Powering ahead toward a climate-proof grid

Argonne and ComEd are working to ensure a reliable and resilient power supply in the face of climate change impacts

The US Department of Energy’s Argonne National Laboratory and Commonwealth Edison Company (ComEd) have joined forces to safeguard the power supply for millions of people in northern Illinois. Through forward-looking grid planning and the integration of climate change projections, ComEd ensures a reliable flow of energy for decades to come. Backed by supercomputing, Argonne’s advanced modeling provides a deeper understanding of changing climate conditions, enabling ComEd to better assess evolving risks to its systems, make informed decisions, and strengthen its electricity infrastructure for future challenges.

Providing a dependable power supply

ComEd has consistently delivered strong reliability to its customers, investing in its power grid to minimize power outages. In 2022 alone, 85%, or nearly 3.5 million, of its customers experienced either no interruptions or just a single disruption.

However, severe weather caused by climate change poses major challenges to the resilience of the northern Illinois electric company’s infrastructure. Conditions such as rising temperatures and increased storm intensity and activity are already having an impact. In August 2020, for example, a powerful straight-line windstorm led to more than a dozen tornadoes in Illinois alone, causing disruptions to ComEd’s infrastructure and leaving hundreds of thousands of customers without power.

“That storm was a clear indicator of the severity of climate risks we may face,” says Ryan Burg, principal business analyst at ComEd. “Illinois is in the center of the US and has a continental climate. This means the temperature is not moderated by an ocean or body of water, so we get extreme heat in the summer and extreme cold in the winter.”
As severe weather becomes more prevalent, ComEd's electrical system must deal with environmental conditions that can directly affect its reliability performance and test the grid’s resilience to severe weather. But changing weather impacts go beyond storms.

Hot temperatures tax grid equipment that requires periods of time to cool off to operate reliably, and heat can even change the way that equipment ages.

“One variable we are monitoring closely is the thermal stress these new heat patterns will have on our equipment,” says Burg. “For example, as the electrical system operates in hotter temperatures in the summer, we can anticipate greater destruction from flooding and faster component degradation. The hotter the system, the more frequently it needs to be maintained.”

With a vision to uphold its service reliability, ComEd is collaborating with scientists to address the potential impact of climate change on its infrastructure.

Preparing for future climate impact

To navigate climate risks, ComEd needs a forward-looking approach to grid planning in order to safeguard power supply. The company has traditionally relied on historical weather data for its infrastructure planning — specifically, records of the hottest weather over the most recent 30 years. But with warmer temperatures expected in the future, this data alone is no longer sufficient.

“One of the biggest systemic problems with power grids is that we don’t have design standards that immediately incorporate future climate impacts,” points out Thomas Wall, climate resilience lead at Argonne National Laboratory’s Center for Climate Resilience and Decision Science (CCRDS). “That’s causing us to design systems in ways that will require reconsideration in the future.”

In response, ComEd has partnered with scientists from Argonne, including Wall, to help understand the likely impact of climate change on its distribution grid and identify adaptation strategies. Ultimately, the company aims to integrate these strategies as well as climate change projections into its infrastructure planning.

For the first phase of this collaboration, the researchers analyzed temperatures, heat index, and average wind. Their findings indicate that by mid-century, northern Illinois will experience hotter weather, with average daytime temperatures surpassing 93–94°Fahrenheit and rising nighttime temperatures.

This increased heat may result in higher air conditioning demands, further straining ComEd’s power grid.

More focused data for more effective planning

The research team used high-resolution downscaling approaches and computationally demanding simulations to enhance the accuracy of their predictions.

“These approaches are resource-intensive but necessary to capture the intricacies of the northern Illinois region,” explains team leader Rao Kotamarthi, who is also CCRDS’ science director. “To perform our calculations, we used computing resources at the Argonne Leadership Computing Facility (ALCF), including an HPE Cray supercomputer, called Theta.”

With this downscaling capability, the team achieved a resolution of 12 km by 12 km for their projections under the first phase of the collaboration. This enabled them to capture climate conditions at a smaller scale compared to the typical resolution of about 100 km by 100 km, facilitating more effective planning for ComEd.

