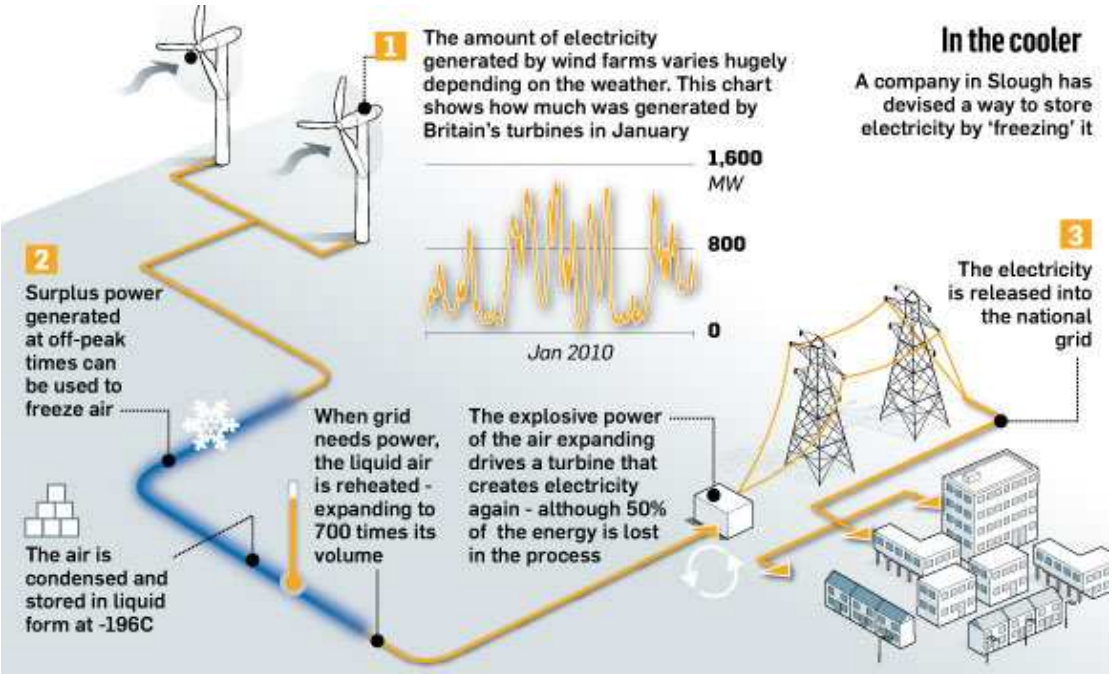
How to store power in a freezer

A British pilot scheme will store surplus renewable energy until it is needed, offering a solution to the problem of power surges and lulls



At 5am on May 30, National Grid took an unprecedented step. The operator of Britain's power network paid Scottish Power £13,000 to shut down two of its wind farms.

It was part of a test to see how the grid would cope with a new dilemma. Renewable energy sources such as the wind and sun produce electricity as the weather dictates. This can lead to huge swings in the amount of electricity entering the grid and it is difficult to predict when they will occur.

Sudden lulls or unexpected surges could lead to power cuts. Unless a solution can be found, temporary shortages of power will become common as renewable energy makes up an ever increasing proportion of Britain's power generation.

In a makeshift hut in Slough, next to a giant biomass power plant, energy industry veteran Gareth Brett is working on a project that he believes could offer the solution.

Brett and his team at Highview Power Storage are piloting a new technology that could store electricity during periods when a surplus is being produced and then release it during the lulls.

"On an annual basis, we can be confident about how much wind energy will be produced, but on an hour-by-hour basis we haven't a clue," said Brett, who used to build nuclear power stations for British Energy.

Highview's pilot plant is built on a site owned by Scottish and Southern Energy. Electricity generated from the biomass plant is used to freeze air to a temperature of -196C.

This transforms air from a gas to a liquid, shrinking it to 0.14% of its previous volume. The liquid air is stored until the grid needs the power again. At that point it is heated up, expanding back into a gas 700 times larger.

