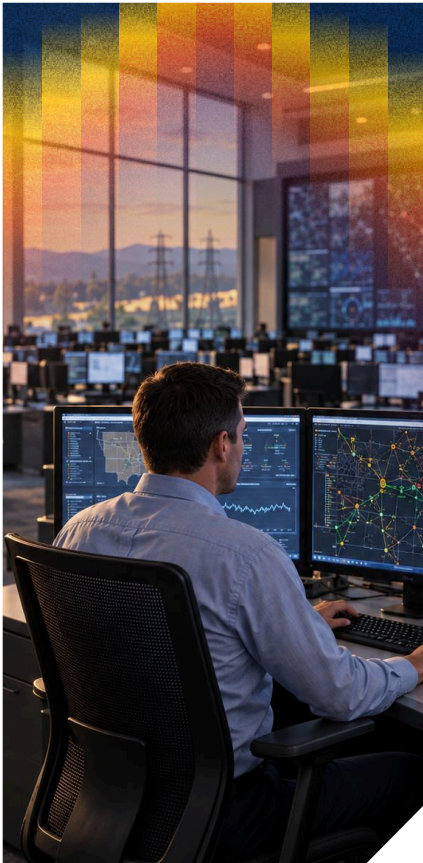




SPP: Operating a More Reliable Power Grid with Faster Solve Times

Using Gurobi's PDHG algorithm, SPP can solve its grid optimization problems up to four times faster, bringing more reliability to the grid while lowering costs for its customers.

As a regional transmission operator (RTO), Southwest Power Pool (SPP) must ensure reliable power supply, adequate transmission infrastructure, and competitive wholesale electricity prices on behalf of its members.

SPP uses a market clearing engine to determine locational marginal prices (LMPs) over varying time periods—from real-time reports issued every five minutes, to studies over a five-day time horizon, to even longer horizon strategic models. At the core of this engine is mathematical optimization, powered by Gurobi.

The Problem

"Each day presents its own unique challenges on the grid," explains Joe Byers, Lead Engineer at SPP. "We have to get our generation fleet on the footprint prepared for the next operating day, and figure out how we're going to serve the power load. As we get closer to the next day, we're running smaller and smaller studies to make sure that we are still secure on our commitments and our ability to provide the power needed to serve the forecasted load."

Depending on changes in weather, availability and variability of renewable resources and maintenance events, the model formulation can grow even more complex and challenging to solve.

SPP's market clearing engine converts input data from the market study into mathematical models, which are solved by Gurobi. They utilize a combination of mixed integer program (MIP), as well as a linear program (LP), models to optimize their market over the given time period, producing generation schedules and LMPs. The results are then shared with SPP's market participants.

However, when transmission issues arise, they place significant strain on the MIP.

And because SPP must post results to their members within federally mandated timeframes, they needed additional solving power to speed up their solve times.

"Clearing engine performance has always been a challenge because there's always more complexity being added to the market. Operations are always adding more and more transmission constraints, so it's a challenge to chase that performance and keep it under control," shares Byers.

To achieve the performance boost they needed, SPP utilized Gurobi's Primal-Dual Hybrid Gradient (PDHG) algorithm on a central processing unit (CPU), and is also considering GPUs.

The solution

SPP noticed their five-day horizon market study MIP had a particularly challenging behavior: the root-node relaxation LP could take a significant amount of time to solve. To approach this problem, SPP reached out to the Gurobi Experts to see if the new PDHG algorithm for LPs could improve the performance.

"PDHG really helped improve the runtime," says Byers. "On our side, sometimes we see that the root node LP can be 300 to 400 seconds. And [with PDHG] that dropped down to less than 100 seconds for some of our more challenging models."

This 4x performance improvement was achieved simply by switching the root node algorithm, and without having to change solvers or take on additional modeling work—a quick win for SPP.

Time saved in the root node can then be reallocated to the branch-and-bound portion of the MIP search, allowing more time to find higher quality solutions within the market's solve time limit.

