AI tool could help plan New York state's transition to clean electrical power

February 23 2022, by Syl Kacapyr

Credit: CC0 Public Domain

Cornell University engineers have developed a powerful artificial intelligence tool that could help New York state and other governments plan the transition to a carbon-neutral power sector, using a combination of machine learning and optimization modeling to provide hour-by-hour analysis of the empire state's energy needs.

States including New York, which has committed to producing 100% clean electricity by 2040, are using technological, environmental and economic data to determine the best policy and investment choices for integrating more renewable energy into the grid. But from a computational perspective, the modeling challenge is enormous, said Fengqi You, the Roxanne E. and Michael J. Zak Professor in Energy Systems Engineering at Cornell Engineering.

"There are design decisions such as how many solar panels or wind turbines to install, and how much energy storage capacity to build," said You, a senior faculty fellow at the Cornell Atkinson Center for Sustainability, "but even more complex are hourly operating decisions such as how much electricity goes from upstate to downstate, or from a storage center to a neighborhood."

You said such high-resolution planning can be achieved using "multi-scale, bottom-up optimization" modeling combined with machine learning. The framework is detailed in the Feb. 7 print edition of the journal *ACS Sustainable Chemistry & Engineering*. The study was co-authored by graduate student Ning Zhao.

The research builds on You's 2019 study that showed how modeling can help steer New York's long-term energy goals. But modeling annual energy supply and demand doesn't account for spikes in demand that occur on an hour-by-hour basis. New York's unsettled weather brings wild swings in electricity demand and intermittent energy from sources like wind and solar.

To illustrate their new energy transition framework, You and Zhao produced case studies on the electric power decarbonization of New York, optimizing yearly capacity planning and hourly systems operations, while incorporating data from the technology, capacity and age of electricity generation and storage facilities from across the state.

"We're trying to bring technologies like machine learning, data analytics, optimization and artificial intelligence to help a state understand what is required to operate not only every year, but also every hour with renewable energy," You said.

In one case study, which proposed expanding capacity for electricity storage in New York, the transition model indicated that the total electricity generation capacity was 39% higher than in another case without expanded storage. If the state were to choose not to expand electricity storage, it would require 200% more generation capacity based on nonintermittent energy.

Detailed hourly simulations indicated that offshore wind, hydro and solar are the optimal power sources by the year 2040, but if power storage capacity could not be expanded tenfold, then solar-energy options would have to be replaced by nuclear in order to create a reliable energy grid.

"It's thrilling to look at the entire transition process that we obtained from these optimization tools," Zhao said. "This can provide a lot of insights of how our future system could look like and how we can push this decarbonization transition forward in an economically efficient and reliable way."

More information: Ning Zhao et al, Toward Carbon-Neutral Electric Power Systems in the New York State: a Novel Multi-Scale Bottom-Up Optimization Framework Coupled with Machine Learning for Capacity Planning at Hourly Resolution, *ACS Sustainable Chemistry & Engineering* (2021). DOI: 10.1021/acssuschemeng.1c06612

Provided by Cornell University