BUSINESS CASE FOR
SCUC Software

PREVENTING A TRAFFIC JAM

ON THE POWER GRID

How security constrained unit commitment software is helping electric utilities and grid operators keep the lights on and improve their bottom lines

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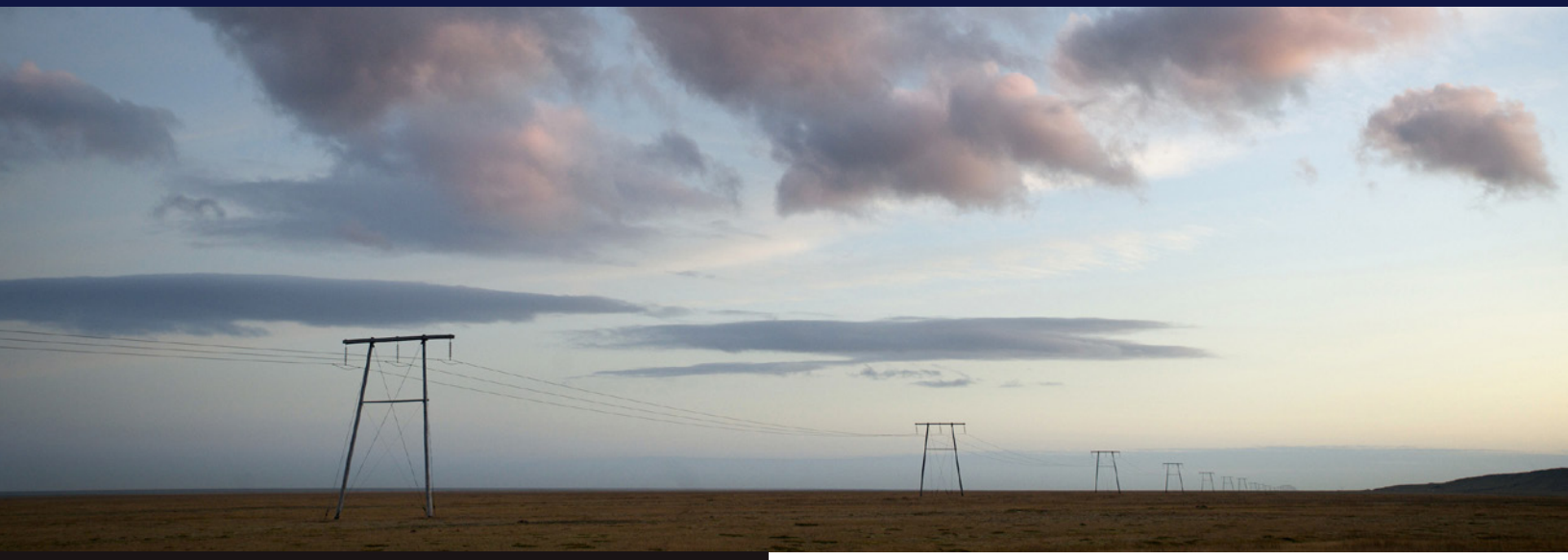

CASE STUDY SNAPSHOT

Problem
Utilities and grid operators face a growing number of variable challenges in delivering electricity to customers as efficiently and economically as possible.

Solution
Security constrained unit commitment software optimizes the commitment and dispatch of generation in order to maintain grid reliability at the lowest possible cost.

Return on investment
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> **“Ten years back, you just made decisions on past data.”**

Ravi Pradhan
Vice President, Technology Strategy at Siemens Smart Grid Division

Preventing A Traffic Jam On the Power Grid

How security constrained unit commitment software is helping electric utilities and grid operators keep the lights on and improve their bottom lines

Until recently, grid system operators and electric utilities relied on someone’s best guess to dispatch generation resources in the most economical way possible.

“Ten years back, you just made decisions on past data,” says Ravi Pradhan, chief technology officer at Siemens Smart Grid.

But today, security constrained unit commitment (SCUC) software is taking guesswork out of the picture.

SCUC software uses a sophisticated set of algorithms to determine the when and how to run the most economical generators at various points during the day, based on anticipated demand. The same programs will examine the physical constraints on the grid and send electricity across the most efficient pathways so consumers can keep their lights on.

"Under normal conditions, if system operators get within 5% of the optimal range -- meaning that they are running enough generation to meet their electricity load requirements within this parameter -- they are doing a good job," says Khaled Abdul-Rahman, executive director of power systems and smart grid technology for the California Independent System Operator (CAISO).

