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Will the lights stay on? Power grids will have to get smart to match supply with demand

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In a laboratory in Italy, 100 fridges sit quietly monitoring their electricity supply. It's an odd thing for fridges to do, but these are no ordinary fridges. They are part of an experiment that, if successful, could transform the reliability of supplying electricity from renewable sources.

One of the key problems with renewables is their intermittent availability. You can only generate energy from the wind when it is blowing, or from the sun when it's shining. Critics argue this is why we will never be able to rely on renewables for the majority of our electricity generation. But that criticism may soon be silenced. Researchers are developing new ways to balance supply and demand so that interruptions to the supply at a power station are unnoticeable to the consumer.

For example, the idea behind the fridge experiment exploits the peculiar way the power grid responds when demand exceeds supply. In Europe, the frequency of the alternating current on the grid hovers close to 50 hertz, in North America it is 60 hertz. If demand increases, or the supply drops - as might happen, for example, if the wind stops blowing at a large wind farm - the frequency will dip below this level by up to 1 hertz as the remaining generators struggle to keep up. If it dips further, to around 48.8 hertz in Europe, the grid operators must shed some of the load, and parts of the country are disconnected from the grid and blacked out.

The Italian fridges are connected to a network that simulates this kind of power crisis, but instead of relying on a central control room to switch out the load, it is the fridges themselves that respond. As the frequency drops, a built-in controller in each fridge detects the change, checks the temperature of the fridge, and calculates how long it can stay chilled without drawing any power. It then switches the fridge off for as long as is safe. A similar system, developed by the the US Department of Energy's Pacific Northwest National Laboratory in Richland, Washington, was successfully tested last year in 150 specially modified tumble-dryers.

If the technology, called dynamic demand, were fitted to enough fridges and air-conditioning units it could go a long way to smoothing out the fluctuations caused by the intermittent nature of renewable energy supplies. A report last year by the UK's Department for Business, Enterprise and Regulatory Reform said the dynamic demand controllers would cost no more than £4 per appliance, a cost easily offset by the market value of the balancing services each fridge provides, estimated at around £30 over its lifetime. Fitting all the UK's 30 million domestic fridges with dynamic demand controllers would slice 2 gigawatts off peak demand, which could mean that two fewer coal-fired power station would be needed, according to Andrew Howe, CEO of RLTec, the London-based company that developed the dynamic demand software being tested in the Italian fridges. If industrial and commercial fridges were also included, dynamic demand

could compensate for the sort of fluctuations expected if 20 per cent of the UK's electricity were supplied from renewables, Howe says.

Dynamic demand is not the only way to tackle these fluctuations. In a contrasting approach, known as smart grid systems, an operating system run by the utility company is in two-way communication with controllers in consumers' appliances. Using information fed in by the appliances, combined with predictions of renewable power output based on local short-term weather forecasts, the operating system can balance demand to match supply by telling non-essential appliances to switch themselves off. "We can turn off a compressor in somebody's air-conditioning system for 15 minutes, and the temperature really won't change in the house," says Karl Lewis, chief operating officer of **GridPoint** in Arlington, Virginia, a company that designs smart grids.

By providing homes with smart meters to monitor their energy use, such systems can also help smooth out demand by encouraging consumers to set their washing machines for cheaper, off-peak times, for example.

GridPoint is working with Minnesota-based Xcel Energy to test the technology on a city-wide basis in Boulder, Colorado. In August, Xcel began equipping homes in the city with smart meters and remotely controlled devices. Next year, it plans to introduce solar and wind energy generators onto the grid. The hope is that the project will pave the way for cities of the future to be powered largely by electricity from renewables.