Building The Smart Wind Farm

IBM demonstrates predictability and profitability of wind energy

The Challenge: Intermittent Winds

Today most states in the U.S., and much of the world, have mandates that power grids must accept renewable energy sources such as wind. Since the nature of wind energy is intermittent, the challenge is to constantly adjust other generation sources to accommodate this variable energy supply. This problem will become more severe as the percentage of intermittent generation in the market increases. In addition, rapid, unpredicted changes in these power sources require grid operators to respond immediately by increasing or decreasing the amount of electricity generated from hydroelectricity, gas, coal or nuclear. Clearly, the variability of wind poses a challenge to those who want to turn wind into a profitable alternative energy source, and to those who must maintain system reliability in the face of the increasing use of such resources.

IBM Wind Power Solution

Conventional fossil-fueled or nuclear power generators require time and expense to power up and have limits on how quickly they can change their production levels. Unit commitment refers to deciding when to turn these generators on and off, and dispatch refers to deciding how much to produce from each generator. To hedge against unexpected load fluctuations and generator outages, system operators keep a certain amount of spinning reserve, generators that are on but producing at minimal levels that can increase production quickly. Intermittent generators require more spinning reserves, the cost of which detracts from the economics of using them.
In virtual demonstrations and real world wind farms, IBM is helping utilities, merchant generators and system operators to make intermittent wind power a more predictable resource. We have created a solution that includes short-range weather forecasting, analytics software and field technologies. Our goal is to help all stakeholders in wind integration profit from wind power that is more predictable, efficient, reliable and adaptive — in a word, smarter.

At the center of the IBM wind power solution is a combination of leading-edge technologies that can deliver detailed wind forecasting and produce more accurate and timely unit commitment and dispatching of power generation assets. These key technologies include:

• **IBM Deep Thunder** — a localized weather forecasting service that is capable of modeling wind conditions along the height of a wind turbine. Deep Thunder can be seamlessly integrated with other software applications and into key business processes in order to drive business value from the predictions.

• **IBM WebSphere® ILOG® software** — an optimization software suite that can provide decision support to system operators, merchant generators and utilities as they struggle to integrate intermittent wind power into the grid in the most efficient way possible. ILOG can provide optimized unit commitment and dispatch scenarios based on wind forecast data and other system information.

Together, the Deep Thunder and ILOG solution offers a new capability to forecast wind (and solar) energy in a more precise and useful way, and to employ these forecasts to maximize the use of this energy while minimizing grid disruption and ancillary costs. This solution makes use of existing data from weather sensors as well as weather forecasting data and services as input to the Deep Thunder model. The solution uses a set of weather scenarios of various probabilities, which are employed in the ILOG suite to allow the user to make better risk-informed decisions on their operations.

### 4D Wind Monitoring and Power Grid Integration

This IBM solution works by linking four-dimensional (three spatial dimensions plus time) wind forecasts from Deep Thunder to the ILOG optimization engine to allow for re-calculation of optimal unit commitment and dispatch strategies, particularly focused on the sub-24-hour timeframe. This system will be able to provide system operators with the ability to manage intermittent wind resources with less spinning reserve requirements for the same level of risk, or to reduce risk with existing spinning reserve levels.

Along with this IBM solution, a stable wind energy source requires additional grid intelligence. In other words, the grid-absorbing wind power must have the ability to recognize upcoming rapid wind changes through forecasting and modeling, and the ability to modify other power sources and loads in the right place and time without impacting customers. While grid issues related to adapting intermittent power are different in transmission and distribution systems, a smart grid is the key enabler to both goals.

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**What A Smart Wind Farm Looks Like**

Wind turbines are tagged with sensors that relay field data, such as wind levels and turbine output, to a central repository. In addition, there are multiple meteorological sensors around the wind farm, measuring wind speed and direction, temperature, pressure and humidity at hub height, along the vertical blade extent and near the ground. With advanced analytics, all of these data are brought together to present a single view of farm health and operations at a glance. All this instrumentation, interconnectedness and intelligence turns a conventional wind farm into a ‘smart’ farm that runs more efficiently, reliably and profitably.
Virtual Scenarios Demonstrate New Possibilities
IBM operates a virtual 42-megawatt wind farm — complete with 25 turbines, control room, maintenance shop and substation — that can be viewed at the IBM Energy & Utilities Solution Lab in Austin, Texas. The following discusses three user scenarios — aimed at three different stakeholders in the energy value chain, all of whom can profit from this solution — that are included in this showcase for the next phase of IBM’s capabilities for wind energy.

ISOs or others responsible for stability of the transmission grid
One of the most severe events for an Independent System Operator (ISO) with substantial wind resources in their grid is an unanticipated “ramp down” event. The IBM wind solution is aimed at providing the ability to predict these types of events far enough ahead of time to allow for optimization of the dispatch, and perhaps commitment, of other units in time to mitigate the effects of the coming change in wind power. This depends on both the Deep Thunder forecasting ability and ILOG's ability to quickly re-run the dispatch and/or commitment cases. A key financial aspect of this case is the ability to reduce spinning reserve on the system, based on growing confidence in the accuracy of the “day ahead” forecast and, more importantly, confidence in the “day of” timeframe. This allows a longer window for bringing up additional supply. Eventually, the spinning reserve can be scheduled as a function of wind power probability.

Generators that own wind and other dispatchable generation assets
Consider a wind power company that currently has a Power Purchase Agreement (PPA) for risk management, but would like to move towards a potentially more profitable merchant model where they would bid into the “day ahead” market on time, volume and price. The risk is in the INC/DEC payments that could be assessed for missing their bid power amount or timing. The gain is in the much higher price per kilowatt-hour that will be paid for the power. The goal of this solution is to reduce the company's risk in balancing merchant versus PPA strategies, and doing so using less alternative generation resources, thereby enabling them to make more money while maintaining an acceptable risk profile.

Utilities that must integrate wind into their systems, often on a “must take” basis
Utilities must make purchase commitments with their ISO as a normal course of business. If they have PPA-based wind farms under contract with them, they have to consider this power in their portfolio as they make these commitments to the ISO. The more accurately the utility knows the actual output of the wind assets, the better they can optimize the amount of power they agree to buy from the ISO to serve their load. Our solution is aimed at providing additional certainty in the wind power output from period to period to assist the utility in making sure they have optimal agreements with the ISO, in order to have sufficient but not excessive power purchase commitments.
Why IBM

IBM is a leading innovator in solutions for the energy and utility industry, including wind, on a global basis. Our simulated wind farm in Austin, Texas, has been created to demonstrate IBM and our Business Partner’s capabilities in wind energy.

We bring the integration skills, leading-edge technology, partner ecosystem, and business and regulatory expertise required to support every level of an implementation for a successful wind farm, from Deep Thunder and ILOG to asset management. We can provide planning and business case development, from pilot programs to full-scale execution. No matter the size of your wind farm. IBM can help you manage all of your wind forecast modeling, farm assets, and business processes in one end-to-end solution.

IBM can also help stretch your funding and fuel growth with capital from IBM Global Financing. Flexible options let you match your lease payments to anticipated funding so you can start your projects right away.

For More Information

To learn more about how the combined IBM Deep Thunder and IBM WebSphere ILOG solution can benefit your wind farm, please contact your local IBM representative or visit:

ibm.com/energy

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