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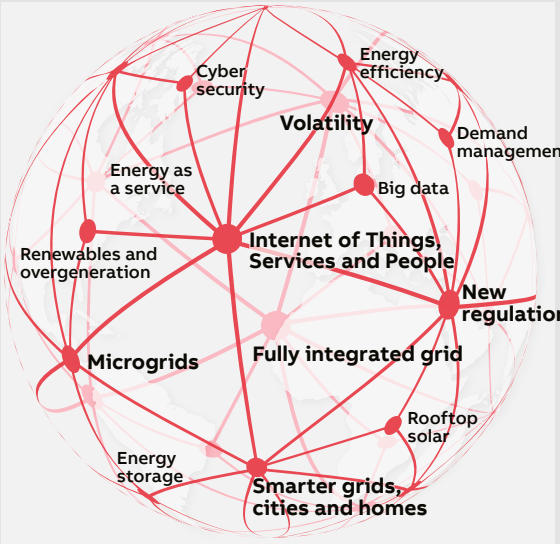
The future is stochastic:
The role of distributed computing in power market simulations



We can foresee the state of the power industry in 2040…and it will look like a scene from a sci-fi movie. As interconnected as we are today, the world will become even more computerized in the decades to come. In a sense, the future is already here; it just hasn't yet become a fully global phenomenon.

Major transformation in the power industry

The global power industry has been experiencing major changes in the past few years. More and more renewables, energy storage technologies, demand-side management programs and other distributed generation technologies are being added to the power system every day. Additionally, more households are buying electric vehicles and installing rooftop solar and household energy storage systems. This means that the generation mix and load profiles are changing rapidly – generation is significantly more intermittent and uncertain, and the load is less predictable.

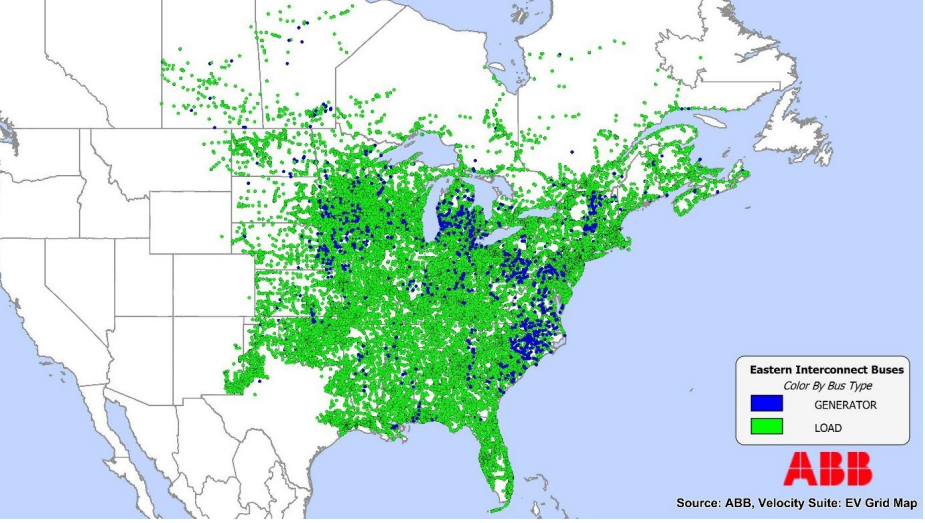
These trends have been substantially increasing the amount of data to be analyzed. Growing uncertainty in load and generation patterns has increased the need for stochastic analysis in the power system simulations, such that stochastic analysis of generation, load, prices, etc., is becoming a standard business requirement. For example, more state regulatory agencies are asking for detailed stochastic modeling as a requirement in the Integrated Resource Plans submitted by the utilities.

Stochastic modeling
"A form of financial modeling that includes one or more random variables. The purpose of such modeling is to estimate how probable outcomes are within a forecast to predict conditions for different situations."

