# Simulator

## Simulator for Measuring the Impact of Wind Energy Integration on Power System Operation

Integrating wind energy into a power system poses numerous challenges in terms of reliability and profitability. In addition to fluctuations in demand, operators must take into account the variable nature of wind power. As an intermittent energy source, wind increases constraints on requirements for the load-frequency control that makes it possible to balance generation and load on the system.

### *Real-time simulation of planning and operations*

The simulator developed at the Institut de recherche d'Hydro-Québec (IREQ) is based on realistic operating strategies and can reproduce power system responses to within a minute. It includes planning and operating processes, power system configurations and historical data on wind energy production and electricity demand. The simulator enables a utility to optimize its power system operations by evaluating impacts on a large number of variables, including:

- Import and export opportunities
- Number of generating unit startups and shutdowns
- Number of automatic shunt reactor switching operations
- Reserve requirements for frequency regulation

### *More than wind energy*

The simulator has been used to evaluate the impacts of bringing 3,000 MW of wind power onto the Hydro-Québec transmission grid. The research team is working on a new version capable of anticipating the impacts of 10,000 MW of wind power. The simulator can show system responses on an hourly forecasting and real-time operations horizon, with or without wind energy. In addition to evaluating the impacts of wind energy integration, this tool will be useful for many other purposes. For example, in the context of smart grids, it can be used to assess the impacts of electric vehicles and the integration of new energy sources. It will be designed with the capability to model power systems other than Hydro-Québec's.

## *A multiagent simulator*

In accordance with the functional model of energy markets in northeastern North America, the simulator reproduces each of the entities or agents involved, i.e., the Generator, the Transmission Provider and the Distributor. The simulator operates in a multiagent system control framework. It uses the JADE platform (Java Agent DEvelopment framework) to model each of the agents, which must work together. By using distributed calculation techniques, it can rapidly simulate planning and operation phases over several years, taking into account the security and regulation rules applied by transmission system operators. All results are validated by means of the Newton-Raphson power flow algorithm, with reactive power management constraints.

### *Main advantages*

- Graphical interface enables the user to create, modify or download configuration files describing projected scenarios.
- User can determine the start and end of simulations, define the method for calculating the wind production forecast and change operating reserve constraints.
- User can produce multi-year chronological sequences covering all major system control parameters in a standard format compatible with most off-the-shelf software.

### *For information*

Innocent Kamwa, Project Coordinator
Institut de recherche d'Hydro-Québec (IREQ)
1800, boulevard Lionel-Boulet
Varennes (Québec) J3X 1S1
Canada
Telephone: 450 652-8122
E-mail: kamwa.innocent@ireq.ca

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