The sudden explosion of air produces a force that drives a turbine, connected to a generator that converts the energy into electricity and feeds it into the grid.

Brett believes that if his technology was applied on a wide scale, wind and solar power could make a greater contribution to our national energy supply without the risk of regular power cuts.

Even without the growth of unpredictable renewable energy sources, it would make sense to store electricity, through technologies such as his, on a much larger scale, Brett said.

"When you look at the country's power consumption, you find that the peak demand occurs in one half-hour period. So you need to have the generating capacity to cope with that, which is a very inefficient way of deploying capital. Several billion pounds of infrastructure are needed just to satisfy that half-hour of peak demand."

The Highview pilot plant, which is partly funded by the Department of Energy and Climate Change, has certainly not been perfected. The process is about 50% efficient, so only half the energy that goes in comes out the other side. The "lost" electricity is used to freeze the air.

Brett said that this gives the technology a "middle-ranking efficiency", but pointed out that it is much cheaper and quicker to install than its main rivals. The planning process is also faster.

Highview plans to start installing its units in the second half of 2012, with systems ranging from a few megawatts to several hundred megawatts. This would make it too large for a household to use, but suitable for everything from a small village or business park to a larger-scale utility.

Highview is one of dozens of companies around the world scrambling for new technologies to solve the problem of how to store electricity. The market is forecast to mushroom from about $10 billion (£6.3 billion) this year to about $225 billion in 2020, according to Piper Jaffray, the stockbroker.

Many entrepreneurs and inventors are involved in the long struggle to make lithium and other rechargeable batteries smaller, cheaper and longer-lasting.

Companies such as Honda and ITM Power in Britain are also working on developing hydrogen energy storage systems for houses, communities and utilities.

These run surplus electricity through water, where a process known as electrolysis separates the hydrogen from the oxygen. The hydrogen can then be used to power a hydrogen car, or passed through a fuel cell, which converts it back into electricity by mixing it with oxygen from the atmosphere.

Bow Group, a right-wing think tank, is so enthusiastic about the emerging hydrogen

technologies that tomorrow it will call on the government to expand its feed-in-tariff scheme by paying households and other small renewableenergy generators 10p for every kilowatt hour of electricity they store using a hydrogen-based device.

The scheme presently pays participants for generating the electricity, with a bit extra for every unit of surplus energy they export to the grid, but it provides no incentive for storing it.

Wind farms around the world are already being closed regularly because they are unable to make use of the power they generate. In Texas, 17% of wind generation capacity was turned off last year. In China 22.5% of wind capacity was not connected to the grid. In Denmark wind generates the equivalent of 19% of the country's electricity consumption, but only about half of this is used locally. The rest is exported through a grid linked to Germany, Sweden and the Netherlands.

In Britain, where wind accounted for only 2.5% of our energy consumption last year, plant closures have so far been confined to that one test case in May.

However, Pöyry, the power consultancy, estimates that Britain will need to increase its wind capacity tenfold — from 4.4GW in 2009 to between 35GW and 45GW by 2030 — if it is to meet its targets for emission reduction and renewable energy generation.

David Clarke, chief executive of the Energy Technologies Institute, a collaboration between government, universities and big business, charged with solving Britain's energy problems, said "low-cost energy storage will play a critical role in the successful delivery of secure and sustainable energy systems in the future".

Clarke is calling on entrepreneurs to submit proposals for new storage technologies and has promised to provide enough development funding to bring at least one of them to the market.

Other storage methods

Pumped hydroelectric storage
The Dinorwig plant in Snowdonia relies on two lakes situated close together, with one much higher than the other. When there is surplus electricity, it is used to pump water from the lower lake to the upper one. When more electricity is needed, the water is allowed to flow down to the lower lake, rotating turbines connected to a generator. The process is expensiv**e, but 70% efficient.**

Compressed air energy system
The excess electricity is used to compress and pump air into underground caverns. When the power is needed, the air is let out and, as it rushes back to ground level, turns propellers linked to a generator. It is 40%-50% efficient.