COMMENTARY

Solving the question of renewable energy storage

As the importance of renewables grows so as well do the questions over intermittent energy supplies and storage solutions

By Phil Thane

- **Pumped storage is the best answer to date, but is limited in terms of versatility**
- **A process using power to convert CO2 and water into methane provides a small-scale alternative**
- **Synthi-gas' strength lies in the fact that it can be pumped in existing gas networks**

Wind, solar, tidal and wave energy have a common feature; they are intermittent. The sun does not shine at night, the wind may drop for days on end and when it does the sea usually flattens out, too.

Tides vary but there is a period each month when peak tidal flow is around midday and midnight, when demand is low.

Installing lots of all of these different technologies across a wide area, linked by a "smart grid" capable of matching load and generating capacity better than the producer managed grids we have today, will help. Building extra capacity provides insurance against some of the generators being left becalmed or in the dark, but extra capacity is expensive.

If the extra capacity produces unsaleable power for most of its life then the expense is unjustifiable. What we need is a means of storing the "spare" power for use when we need it.

Pump it up

To date the best answer is pumped storage – using surplus power to pump water up to a reservoir high on a hill, then allowing it to flow down through a turbine to a lower reservoir to re-generate the power when it is needed.

When it was fully commissioned in 1984, Dinorwig Power Station in North Wales was regarded as one of the world's most imaginative engineering and environmental projects. It is still the largest scheme of its kind in Europe.

Both reservoirs are based on existing lakes; the upper, Marchyn Mawr, was increased in size by adding a dam and the lower Llyn Peris was enlarged by removing large quantities of slate quarry waste that had been dumped in it over many years.

Dinorwig can produce electricity (1,320 MW) in 12 seconds when there is a sudden surge in demand and if necessary the station can generate 1,680 MW for five hours. Pumped storage schemes are increasingly common, but they are expensive. Dinorwig has 16 km of underground tunnels and its construction required 1 million tonnes of concrete, 200,000 tonnes of cement and 4,500 tonnes of steel. And of course you need a mountain and a couple of lakes.

Large pumped storage schemes require a heavy-duty connection to the grid capable of dealing with the high output, North Wales has the infrastructure, built originally for the nuclear power plants (NPPs) at Trawsfynydd and Wylfa, and the Anglesey Aluminium smelting plant. Few mountainous regions have such a connection available.

It's a gas

Useful though pumped storage is, there is a real need for a smaller-scale, cheaper method of removing excess power from the grid and storing it.

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Researchers in Germany and Austria think they have a solution – using electrical energy to convert carbon dioxide and water into methane, which can be stored and distributed through existing natural gas networks.

The process was developed by the Centre for Solar Energy and Hydrogen Research Baden-Wurttemberg (ZSW), in co-operation with the Fraunhofer Institute for Wind Energy and Energy System Technology IWES. An Austrian partner, Solar Fuel Technology, is commercialising the process and already has a demonstration plant operating successfully in Stuttgart. They are planning a substantially larger system – in the double-digit megawatt range – and this will open in 2012.

The system relies on two well-known processes, electrolysis to split water into hydrogen and oxygen and the Sabatier process, in which hydrogen is reacted with carbon dioxide at elevated temperatures and pressures in the presence of a catalyst to produce methane and water.

Neither process is new; Paul Sabatier worked out the principles of catalytic reactions in the 1890s, and electrolysis was discovered around 1800. ZSW's work is about bringing the two processes together and making them efficient on an industrial scale. ⏩

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Efficiency isn't everything

Pumped storage has better efficiency – 70% or more of the power used to pump water uphill can be recovered, whereas ZSW claim the figure of "more than 60%" for their synthi-gas process. However, it seems they are referring to the current-to-gas process only; if the gas was used to fuel a power plant the total efficiency would be even lower.

Synthi-gas does have other advantages though, primarily the capability to store a great deal more power. Many European countries already have massive natural gas storage capacity; in Germany this amounts to more than 200 billion kWh – enough to satisfy consumption for several months, which is something pumped storage can never achieve.

Integration into the infrastructure is straightforward, as synthi-gas can be piped straight into the existing gas network.

Gas is very versatile, too, and once in the gas grid it can be used wherever it is required; efficient combined-cycle turbine generators can turn it back into electric power, it can be used in domestic or industrial heating, or for cooking or to fuel vehicles.

It may well turn out that synthi-gas is the most efficient means of powering "electric" cars; certainly the well-established method of using liquid petroleum gas (LPG) in road vehicles makes more sense than building a whole new infrastructure for hydrogen.

One small problem

There is a snag, however, and that is sourcing the CO2 needed. Despite a 36% increase in the level of CO2 in the atmosphere since 1832, in absolute terms it is still less than 0.04% by volume.

Even in flue gas CO2 is a minority component, typically 3-15%, and the carbon capture methods proposed for "clean coal" power plants remain lab-scale projects at present.

The CO2 Capture Project, a partnership of the world's leading energy companies, academic institutions and government organisations, is developing technologies to make carbon capture and storage (CCS) a practical reality. They see three potential ways of capturing CO2: passing flue gas through a solvent; gasifying coal then burning the gas in a catalytic reactor to produce a higher level of CO2, or burning the fuel in oxygen rather than in air so that the flue gas is almost entirely CO2 and water.

This last option seems the best fit with the ZSW process, since some of the oxygen required can come from the electrolysis part of the process, but there is a lot of large-scale engineering needed to turn a promising idea into a functioning industrial process. ■

Renewables take central role in India's CER policy

A report claims India's renewables energy projects will drive the country's Certified Emissions Reductions (CER) portfolio over the 246 million mark by 2012

By Siddharth Srivastava

- **Renewables will earn India 76 million CERs by 2012, worth a potential US$879 million**
- **Many renewable projects are dependent on future income from CER sales**
- **India is among the top five GHG producers, although per capita production is only 5% of US output**

The number of carbon credits or certified emission reduction (CERs) certificates generated in India is set to grow three-fold over the next three years as more renewable energy projects make successful applications to the UN.

A report from leading research and credit-rating firm CRISIL said that Indian clean energy projects would receive 246 million CERs by December 2012, a three-fold rise from 72 million in November 2009.

The Clean Development Mechanism (CDM) enables developed nations to meet emissions reduction levels by purchasing CERs issued to projects in developing nations that reduce greenhouse gas emissions (GHG) under the UN Framework Convention on Climate Change (UNFCCC).

Each CER represents the removal of 1 tonne of carbon dioxide or its equivalent GHG from the atmosphere.

RE driving force

Renewable energy projects registering with the UNFCCC will drive the issuance of CER volumes. According to Nagarajan Narasimhan, director of research at CRISIL, "we expect the government's focus on renewable power projects to drive this growth."

According to CRISIL, the majority of CERs earned until now have been for hydro-fluoro-carbon (HFC) reduction projects. As industry shifts to the use of non-HFC refrigerants, HFC-related CER issuance growth will drop perceptibly.

However, this will be compensated by the rise of renewables projects. ▸▸