"But if grid operators are nailing it down to a 1% range, they are nearly perfecting their jobs," he says. That's possible now with the advent of SCUC software.

The technology, which functions in real time and can look forward in time, is used to optimize wholesale energy markets in two ways. First, it assesses how much energy is needed to meet demand within a specified area. Second, it determines the best generation sources to dispatch while considering all potential constraints on a transmission system.

The software is about optimizing the use of energy, which means saving money and potentially avoiding the construction of expensive infrastructure such as new power lines and power plants. According to Siemens, utilities have seen a full payback of the SCUC software solution within a matter of weeks.

"It does a lot of fast thinking that human beings can't keep up with in a system of increasing complexity," explains Warren Causey, a smart grid consultant in Atlanta. "The days of doing this all by hand, through experience and knowledge of systems, is drawing to a close. No one individual or group can keep up with all the variables in generation today."

Dispatching Resources

Balancing the demand for and supply of electricity on the power grid is not an easy job. Depending on the region, electric utilities and grid system operators have been tasked with this critical responsibility.

In traditionally structured markets, vertically integrated utilities own and control the generation, transmission and distribution assets – and thus must make the decisions about which plants to dispatch based on fuel costs. Applications like SCUC software could benefit them considerably. Consider a utility that has a mixture of natural gas turbines and thermal heat recovery. Among other functions, the software can accurately model how much heat to recover and when to ramp equipment up or down.

"Bulk electric energy storage is commonly much smaller than power system aggregated demand. Hence, generation must be scheduled to be equal to demand at all times, which is the commitment side of the equation," explains Amin Khodaei, professor of electrical engineering at the University of Denver. "We have to add the physics of the transmission network to the picture when balancing generation and demand, and ensure that the generated energy is supported by adequate transmission capacity to be reliably delivered.

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Warren Causey
Utility industry consultant

"We also need to consider contingencies when there is one or more unintentional outage of power components, which is the security part," adds Khodaei. "We need to determine how much energy is to be produced by each power plant and how to manage the power system when an outage does occur."

In restructured markets, regional transmission organizations (RTO) or independent system operators (ISO) were established to manage the grid operations of several utilities and give all generators equal access to the grid.

Grid operators are federally regulated and take bids collectively from buyers and sellers of electricity and subsequently establish a price. They schedule the physical delivery of that product on a day-ahead basis or in real time. Low cost generation is dispatched first.

Most of the solutions give market participants the most up-to-date information on supply, demand and pricing at numerous delivery points on the transmission system during periods of congestion. At the same time, system operators have the ability to order power generators to ramp up or down. As such, many have already augmented their practices with software that can help them do their jobs.

"Because you are pinpointing the cost to individual units, it is a more economical decision," explains Joe Ciabattoni, manager of markets coordination for PJM Interconnection, the system operator for parts of the Northeast, Mid-Atlantic and Midwest regions. "Now, we can fine tune the dispatch to the unit level as opposed to the transmission zone level, meaning that it is a cost savings to our members. There is more precise control of transmission constraints and there is better reliability."

The security constrained unit commitment software works well for independent system operators, which manage the grid for multiple participants that bid their generation into the system and that expect to be fairly treated, Ciabbattoni adds. It's an engineering solution "that has a basis in math and science."

Variable Generation

Matching generation with demand is a challenging task under any set of circumstances. But if wind and solar generation are thrown into the mix -- the kinds of fuels that introduce intermittency -- then the job becomes even more difficult.

Many regions, for example, have ample wind resources but they struggle with incorporating such resources onto their grids because they must be backed up with other resources.

Security constrained unit commitment software

can accurately predict those variables -- allowing system operators to plan accordingly, says Massoud Amin, chairman of the IEEE Smart Grid and a professor of electrical engineering at the University of Minnesota.

"If system operators can accurately gauge when wind or solar resources might be down, they can dispatch other low-cost generation that is on their systems," Amin explains.

"The system would not lose the ability to serve the load connected to it and there would be no cascading blackouts," adds Abdul-Rahman with the California ISO. "If a contingency happens, in any case, we can recover."

SCUC software is essential to system operators as they seek to integrate more wind and solar resources onto their grids -- a task likely to increase in the face of pending national constraints on carbon emissions. And as more electric vehicles hit the road and smart technologies become ubiquitous, they will add a whole new layer of challenges to the equation. "Grid operators will have to be at the top of their game," says IEEE's Amin.

