The Future of the Energy Storage industry in Scotland

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Summary

- Government pays tens of millions of pounds a year to wind farm operators to turn off the turbines because they are producing electricity 'at the wrong time'.
- The efficiency of our energy system is greatly reduced because of lack of energy storage; proper storage would immediately increase efficiency and Scotland would meet its ambitious renewables targets significantly quicker.
- In the medium term, energy storage will be a fundamental component of our energy system; delaying the transition to that energy system would appear to be both short-sighted and lacking in ambition
- An investment of about £1.5 billion will create a network of energy storage plants all over Scotland. This will be paid for through savings in 'constraint payments' (paying operators to 'dump' surplus energy), increased efficiency of the generation infrastructure and by redirecting investment from new peak time generation capacity which it would replace.
- The investment would create between 4,000 and 5,000 Scottish jobs in manufacturing, assembly and operation. If the storage strategy included local combined heat and power plants with district heating the number of jobs created would be very much higher
- Since energy economies around the world will require these technologies, Scotland could create a global leading position and develop an export industry in manufacturing and design and deployment
- This will not happen unless Scotland takes Norway's approach to oil. If Scotland does no more than give payments to multinationals to create this capacity it is unlikely that either the engineering expertise or manufacturing jobs will be secured here. There must be a strategy for rapidly developing the engineering capacity in-country and to keep the jobs here.
- The technology discussed in this paper (liquid air storage) is recognised as the most efficient technology available. It is particularly suited to supplying heat as well as power and so can become a major component in a strategy to reduce greatly Scotland's reliance on imported gas for heating. However, as other technologies develop (such as hydrogen-powered vehicles) storage technologies such as hydrogen storage will also be necessary.
- In summary, the Energy Storage Industry could be a major new sector of the Scottish Economy creating jobs, wealth and exports. But if Scotland is not to miss out on this opportunity it requires a much more ambitious strategy.

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There is no doubt that Scotland is now in a position to transform its energy sector. Scotland is set to meet the target of 30 per cent of the country's total energy consumption from renewable sources by 2020. And the Government expects renewable energy to deliver up to £30bn investment and 40,000 jobs. Such a transformation will provide increased energy security and reduce greenhouse gas emissions by a factor worthy of any low carbon economy.

However the real challenge lies in the ability of Scotland to make necessary step changes. Most importantly to radically change the way in which the energy sector is structured and the ways in which new technologies are adopted and applied. In practical terms the Kyoto target of 80 per cent reduction in green house gas emissions by 2050 is a transition from roughly 10 tonnes of CO2 emissions per person per year to two tonnes. The implication being that in order to achieve these ambitious targets there needs to be a series of quantum leaps in the availability and adoption of key technologies that impact on all our lives.

We have witnessed already the first wave of renewable technologies in the form of the onshore and offshore wind sector. But we are now on the cusp of the next step change, namely the adoption and application of energy storage technologies.

Energy storage can provide electricity to the grid when the wind does not blow and demand is high. And energy can be stored in a situation where renewable sources are providing electricity but there is no demand (sometimes called 'wrong time' supply). The energy storage technologies are also able to extract waste heat energy from industrial plant and other sources. The efficiency of operation of these energy storage technologies has now reached a point where their application is commercially viable.

Scotland has existing pumped hydro storage facilities at Ben Cruachan and Ben Foyers which help to optimise Scotland's power network system. However their capacity is relatively limited at 740MW. In a report in May 2013 Strathclyde University identified:

> "a need for 1750 MW of storage in 2015 and 3086 MW in 2020. Using a non-specific 100 MW Liquid Air Energy Storage facility would indicate 16 or 17 installations in 2015 and 31 or 32 by 2020". (***Scotland: A Case Study for Liquid Air Energy Storage. William Holt. 3rd May 2013. Dr Elsa Joao. Supervisor. MSc in Environmental Partnership. University of Strathclyde)***

Strathclyde University has highlighted the need for up to 32 Liquid Air Energy Storage facilities each with a capacity of roughly 100MW to be built by 2020. These facilities would deliver an additional combined energy storage target of over 3,000 MW.

The Strathclyde University report also includes comment by the Institution of Mechanical Engineers:

> "There are still major concerns in the engineering community regarding Scotland's ability to provide the human resources needed to design, project-manage, install and commission the volume of equipment that will be required to meet such ambitious targets. One strategic approach to this challenge might be to assume that appropriately- trained people from overseas will be able and willing to work in the renewable energy sector in Scotland. However, many countries across the globe are also aiming to meet challenging renewable energy targets over the next few years and it is not necessarily certain that such people could be attracted to work in the sector in Scotland rather than elsewhere."