“We’ve traditionally used weather normalization and planned to a 90–10 peak. This means that maximum loads are adjusted to account for extreme hot and cold conditions expected to occur once every 10 years. This process is informed by the past 30 years’ annual peak day weather history. Now, we’re reevaluating our approach to consider the possibility of higher extremes than before.”

— Ryan Burg, Principal Business Analyst, Commonwealth Edison Company
**Better informed decision-making**

Using climate data from the study, ComEd is considering ways to improve its infrastructure planning to meet projected energy demands and mitigate the impacts of climate change, ensuring a reliable power supply to customers.

According to Burg, this data is already beginning to influence decision-making at ComEd.

“We expect to draw on these studies to inform our standards-making practices and what kinds of equipment we should procure in the future, and to consider the potential loads from our customers,” he says. “These analyses can help us think about some of our work practices, such as the possibility of more extreme cold in the winter, extreme heat in the summer, and increased load demands with home and transportation electrification.”

There is also a growing recognition that the current or past climate may not accurately reflect the future. “It’s really finding its way into a lot of our conversations,” adds Burg.

**Enhanced design assumptions for greater preparedness**

With insights from the study, ComEd can begin to evolve its infrastructure planning process to better account for the changing climate and potential future conditions.

“For forecasting purposes, we have traditionally used a weather normalization process and planned to a 90–10 peak. This means that maximum loads are adjusted to account for extreme hot and cold conditions that are expected to occur once every 10 years. This process is informed by the most recent 30 years of annual peak day weather history for the area. Now, we’re reevaluating our approach to consider the possibility of higher extremes than what we have previously experienced.”

According to Burg, the scenarios Argonne ran have provided important insights into the highest possible level of weather severity.

“While it’s not impossible for weather to surpass the levels Argonne has predicted, it has helped us understand a realistic range of values. Our distribution planning groups are now contemplating revising design weather assumptions.”

**Building tools for climate resilience**

ComEd is now in the early stages of working with Argonne to develop planning tools that will help identify and map out vulnerabilities in its power system. This is especially important as the utility company navigates numerous industry changes, from shifting climate patterns to transitioning to clean energy generation.

“In the long run, we know we will need multi-level tools that offer granular insights,” says Burg. “We need planning tools that support a lot of decision-making for infrastructure owners. And at a system level, we must consider resource adequacy and communities’ climate exposure.”

**Predicting climate conditions more accurately**

As Argonne and ComEd move on to the next phase of their collaboration, they expect to capture climate conditions on a much smaller scale than before, improving their understanding of climate effects.

“We can now simulate more detailed climate models, which give us greater locational information about impacts across ComEd’s service territory,” says Wall.

“We can now simulate more detailed climate models, such as the 4-km model the team is currently running. These models give us greater locational information about impacts across ComEd’s service territory.”

— Thomas Wall, Climate Resilience Lead, Center for Climate Resilience and Decision Science, Argonne National Laboratory
The idea is that as computing capacity at the lab increases, we can achieve higher resolution and more accurate predictions.”

– Rao Kotamarthi, Science Director, Center for Climate Resilience and Decision Science, Argonne National Laboratory

By drawing on advancements in computing power, Argonne is striving to deliver more actionable outcomes and enhance ComEd's understanding of climate impacts specific to the region.

“As part of phase two of the study, we're using the ALCF's new HPE Cray supercomputer called Polaris to simulate models at a 4-km resolution,” shares Kotamarthi. “The idea is that as computing capacity at the lab increases, we can achieve higher resolution and more accurate predictions.”

After attaining a resolution of 4 km, the next step is to develop models with a finer scale of 1 km using Argonne’s upcoming exascale supercomputer, Aurora. This refinement aims to simplify the modeling process and capture climate conditions with even higher detail and precision. Simultaneously, Kotamarthi’s team is exploring machine learning techniques to enhance the efficiency and accuracy of climate modeling.

“We're already trying to figure out how to scale this and how much data we need,” says Kotamarthi. “Machine learning will be a key aspect of our work as we go forward.”

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