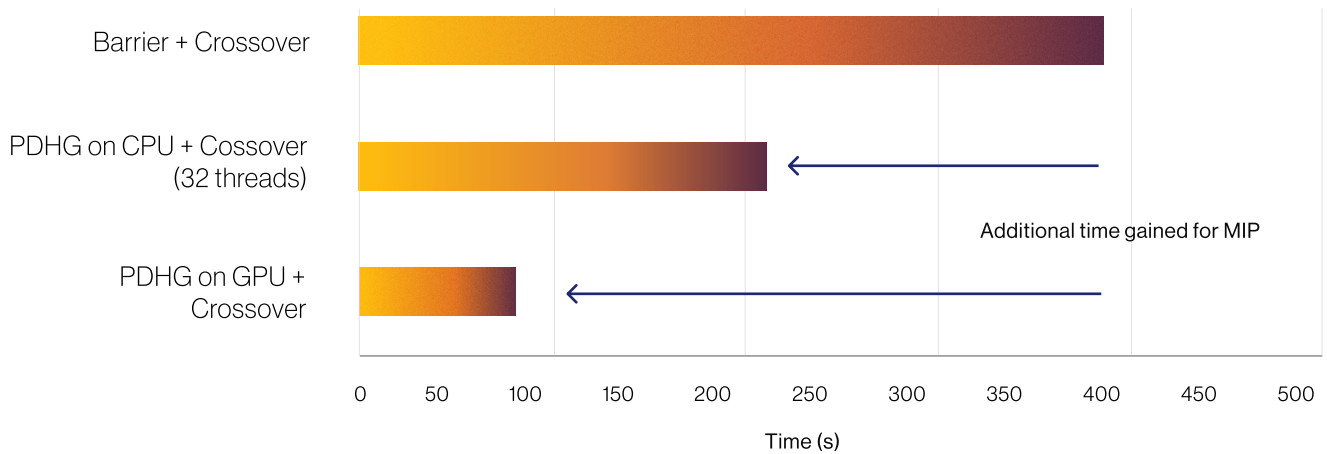
Industry Power & Utilities
Location Americas
Use Cases Power Grid Operation
Website www.spp.org

SPP works with its partners and stakeholders to ensure the reliable and affordable delivery of electricity to the millions of people living in their multistate service territory.

Results

- ◆ Enforcing more transmission security constraints in the day-ahead solution results in more reliable real time operation
- ◆ **Up to 4x faster** root node solve time with PDHG on CPU compared to Barrier on CPU
- ◆ **Up to 3x faster** root node solve time with PDHG on GPU compared to PDHG on CPU – **12x faster overall** than solving with barrier on CPU

Root Relaxation Runtime



“The faster we can solve the root node, the more iterations we can get. And that helps us downstream, going into real time, to have the correct committed generation to tackle all the real-time problems that could appear.”

Joe Byers,
Lead Engineer

The Gurobi Experts ran extensive tests on several representative models shared by SPP, and found that PDHG on a CPU with 32 threads improved the runtime by 2x on average, and there was an additional 2x improvement when using NVIDIA Grace Hopper GPU hardware.

While gains varied across models, the overall effect was clear: The PDHG algorithm is responsible for significant root node runtime improvement, and taking the additional step of running on GPU hardware can yield an additional performance boost.

The figure above shows the runtime for a sample model instance using three different methods on the root node. Gaining up to 300 seconds within their overall time limit that they could then devote to the MIP Branch-and-bound search enables higher quality solutions overall.

Results

The benefits of these speedups extend to SPP's customers, as well—bringing more reliability to the grid, and lowering costs.

“Our operations team wants to activate as many transmission constraints as possible, because as it flows down to real time, it makes everyone's job easier with the software automatically managing the system,” Byers explains. “So the more transmission constraints we can put into there, then the more reliable generation we have committed to be able to handle the transmission problems.”

Along the way, SPP has found the responsive support they needed from Gurobi.

“The onboarding process was very smooth,” says Byers. “Everyone was super helpful, and all around it was a great experience.”



In Memory of Joe Byers

The Gurobi Team extends our deepest condolences to Joe Byers's family, friends, colleagues, and all those mourning his loss. Joe passed away before the publication of this case study. He demonstrated a remarkable commitment to his field and a passion for advancing innovation through optimization. His contributions helped further optimization awareness and practical breakthroughs across SPP. We had the privilege of working with Joe, and we will remember both his lasting impact and the dedication he brought to his work.

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