What Scotland is facing therefore is the emergence of a new important sector of the economy for which the country does not appear to have the necessary home-based skills. Furthermore there is no coherent vision of how the energy storage sector can evolve to provide maximum community

benefit in terms of employment and local impact. Indeed there is little widespread recognition that the opportunity actually exists. So how best can we proceed for the Common Weal?

In Norway they have not accepted the 'free market' view that there will be an influx of qualified engineers and capital only if the pickings are good and investors are interested. The Norwegian Government contracted the development of key sectors to specific companies and included national capacity development as a core specification of the contract with resources returning to public ownership. Scotland has the opportunity to take the same approach in the case of energy storage in particular the integration of energy storage into District Heating systems.

It has been predicted that in 2020 approximately half of Scotland's total energy demand will be for heat energy. And there is a real desire by the Scottish Government to supply a large proportion of the heat demand via District Heating. District heating generates heat in a central location and distributes the heat for residential and commercial heating. The advantage of district heating systems is that they can provide high efficiencies and better pollution control. District heating with Combined Heat and Power (CHPDH) is arguably the cheapest method of cutting carbon emissions and has a low carbon footprint.

In Denmark CHPDH has been developed that is integrated with various methods of energy storage. Indeed Denmark now leads the world in the understanding of how best to develop such CHP systems, a global position they did not hold twenty years ago.

Scotland needs to develop its own system of Combined Heat and Power District Heating that brings together energy storage with sources of 'wrong time' renewable electricity and waste heat in a new localised business and operational model. Such a model would ensure lasting community benefit and ownership for the good of all.

We can certainly learn something about how to approach the emerging market for energy storage by looking at our Scandinavian neighbours. But there are also lessons to be learned further afield. California is not known for its fuel poverty and bad weather. However it does have a fast growing renewables sector and a clear recognition of the need for a related energy storage industry. In March 2012 a bill was passed that 'directed the California Public Utilities Commission to establish procurement targets and policies for cost-effective and commercially viable storage systems for the state's investor-owned utilities'. Utilities were required to incorporate energy storage in their distribution networks. The rules mandated storage equal to 2.25 per cent of daytime peak power by 2014 and five per cent of daytime peak power by 2020.

The State legislation was the first of its kind in America and was a real attempt to coordinate energy storage capacity building with other initiatives such as California's 33 per cent Renewable Portfolio Standard, Resource Adequacy activities and Long-Term Procurement Planning. The latter is precisely what is needed in Scotland as well as base regulation.

Long Term Procurement Planning has ensured that energy storage is now seen in California as a key ingredient in the energy policy landscape and is very much part of the policy roadmap. The result in California is that there is now an active energy storage industry with an estimated annual investment of over $400m and growing. And they see a bright future in the coming decade as part of an emerging "Trillion Dollar global industry".

So what is the Scottish Government's policy to this important emerging industry? In June 2013 the Government made an Energy Storage policy statement (Electricity Generation Policy Statement 2013):

> Paragraph 71: We conducted an Energy Storage and Management Study in 2010. It didn't include a scenario which exactly matched our 100% renewable electricity target, although it did find that, in the event of renewable generation reaching 120% of demand, there could be a role for storage from 2020 onwards, even with planned upgrades to interconnectors. (http://www.scotland.gov.uk/Publications/2013/06/5757/3)

So energy storage, according to the most recent Government policy, is something to be looked at after 2020 only if other stringent conditions are met. Isolated projects, such as the Orkney Energy Storage Park are being developed but this is a long way from the estimated £1.5bn investment needed by 2020 if Scotland is to be a player in the global energy storage market. Little is being done to create this important industrial and energy supply sector.

Regrettably there is no recognition in Scotland of energy storage requirements and the very real opportunities for training, jobs and a place in an emerging global market. What is needed is a radical rethink about the way in which Scotland approaches these step-changes and puts in place the legislation, procurement planning, training and investment that will ensure success. By accepting that energy storage has a critical part to play in grid development and district heating, Scotland can seize the opportunity to establish a major new industry in the decade ahead for the good of all.

Liquid Air Energy Storage Explained

This paper is 'technology neutral' - the case for an energy storage network and the industry sector it could stimulate remains the same whatever technology is used. However, at the moment 'Liquid Air' storage is the leading technology. The Liquid Air energy storage process has four simple stages:

1. "Wrong-time electricity" is used to take in air, remove the CO2 and water vapour, which would otherwise freeze solid

2. The remaining air, mostly nitrogen, is chilled to -190C (-310F) and turns to liquid - this provides a compact storage medium that can later draw energy in the form of heat from the environment

3. The liquid air is held in a giant vacuum flask until it is needed

4. When demand for power rises, the liquid is warmed to ambient temperature. As it vapourises, the expanding gas drives a turbine to produce electricity - no combustion is involved