Bite-size Climate Science

Energy Storage

How do we store renewable energy so it is there when we need it?

SALISBURY ECO-HUB ALLIANCE

Generating electricity from wind turbines and solar panels is cheap and easy when the wind is blowing and the sun is shining, but this means that sometimes we will have more than we need and at other times not enough. We need to be able to store surplus energy on windy and sunny days to use when demand exceeds supply.

Batteries can only be a part of the answer

Battery technology has improved greatly in recent years, but there are still only limited resources available of the minerals like lithium and cadmium needed to make them. Most of that will be needed for electric vehicles, computers and phones. Some of that battery capacity can also be used to store surplus energy, but batteries cannot solve the whole problem on their own.

A whole range of different solutions is available

Fortunately, there is a huge variety of different ways of storing energy, many of which are tried and tested over many years. Any method of converting electrical energy into another form of energy which can be stored, and then be converted back into electricity later when needed, can be used to even out the peaks and troughs in electricity supply and demand.

Pumped storage - simple and effective

One of the simplest methods is known as pumped storage. This involves using surplus electricity to pump water from a reservoir at the bottom of a hill up to another one at the top. When extra generation is needed, the water at the top is allowed to run back down to the bottom, turning turbines to generate electricity as it does so. Storage capacity (gigawatt hours GWh) is determined by the size of the top reservoir, generation (gigawatts GW) by the flow through the turbines.

Dinorwig Power Station in North Wales with its upper and lower reservoirs (left) opened in 1984 on the site of a former slate quarry, and is the largest pumped storage scheme in the UK. It has a storage capacity of 9.1 GWh, and can supply over 1.7 GW - enough for over 2 million homes. With other plants in mountain areas of Wales and Scotland, the UK currently has 2.8 GW capacity from pumped storage generation.

Building from Dinorwig's design, China now leads the world in pumped storage with a capacity of 40 GW installed or under construction. France has Europe's largest plant (slightly bigger than Dinorwig) and also the world's smallest. In 2012 the Goudemand apartment building in Arras (right) was fitted with an open-air tank for pumped storage on the roof and underground tanks in the basement. With solar panels, wind turbines and additional batteries, this makes it independent of the grid, and demonstrates that pumped storage does not have to depend on large projects and mountain locations.

Above: Goudemand building, Arras, France

Hydrogen - versatile gas power from renewables

When a direct electric current is passed through water, water molecules are split into their component
gases, hydrogen and oxygen. The oxygen can be released to the atmosphere, and the hydrogen collected as a fuel which, when burnt, simply recombines with oxygen from the air to produce water vapour - with no harmful CO_2 or other pollution. That makes this process, electrolysis, an ideal method for storing surplus electricity from wind turbines or solar panels on windy or sunny days.

Hydrogen is a highly versatile fuel. If mixed with renewable biogas (methane generated from decaying vegetable matter) it can be used in place of natural gas (a polluting fossil fuel) to generate electricity when needed. It can also be used in energy-intensive industrial processes like steelmaking, or in place of petrol or diesel to power vehicles or even aeroplanes.

Other forms of energy storage are possible, and needed

Whilst batteries, pumped storage and hydrogen are the most obvious and best developed options at present, almost any physical, mechanical or chemical process which converts one form of energy to another could be a possibility. Even compressed air has been seriously suggested, and would certainly be simple and low-tech. So long as a surplus of renewable energy can be generated (which it can with sufficient wind and solar power), storage is simply a matter of choosing a method which is easily available and reasonably efficient.

The present lack of storage means that surplus renewable energy is being wasted. On days of peak wind or solar production, when we should be taking maximum advantage, the National Grid is actually paying producers to discard energy instead of putting it into the system, because they have fixed contracts with other, non-renewable, suppliers. Wasted energy is actually costing consumers in higher bills. Increasing storage capacity should be a priority.

Diversity of energy supply is an asset

The idea that renewable energy is unreliable because it is weather-dependent is one which is often over-stated by those with a vested interest in fossil fuels or nuclear power. With a geographical spread of both wind and solar it is less of a problem than many people imagine. In the UK the weather is rarely the same from one end of the country to the other, and calm days are usually the sunniest and overcast days the windiest. Nevertheless, alongside sufficient storage capacity, a wider variety of renewable sources oould be an advantage.

Tidal power - neglected potential

Tidal power is an additional option which has been sadly neglected in the UK, despite our long coastline and wide tidal range. It is highly dependable, because the tide rises and falls twice a day whatever the weather as predictably as clockwork, and it can be harnessed in various ways.

Undersea turbines are like windmills on the seabed, turned by tidal currents, but because water is much heavier than air they can generate far more power at slower speeds than wind turbines. Tidal barrages use dams across river estuaries to trap tidal flows, with turbines generating power from both the incoming and outgoing tides. Tidal lagoons work in a similar way, but avoid blocking river flow and damage to coastal ecosystems by using artificial off-shore lagoons.

La Rance tidal barrage (above) in northern France has generated electricity since 1966, and repaid its construction costs in 20 years. Its electricity costs just € 0.12 (11p) per kWh.

Tidal power could provide extra diversity and dependability to renewable energy supplies without reliance on costly new nuclear power, and the UK is well placed to lead the world in its development, but it needs the consistent funding it has lacked so far.

Published by Salisbury EcoHub Alliance www.transitionsalisbury.org/ecohub salisburyecohub@gmail.com