"If the plan of integration requires 40% more wind, which is entirely feasible by 2030, it would necessitate a 9% increase in high voltage transmission," he says. "But implementing dynamically-optimized security constrained unit commitment algorithms fused with real-time information would help run the overall system more efficiently and more securely," he explains.

"During the past six years, we have made solid progress on building end-to-end smart self-healing grids in North America and in many other nations," Amin says.

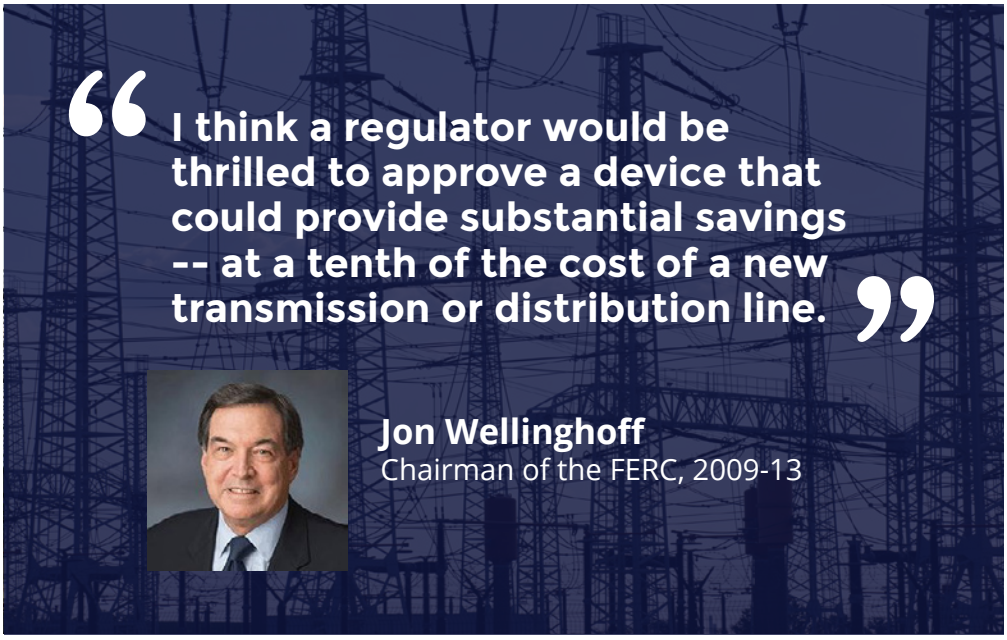
"They are smoothing out the uncertainties tied to variable weather, load patterns, distributed generation resources, emerging storage technologies and dynamic pricing," he notes. And with smart meters, the new security constrained software can support the integration of demand response and distributed renewables in real time.

The price tag of the security constrained unit commitment software depends on the size and complexity of the system. In either case, utilities and system operators see returns on their investments because the electrical system runs more efficiently by dispatching the most optimal fuels over the best lines available.

While the U.S. Energy Information Administration expects the demand for electricity to rise by about 1.5% over the next two decades, such efficiencies could reduce the need to build new power plants and new transmission lines. That's something that the Federal Energy Regulatory Commission (FERC) is following, given that high-voltage transmission is within its purview and it authorizes rates of return on those investments.

"FERC ensures that the transmission system is operating efficiently," says Jon Wellinghoff,

former chair of the commission and now a lawyer with Stoel Rives in San Francisco. "If the technology would reduce the need for new lines and new power plants, then this is something in which FERC would take an active interest."



"I think a regulator would be thrilled to approve a device that could provide substantial savings -- at a tenth of the cost of a new transmission or distribution line," adds Wellinghoff. "If the alternative is to build a new line and it would cost $1 billion and the technology device provides the same improvement for $100 million, then it is a no-brainer."

Coming of Age

On a grand scale, the modernization of electrical systems is all about the smart grid and the ability to permit two-way communications between utilities and their customers, creating efficiencies on the transmission grid, allowing room for more "green" electrons and avoiding blackouts.

But on a granular level, modernization is about giving utilities and grid operators the means to dispatch the most economical generation units and to push those electrons efficiently through a transmission system that has thousands of constraints attached to it. And that's what security constrained unit commitment software does.

"We invest in these products each year as we continually improve our processes and incorporate new logic to handle new resources," says PJM's Ciabattoni. "Years ago, we didn't have wind energy and it has to be handled differently from other fuels. But now operators can bridge those constraints and put them into the application."

Such technological progress means potentially cheaper energy production and greater reliability -- advances that will assuredly continue, enabling an increasing number of utilities to get on board.

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