in regions where it is aging and more vulnerable.

EVs—from family SUVs to on-highway trucks—are boosting the demand for electricity. In the U.S., the Infrastructure Investment and Jobs Act designates $65 billion for grid upgrades, with $5 billion earmarked to support states in the creation of EV charging corridors nationwide. As other industry sectors move toward electrification, there will be an even greater reliance on renewables. According to a 2022 Black & Veatch report, *Megatrends in Power,* 64.8% of organizations said they have carbon reduction, greenhouse gas emissions reduction, clean energy or renewable goals. Utility customer have a growing thirst for renewable energy sources.

Utility-scale wind and solar farms necessitate additional transmission capacity to get electricity to where it is needed. Sophisticated distributed energy resources management systems (DERMS) are needed to control when the generated renewable energy is used, deciding when it should be stored and when to dispatch it to the grid.

Digital technology is going to play a major role in grid reliability going forward.

An ABB 2022 study, *Billions of Better Decisions: Industrial Transformation's New Imperative,* found that 96% of the 765 international corporate decision-makers surveyed believe digitalization is essential to sustainability. The research, which surveyed industrial customers of utilities, focused on opportunities to leverage the Industrial IoT and empower companies and workers to make better decisions to benefit both sustainability and the bottom line. Unlocking insights hidden in operational data will enable better decision-making across various industry sectors, including energy.

Intermittency solutions

As utilities build grid resiliency, they must also plan for the basic intermittency that comes from wind and solar generation. Even in the Sunshine State, one utility has built the world's largest battery energy-storage facility. Florida Power & Light's Manatee Energy Storage Center in Parrish captures energy generated by FPL's nearby solar field for use at night and during cloudy days.

FPL's facility has 132 metal containers, each holding 400 battery units. Each of the containers can store 7 MWh, roughly enough energy to power 329,000 homes for up to two hours. This allows the utility to store excess solar power for use when it is needed by the grid. FPL has more than 500 MW of solar generation currently with a goal of reaching 3,200 MW during the next decade.

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While intermittency is a factor with wind and solar, renewable energy sources play a vital role in grid resilience because they are not reliant on fuel supply chains. Renewables can provide black-start capability to the surrounding grid with smart monitoring and switching equipment such as ring main units (RMU), and with energy storage can act to support emergency services during outages. New trends in solar generation mean more efficient land use and creative utility-scale deployments such as solar trees and solar car ports at parking facilities. Supported by rapid advancements in battery energy-storage systems (BESS), progress is being made thanks to artificial intelligence that maximizes battery life by learning various load factors and even using weather forecasts to improve performance.

Strategies using load leveling and peak shaving are part of addressing intermittency, but energy-storage systems are essential for greater flexibility. Finding economical methods to capture energy at off-peak times when demand is lower and discharging the energy for use at peak demand become vital as the renewable share of generating capacity increases. Meeting this "duck curve" is especially challenging with solar, which is plentiful while the sun is shining and drops as peak evening demand hits the grid.

Storage answers

Energy producers are meeting the need for balancing the supply of electricity to grid demand in the age of renewables with advanced storage solutions. Avoiding costly outages is complicated when climate goals require a transition unlike any other the industry has ever faced. The need for a more resilient and dynamic grid is leading to a substantial increase in the number of energy-storage projects.

Innovative thinking and new technologies, such as BESS and DERMS, support grid resilience and reliability. Battery energy storage helps balance the supply of power, while also acting as back-up power in the case of a grid supply failure.

It may also serve to eliminate brownouts, over-voltages and electrical noise. Energy storage can be used to help the grid respond quickly to unexpected imbalances between generation and demand. Data centers, healthcare facilities, airports and public-safety facilities are just a few types of energy users that require uninterruptable power. In other cases, economics make interruptible power a reality for some businesses. BESS can mitigate costly downtime and restart costs.

The reality is that building out the necessary infrastructure will require years to accomplish. In the interim, battery energy-storage systems hold the best potential to help bridge the gap.

As grid infrastructure is being upgraded, there is an opportunity to design resiliency into the system. Changes to the way energy is transmitted need to be implemented. Reducing the vulnerability of overhead transmission and distribution lines by using underground cabling will not only harden the grid, but has the potential to improve everything from quality of life to safety. For utilities, improvements in resiliency indexes have benefits in terms of customer satisfaction, reduced repair and maintenance costs, and can help gain regulatory approval for further investments in key projects.

An integrated solution

As utilities work on these challenges, there are vital roles for independent power producers, reliability councils and government regulators to play. Balancing the supply and demand, encouraging the development of storage systems capable of growing with the onslaught of renewables, and creating an environment where contractual agreements recognize and share the risks inherent in a system that relies on intermittent generation are all real-life needs.

Utility CEOs and investors in renewable power have been deliberate in their approach to meeting sustainability goals, but meeting the infrastructure, intermittency and storage challenges won't happen overnight. It requires cooperation at many levels, including from regulatory and funding perspectives. The demand for renewables is undeniable. More than 350 companies have committed to the RE100 pledge created by the Climate Group, which calls for 100% renewable energy utilization across global operations. According to Black & Veatch, more than 50 companies had already reported reaching the goal by 2020, with another 65 having achieved 90% compliance. In the U.S., ABB has joined the Department of Energy's Better Climate Challenge, committing to reduce greenhouse gas emissions by at least 80% within 10 years.

Electrification is driving increased worldwide energy demand as society mandates decarbonization, placing an emphasis on increasingly automated, smarter grid components with an interconnected set of resources that include battery energy storage needed to foster a reliable, secure energy future.

The next phase in meeting climate goals requires utilities to make substantial investments. Innovation in utilizing DERs is happening at the exact same time serious questions are being asked about the aging grid and many generating assets are reaching lifecycle performance challenges. A comprehensive approach is needed among generators and grid operators that includes a fresh look at distribution equipment, substation automation, cybersecurity, asset protection, transmission solutions and digital remote monitoring and operations.

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Grid resilience: The legacy of a storm

After Superstorm Sandy devastated coastal utility infrastructure in 2012, Consolidated Edison launched a $1 billion program to protect New Yorkers from the next major storm.

A key part of this effort effectively digitized their substations, giving Con Edison greater situational awareness of grid assets and overall conditions. Digital switchgear provides real-time data by using sensors to measure temperature and humidity, as well as monitoring utilization and operating cycles of electrical devices. This helps Con Edison predict potential failures before they occur or alert grid operators when maintenance is needed.

Similarly, Florida Power & Light installed 223 flood monitors at flood-prone substations to warn operators when to de-energize equipment. This step saved millions in repair costs during Hurricane Irma alone.

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