Source: http://www.investopedia.com/terms/s/stochastic-modeling.asp

Power market modeling and challenges with big data

Let's say that you need to run a nodal electric market simulation solution that incorporates extensive details in generating unit operating characteristics, transmission grid topology and constraints, and market system operations to support economic generation and transmission planning. You want the model to run hourly or 5-minute simulations of the power system in the entire Eastern Interconnect that includes thousands of renewable and other generators and around 84,000 generator and load nodes. You would also like to have 50 stochastic draws on the hourly or 5-minute generation profiles of these renewable generators – now the simulation run-time is expected to be 50 times longer. The problem gets even more complicated when we include stochastic draws from load shapes and fuel and power prices. When all is said and done, you may end up with a very large simulation system with extremely long run times, even lasting for several days.



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How do you carry out a nodal electric market simulation? With ABB's e7 PROMOD® and ABB Market Data.

Dealing with simulation run-time issues

Run time issues can be solved in two layers:

1. Commercial optimization solvers
Commercial optimization solvers such as Xpress Solver have unique features for problem decomposition and distributed computing, and therefore help minimize simulation run times. However, stochastic draws significantly increase the number of simulations and, therefore, run times. As such, these solvers often need to be accompanied by a network of powerful computers to deal with run-time issues.

2. Distributed computing
Distributed computing refers to systems with multiple computers working together to solve a single problem. A distributed computing system divides a single problem into many parts, and each part is solved by different computers. The computers need to be networked to communicate with each other and solve the problem. If the computers are networked properly, they work as if they are a single entity. Therefore, if you have a simulation with 50 stochastic draws, you could push each simulation out to its own machine and the entire stochastic simulation would take the same time as a single simulation.

A distributed computing architecture includes a number of client machines with software agents and distributed computing management servers. The agents running on the client machines detect the idle machines and notify the management server about the availability of the idle machines. The management server sends the idle machines the application software to be processed. These client machines then run the application software and send the results back to the management server.[1]

There are two main types of distributed computing:

1. Distributed computing through on-site local grid
An on-site distributed computing system requires a certain number of local computers connected to run simulations. The main advantage of using a local grid is that your company has total control over the use of the entire network. However, having a local network may initially require significant hardware investments and maintenance efforts.

2. Distributed computing in a cloud environment (cloud computing)
Cloud computing, also known as on-demand computing, is a kind of internet-based computing that provides shared processing resources and data to computers and other devices on demand. Clients of cloud computing services can process their software applications and data using third-party servers and data centers.

[1] For more details, see Techopedia at https://www.techopedia.com/definition/7/distributed-computing-system
[2] https://en.wikipedia.org/wiki/Cloud_computing

The main advantage of cloud computing is that it provides economies of scale, as large quantities of computing resources are shared over a network. Also, it does not require any expensive upfront hardware investments and you can use the computing power of hundreds of computers without having and maintaining them on site. This may help electric utilities and other companies to keep their IT costs under control.

It's better in the cloud: Software as a Service (SaaS)

SaaS is a service model that provides software applications over the internet. ABB's Energy Portfolio Management group offers integrated software applications that can be delivered in cloud platforms where clients can develop, run and manage applications without building and maintaining an IT infrastructure. Clients can access these integrated applications from any location using a computer with internet access.

Bright future

What kind of energy future is waiting for us? There is a lot of uncertainty but one thing is certain: We have to find more sophisticated – yet efficient – ways to carry out stochastic forecasting and power system simulations in order to better evaluate the ongoing impact of renewable generation. Luckily, recent developments in cloud computing and other technologies are making complex simulations a reality. With cloud computing, no data is too big and the future is bright.

About the author
Erdal Kara is an industry solutions executive at ABB, providing technical sales activities for ABB's Capacity Expansion, Portfolio Optimization and PROMOD® software solutions. He has detailed knowledge of the CAISO tariff and FERC regulations and expertise in energy market analysis, forecasting, economic modeling and power plant valuation.

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