E.ON: Optimizing the Renewable Electric Grid

CASE STORY

Modern power grids have grown remarkably complex. They incorporate an increasingly diverse and decentralized set of generating facilities, in order to supply an ever-larger number of consumers.

This evolution has been fueled by the rapid proliferation of renewable energy sources—indeed, many households are themselves contributing to the grid as 'prosumers', who generate their own power from sources such as solar panels.

This complexity creates hard problems in terms of logistics and ensuring that every household or business on the grid consistently has the power they need, when they need it. German utility provider E.ON is exploring how the quantum computing platform developed by D-Wave can address those challenges both now and in the long-term future.

In a recent preprint, "Community Detection in Electrical Grids Using Quantum Annealing", a team of researchers led by E.ON Chief Data Officer and Global Head of Analytics and AI Juan Bernabé-Moreno applied D-Wave's technology to the challenge of optimally managing the electricity contributions of prosumers within a grid. This decentralized power production is a boon to the system overall, but requires careful management to ensure that access to electricity is equally distributed and stably maintained for all other customers on the network.

One solution is to partition the grid into microgrid clusters, where energy production and consumption can be locally managed. However, it can be extremely challenging and computationally intensive to identify the optimal solution to this partitioning problem. One approach is to apply complex network and graph theory as a tool to reveal characteristics of the electrical grid to

The "IEEE 118-bus test case shows time performance speed-up. The increment in performance would enable real time planning and operations of electrical grids", noted the E.ON team

facilitate the clustering process and optimize the creation of these virtual microgrids. This "modularity-based graph partitioning" has been used successfully for other applications that involve networks, such as social networks, metabolic networks, and computer networks. In this new work, the E.ON team applied it to problem of optimizing the power grid.

Quantum approaches successfully partitions the most complex of the IEEE test cases, the "IEEE 118-bus" test case.

Courtesy E.ON

Using three well-known IEEE test cases for simulating optimal power flow though an energy network, the E.ON team performed a head-to-head comparison of a D-Wave quantum annealing system, two D-Wave hybrid (quantum-classical) solvers, and a classical computing system. The D-Wave quantum annealer delivered comparable output for relatively smaller and simpler test datasets, although they also took longer to arrive at a solution.

When the team evaluated much larger datasets, however, the advantages of quantum computing became clear. In this scenario, the quantum computer and the hybrid solvers were able to efficiently arrive at a robust grid-partitioning solution, while the classical computing approach continued to grapple unsuccessfully with the problem.

"This potential speedup would help to plan and operate electrical grids in real-time," noted the E.ON team, adding that it should be feasible to actively tune the clustering process to accommodate changes in prosumer activity in the overall grid.

The company has also been exploring other exciting applications for quantum computing. These include 'predictive maintenance' strategies, in which machine learning is employed to identify vulnerabilities in a power plant or electrical grid, allowing operators to identify and replace damaged or aging components before they fail.

In the years to come, E.ON sees the potential for quantum computing to transform the energy world on multiple fronts, including the development of improved climate models to guide the deployment of renewables, design of superior materials for batteries and grid infrastructure, and even identifying optimal regulatory frameworks for energy generation and distribution. "Quantum computing is key to overcome the problems and limitations we have today with AI," said Bernabé-Moreno at the 2020 Energy Innovation Days conference. "They're going to go hand in hand, and they are going to just make us take the energy transition to the next level."

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D-Wave Launch: The on-board to quantum computing program

If you are ready to get started but not sure how, the D-Wave Launch program has been designed to help enterprises at every step of their quantum journey, from problem discovery through production implementation.

- Identify the problem best suited to quantum
- Get your team trained and start the development process
- Move your application into test and ready for production
- Get your application up and running to deliver benefit to your business

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