Fuel Cell Technology Comes of Age

Introduction

A unique problem faced by electrical power generators compared to other energy operators is that their product cannot be stored in great quantity. Innogy, the soon-to-be demerged UK arm of National Power, believes that it has developed a utility-scale source of flexible stored power, wherever it is required, based on fuel cell technology. In this feature we, look at the development of the technology and some of the implications of Innogy's break-through for the sector.

Power System Characteristics

It is a truism that electricity cannot be stored, but one that is not strictly correct. Pumped storage hydro-electric schemes exist which use cheap off-peak electricity to pump water into a reservoir. They can release the water at times of peak demand to produce power. Stations of this type are expensive to build and are limited geographically to a small number of remote sites.

One consequence of such limitations is that a balanced power system requires some power stations to provide peak power to the electricity grid to supplement the base-load from the larger, inflexible plants that tend to dominate power systems. Peaking plants operate at reduced capacity for most of the time, perhaps only reaching full power production on a handful of occasions through a year in normal operating conditions. The economics of peaking plant means they can be extremely risky investments.

Fuel Cell Storage

Innogy believes it has found a solution to storage problems after almost a decade of research. It is developing a technology that it claims will make electricity as storable as any other traded commodity. Innogy has labelled the new fuel cell-based technology *Regenysys*.

Regenysys was demonstrated for the first time to the UK's scientific community at the Royal Institution on 5 September. Professor Susan Greenfield, Director of the Royal Institution, who hosted the lecture, said that this technology could "prove to be a milestone in the history of electricity generation".

Based on an electrochemical process operating like a rechargeable battery, Regenysys enables power producers to store electricity and release it instantly when demand levels require. The system works by charging two liquid electrolyte solutions, made up of safe sodium bromide and sodium polysulphide salts, via inert electrodes. The charged potential of the cell is a mere 1.5 volts - the same as a household battery - but

Innogy has developed an application for stacking hundreds of individual cells together in series to give higher voltages.

The technology is very flexible. Further modules can be added in parallel to give the required power rating. And once the electrolyte pumps are running, the plant will be able to deliver its power in only two milliseconds - much faster than other forms of fast response generation such as hydro-electric power.

Innogy believes the project will transform power system trading. "We like to think of this as an electricity warehouse rather than as a giant rechargeable battery. Just like a warehouse, it will allow generators to put electricity in when the prices are cheap and to sell it again when the prices are high," David Threlfall of Innogy said.

First Commercial Station

The first commercial facility is planned for National Power's Little Barford site in Cambridgeshire. The £15m project will be capable of storing 120 MWh of electricity and will be able to provide 15 MW of power, enough to meet the needs of 15,000 people or a small town. It is intended that the new installation will serve as the source of back-up supplies to enable the provision of a black-start service from the neighbouring Little Barford power station and is looked on favourably by NGC, the gird operator, as a provider of valuable ancillary services.

Innogy has signed a further initial agreement to provide a similar Regenysys plant for Tennessee Valley Authority of the US.

In a separate development in August, the US's largest commercial fuel cell development to date went live, at Anchorage, Alaska. The scheme involves five fuel cells aggregating 1 MW of electricity. So Innogy is well-placed to take the technology through as a world-leader in its commercial application.

Benefits

The range of applications for the technology is one of its main features and key attractions. Energy storage and power delivery are separated so it is a very flexible tool with many applications. The benefits are potentially enormous and include:

- increased utilisation of power system assets (eventually leading to fewer power stations and power lines)
- reduced emissions, and
- lower prices.

Realisation of these benefits depends on significant take-up of the technology which is arguably some way into the future. Nonetheless, for the short-term some more specific applications are likely to reap rewards.

Security Value

Fuel cell technology could significantly improve producers' ability to meet demand, improve their operational control, and provide greater security of delivery. Innogy believes that, in the future, electricity storage could be used to avoid the need for expensive peaking plants.

"We have tremendous flexibility to provide high power, low discharge systems, which could replace super-capacitors for filling in short interruptions on the national grid, or low power, long discharge systems for safety critical control systems," the company says.

The Anchorage scheme provides a practical example of the security benefits. The fuel cells are part of the local electricity utility's grid. They operate in parallel with the grid and are despatched from the grid's control centre. If there is a grid outage, the fuel cells switch over to operate as an independent system. The automatic transition is seamless, eliminating the need for conventional non-interruptible and stand-by generators.

Transforming Green Power Economics

Regenysys could also transform the economics of alternative, clean sources of power such as wind or wave farms. Unpredictability is one of their key characteristics. They do not have automatically the chance to bid to supply electricity at the most lucrative peak times. Markets such as the new NETA market penalises unpredictability, and advocates of renewables believe that the new trading arrangements will further disadvantage them relative to conventional technologies.

A storage facility would overcome this problem by allowing operators to stockpile power when generating conditions were good, allowing it to be sold at any time during the day.

Environmental Benefits

Fuel cells do not burn fuel. Storage of the power therefore does not add to emissions of greenhouse gases. Depending on the way in which it is used it could contribute to reducing emissions of greenhouse gases. If electricity generated from low or zero emission sources is used to charge up the fuel cells – perhaps at times when power from those sources would not normally be in demand – the power could be released at peak times. If this were the case, it may displace higher emitting power sources thus reducing overall levels of emissions.

Obviously, these benefits would only be harnessed where the primary energy source is from clean technology. But the potential for coupling the technology with renewable applications is immense.

Clearly this does not take into account the emissions associated with manufacturing the fuel cells and disposing of the chemicals at the end of the unit's life.

Economics

The costs of Regenysys are currently comparable to pumped storage at £1000/kW. It is much more flexible than pumped storage, can be sited anywhere and can be installed incrementally without any huge initial capital outlay. It also has a faster electrical response. Innogy is hoping that the cost of the technology will come down rapidly as the market takes up the technology.

Prospects

Getting the price down is seen as an achievable medium-term objective. National Power's advisers on the demerger of its UK and overseas businesses have forecast that Regenysys could add more than £1bn to Innogy's market value. If so, power system development could enter into an exciting new era, with much greater emphasis on smaller, distributed generation.