dynamicDemand
grid stability through demand control

Dynamic Demand Control - what is its financial value?

Frequency response - technical background

The National Grid Company (NGC) is responsible for the day-to-day running of the UK's power grid. They are legally obliged to ensure that the system remains stable and that there is a continual balance between supply and demand.

The NGC is able to predict to a reasonable accuracy (within one or two percent) the demand pattern throughout any particular day. This means that the free market in electricity is able to schedule just enough generation in advance. Any remaining imbalance is then down to inaccuracies in the prediction, or to unscheduled changes in either supply (such as a power station fault) or in demand.

The remaining power imbalance is removed by requesting generators to operate in so called "frequency-response" mode. (The grid "frequency" -- nominally 50Hz in the UK -- is a system-wide indicator of overall power imbalance. For example, it will drop if there is too much demand because generators will start to slow down slightly.) A generator in frequency-response mode will run at reduced output in order to provide spare capacity. It will then continually alter its output on a second-to-second basis according to the needs of the grid.

The cost of frequency response

Frequency response is expensive because it involves a generator operating at less than full output which is a considerable opportunity cost. Also for most generation technologies, running at reduced output means running at reduced fuel efficiency. Added to this is the potential wear-and-tear costs of continually changing output. The NGC spends around £80m a year on frequency-response contracts to generators. This obviously does not include payment for the actual electricity units generated.

The National Grid Company predicts that the cost of frequency response is likely to increase markedly in the immediate future due to plans to create a free market in response (plans which are currently being prepared by the regulator Ofgem). It is also likely that the price will be further increased as more wind power is connected. Wind power is more variable and more difficult to predict than conventional generation which means that more of the balancing of the system will need to be done at the last minute (or second) by frequency response, rather than by planned scheduling.

Ball-park value of dynamic demand control

Appliances (such as refrigerators) which could operate in frequency control mode could provide a similar frequency response service to generators. Early simulation studies indicate that it might be possible to provide the current requirement for frequency response through dynamically controlled refrigeration. If so, an estimated 1.3GW of dynamically controlled refrigeration would be needed to meet the entire current requirement for response. The total domestic refrigeration load alone is 1.9GW, so this is not an impossibility. (Clearly industrial refrigeration, air conditioning, water heating or pumping could also be candidates.)

A domestic refrigerator with an average power consumption of 50 watts would provide $50 / 1.3x10^9$ of the total response (worth £80m per year). In other words, it could in theory "earn" around £3 per year through frequency response. With an average lifetime of 17 years, and a discount rate of 6%, this amounts to £30.

The dynamic controller could also provide other ancillary services, such as aiding "black-start recovery" (the ability of a power grid to be brought back to service after being totally de-energised), with only a small change to firmware. In which case, the figure may be a little more.

One possible commercial model would be that the National Grid Company (NGC) offer to make an upfront payment for each dynamically controlled refrigerator connected to the system (as long as the appliance was shown to meet a standard test to ensure that an aggregation of such devices would perform the desired service over the alleged time-period and lead to a complimentary reduction in generator-based response payments). The upfront payment might be in the form of an annual payment to a fridge manufacturer based on sales figures.

Approximately 2.5M fridges are sold in the UK each year. A fridge manufacturer with a 10% market share who fitted a dynamic demand controller to all of their fridges, could be expected to receive up to £7.5M per year upfront payments. If the controllers cost £5 each to incorporate into the fridges, the annual profit would be £6.25M per year.

Clearly, more work needs to be done. Detailed research needs to be undertaken to obtain more accurate figures. The aggregated properties of many dynamically controlled appliances need to be assessed in more detail. And efforts need to be channelled into creating a market for micro-response. However, these ball-park calculations do show that in principle dynamic demand control on individual appliances could pay - and pay well.

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