The balancing stress-test

To avoid power outages, electricity demand needs to balance with electricity supply at all times. This is a tricky task as both demand and some foms of supply fluctuate throughout any day, over a week and between the seasons.

For comparison, today's average electricity consumption is 42 GW and in several possible pathways to 2050 Britain's average electricity consumption is 84 GW. The output from 236 GW of offshore wind, the maximum level assumed in the 2050 Calculator, could vary between 0 GW and 236 GW. For comparison, Britain's average electricity consumption in 2050 could possibly be 84 GW (today's average consumption is 42 GW).

Significant additional interconnection, demand shifting and storage requirements could be needed. For example, the existing interconnector between England and Scotland is 2.2 GW and the Cruachan and Foyers pumped storage facilities have a capacity of 0.7 GW. But level 4 for onshore wind assumes 50 GW of capacity in 2050, and if half of this were located in Scotland then the scale of balancing systems required might involve the construction of about 4 GW of additional interconnection from Scotland to England and new storage systems in Scotland able to absorb a further 10 GW.

The 2050 Calculator includes a 5-day 'stress-test' which models the impact of a period of cold temperatures and low winds, in order to understand the scope of the balancing challenges during such adverse weather conditions. It is assumed that over a 5-day period the UK temperature drops to below zero which increases heating demand (to a degree that depends on buildings' insulation levels). It is also assumed that the output of both onshore and offshore wind drops to 5% of installed capacity, and solar generation levels are below 80% of average output. Each 2050 pathway which is selected by a user generates a different electricity balancing challenge, and the 5-day stess-test indicates how much of the total capacity of the electricity network is used. If the chosen pathway exceeds 100% of that capacity then the Calculator contains 2 further options:

1. The user can increase the level of storage, demand shifting and interconnection.
2. The Calculator computes the capacity of backup generation required to cover the electricity shortfall, assumed to be unabated gas-fired power stations.

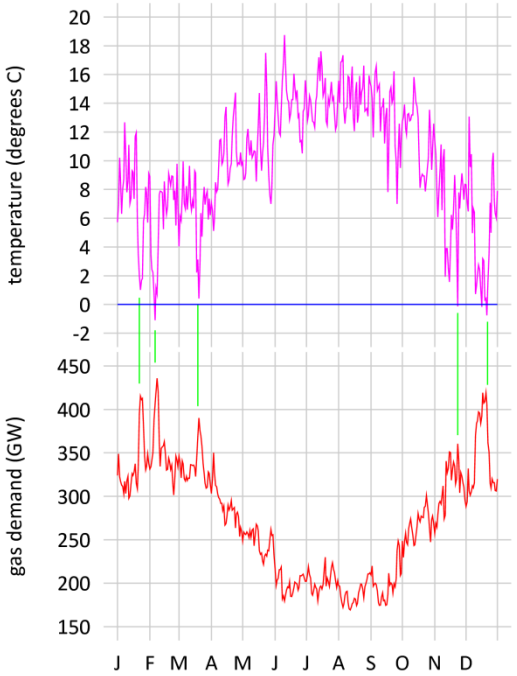

Figure 1. The stress-test assumes that a drop in wind occurs during a cold winter day, such as those illustrated in the 2007 temperature data in the top graph on the left. On these days, heating demand can increase by more than 100 GW above the annual average, as illustrated in the 2007 gas data in the bottom graph on the left.

Interaction with other choices

The renewable technologies chosen (in particular onshore wind, offshore wind and wave power), the degree to which heating is electrified, and the number of electric cars chosen under the transport option determine what the requirement for back-up generation is and how much demand shifting is possible.

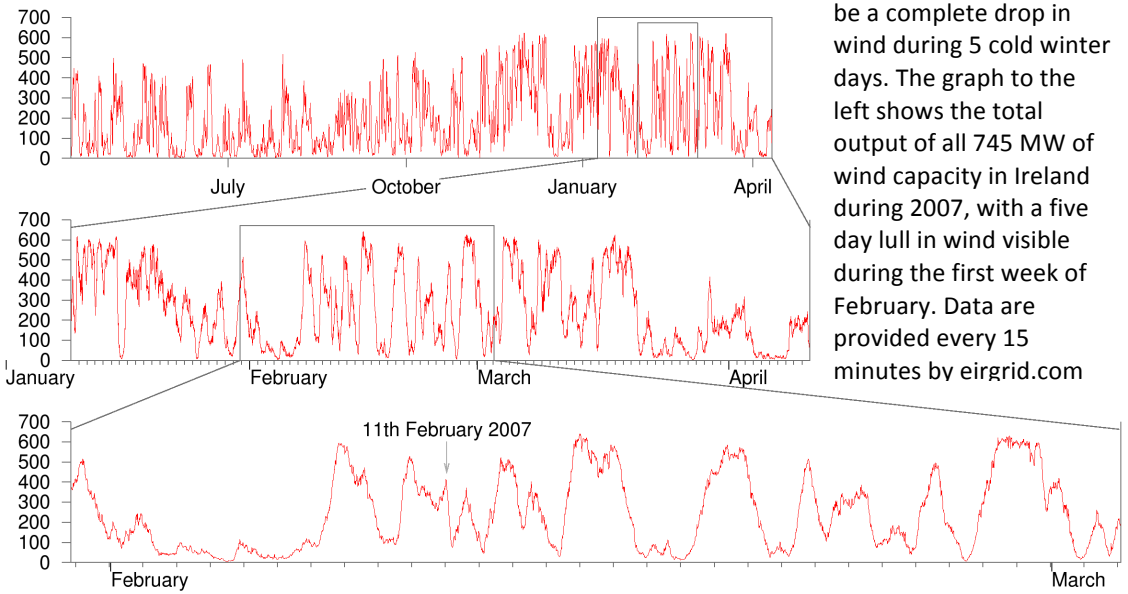

Figure 2. The stress-test assumes that there could be a complete drop in wind during 5 cold winter days. The graph to the left shows the total output of all 745 MW of wind capacity in Ireland during 2007, with a five day lull in wind visible during the first week of February. Data are provided every 15 minutes by eirgrid.com