

An extension of a new methodology for assessing storage in reducing costs for electricity system operation and investment

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Summary

This research will address an important practical problem, which must arise as the British (or any other) electricity supply system starts to generate 20% of its output from wind power. Due to the fact that wind power varies wildly (approximately as a Brownian random walk), it becomes physically impossible for all existing thermal generation systems to keep up with the wind variations. This threatens many risks: e.g. that some wind power must be wasted, that fuel costs for the remaining thermal generation will be raised, that users will receive interrupted supplies and/or poor quality supplies.

Engineering has few traditional tools for dealing with the economic effects of a continuous Brownian motion disturbance. Yet it is known that the existing thermal generators may not be able in principle to compensate for the fluctuation of wind power. Storage of temporary surpluses of wind power are feasible, but storage may or may not be economically efficient as a part of the engineering solution.

To address this problem, we are extending a previous research approach of ours. We exploit the fact that Financial mathematics already has many tools for studying the effects of economic variables which follow random walks (e.g. share prices). We reapply and recombine selected versions of financial tools, in order to model the situation where a thermal generator is “chasing” the random wind supply up or down, in an attempt to produce exactly the (relatively steady) total supply that users require.

Such systems can be studied by Monte Carlo simulation, but the new financial mathematical techniques are at least a million times faster, and this provides much richer opportunities to evaluate alternative designs and alternative operating rules. In this research we will break new ground by studying effects at three levels (the ramp rate, the actual generation rates and the quantity of surplus presently in store, when storage is used).

We are also breaking new ground by defining “income and cost” variables for a complete design of electricity system (meaning in this model, a given finite set of presently active thermal generators, plus wind generators, and -if used- a storage system for storing surplus wind energy, and a few fuel-inefficient

but “very fast ramping” thermal generators). We will be able to quantify the benefits of “remixing” the uses of all these elements of the total supply system, to achieve physical power management that is both physically effective and economically efficient