SCENARIO MODELLING OF AUSTRALIA'S NATIONAL ELECTRICITY MARKET USING NEMSIM

George GROZEV, Marcus THATCHER, Per DA SILVA, Wan Yee CHAN
CSIRO Sustainable Ecosystems, PO Box 56, Highett, Victoria 3190, Australia
George.Grozev@csiro.au

(1) Overview

This work presents a scenario-based approach for modelling Australia's National Electricity Market (NEM) using the agent-based simulator NEMSIM (Grozev et al., 2005), which is being developed by CSIRO's Energy Transformed Flagship project. NEMSIM models the major coal, gas, hydro and wind energy sectors and accounts for greenhouse gas emissions due to electricity generation (Batten and Grozev, 2006).

Modelling electricity markets is challenging because of the intricate interactions and interdependencies between market participants, physical infrastructure and government regulations. Traditional electrical simulation models could not be used for the deregulated electricity market since the new driving force for operational design is market behaviour, which was absent in previous, centrally planned, electricity systems. A review and a classification of electricity generation market models is presented by Ventosa et al. (2005). Our focus in using NEMSIM for scenario development is on *agent-based modelling* (ABM) and simulation. The ABM methodology is establishing itself as a mature research area of *complex adaptive systems* (Samuelson and Macal, 2006). This framework allows simulation of decision making and market behaviour of company agents that are heterogeneous and they differ on a range of factors such as: bidding strategies, production capacity, generation technology, ownership structure, physical location and risk profiles.

Another important aspect of NEMSIM scenarios is their dependency and compatibility with climate change scenarios. The simulation incorporates key climate dependencies of electricity supply and demand.

(2) Methods

Many of the decisions made by company agents in NEMSIM depend on electricity demand, which has a significant variability due to its dependence on temperature, humidity and (in countries with colder climates) wind speed. The NEMSIM regional electricity demand model (Thatcher, 2007) accounts for daily, weekly and seasonal demand behaviour patterns (i.e., reproducing realistic annual load duration curves) so as to produce hypothetical demand data in 30 min intervals for decadal time scales. It is compatible with any global climate model dataset and therefore provides a capability to explore various climate change scenarios.

The supply model is based on a heuristic dispatch algorithm and sophisticated bidding behaviour of company agents. Generator companies make offers to produce electricity for every half an hour of the next trading day (Hu, Grozev and Batten, 2005). Their bidding patterns can be prescribed based on publicly available market data. NEMSIM currently provides a set of bidding models, including lookup bid generators, file bid generators, dynamic and energy targeted bidding generators.

Electricity market simulators have been traditionally designed to model large generation capacities and sizeable transmission power flows. The NEMSIM development group is in a process of developing a simulation capability for distributed generation (DG) and demand side response. The capacity of a single distributed generator is typically much smaller than the usual lower limit of 30 MW for market scheduled generators in the NEM. In order to simulate DG together with central generation options, an aggregation of many distributed generators (and demand side responses) is required to achieve a comparable granularity in the modelling and to obtain good computer simulation performance. Important characteristics of these aggregators are intermittence, possible scheduling, generation output profiles and again dependency on climate scenarios for renewable DG.

(3) Results

Several case studies will be presented to demonstrate how NEMSIM could be used to build and analyse different what-if scenarios (Chand et al., 2008).

(4) Conclusions

Electricity market models must consider at least three interrelated, dynamic processes: (i) market participants' behaviour; (ii) the physical limitations of production, transmission and distribution assets; and (iii) the environmental outcomes associated with electricity generation, transmission and consumption. Simulating multiple scenarios with NEMSIM can maximise organisational benefits by exploring trading and investment opportunities, institutional changes, energy futures and market rules. NEMSIM can be further developed to evaluate new technologies such as distributed generation, renewables and demand side response.

References

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