Energy Storage

Snapshot: Energy can be stored at variable scales, for both electricity and heat, in a number of ways, through technologies such as hydro pumped storage, hydrogen and fuel cells, compressed air and cryogen.

A clear case has been made that if the energy sector is to maximise environmental, economic and social benefits, renewable energy will need to be linked to energy storage. Energy storage technologies can counteract intermittency associated with certain energy supplies, can ensure excess power is not lost at times of high production, can provide energy on demand off-grid in a variety of ways. Oversupply is likely to become more prevalent the closer Scotland gets to realising its 100% electricity from renewables target. It is also expected that energy storage will be essential if Scotland is to realise its ambition to become a renewable energy exporter and to attract the economic advantages of ensuring that the energy storage supply chain locates in Scotland.

However, whilst hydro pumped storage is long established, the majority of other energy storage options are either still in technological development or are still being made market- ready and are not in widespread commercial use.

In the short term though, there are step changes which will help bring about energy storage advantages. Technologies such as fuel cells, long established in their own right in a variety of applications including Combined Heat and Power, have the capacity to be installed in domestic and non-domestic situations to support the future transition to renewable energy storage. Initially they will powered by non-renewable feedstocks and produce unwelcome by-products, albeit with more efficiencies than diesel counterparts, but they can be connected to renewable energy power supplies when they become available. Therein, there is clear benefit in supporting the installation of technologies which can assist in the transition to renewable energy storage.

Hydrogen, as an energy storage means for renewable energy, using fuels cells in particular, has great potential by providing reliable on-demand clean heat and electricity for domestic and non-domestic properties, power for vehicles and aviation. Hydrogen can be produced from a wide range of renewable energy sources including wind, the fermentation of waste, biomass and biogas and offers significant possibilities as a low cost fuel. The by-products of hydrogen storage from wind energy are benign, producing heat and water, with the former offering potential renewable heat advantages.

At Billingham, Teesside, the planning authority is currently considering the UK's first 50 Megawatts (MW) municipal waste to hydrogen gasification power plant (Air Products). To date, in Scotland, the provision of complete 'renewable energy – fuel cell – hydrogen storage' systems are rare, with operational examples limited to isolated projects such as the Pure Energy Centre, Shetland and within the Hydrogen Office demonstration project in Fife. However, some renewable energy developers are now beginning to explore schemes with a hydrogen storage element.

The 2020 Routemap for Renewable Energy in Scotland sets out key actions for bringing forward energy storage, hydrogen and fuel cell technologies. is working with Scotland's specialised fuel cell companies amongst others to bring models for the combined technologies to market.

Suggested areas of focus for planning authorities:

- Consider identifying opportunities for energy storage including hydrogen storage and fuel cell uses as appropriate uses for certain development plan land allocations
- Consider infrastructure needs to support energy storage including the hydrogen and fuel cell sector and bring forward matters through development plan action programme
- In deciding applications for all renewables types consider the potential for energy storage such as hydrogen and fuel cell storage, within the site or in accessible nearby sites or within transitional technologies
- Detail the criteria to be applied in assessing applications with energy storage including hydrogen and fuel cell storage capacity or which have transitional technologies;
- Establish a protocol for involving key consultees in pre-application discussions and during applications;
- Ensure planning conditions and agreements are reasonable and proportionate.

Opportunities within Planning Processes for Planning Authorities:

Stage in Planning Process	**Actions for Energy Storage**
Monitoring and Evidence Base	• Collate information on renewable energy sources within the planning authority area; • Identify sites of high heat or electricity demand; • Determine whether sites within existing industrial land allocations are suitable for energy storage and if there is any additional suitable brownfield land; • Assess whether other sites need to be allocated to support the demand for energy storage ; • Consider grid, transport and other infrastructure factors.
Allocating Sites within Development Plan	• Work with the energy and transport sector, Scottish Enterprise and Highlands and Islands Enterprise to determine the most appropriate new land allocations for energy storage within development plans. • Provide clarity on locations where energy storage operations could operate • Ensure full consultation has been carried out with key consultees to determine impacts, including Health and Safety Executive (HSE). • Strategic Development Plan Authorities (SDPAs) are well positioned to consider strategic regional and cross-boundary opportunities
Drafting Development Plan Policy	• Ensure that a supportive policy framework is provided for energy storage and transitional technologies • Ensure that policy provides safeguards on matters such as design, public health, access, grid, security fencing and decommissioning issues.
Development Plan Action Programme	• Determine if there are existing energy storage businesses within the planning authority area, academic institutes working on energy storage or demonstration projects in practice, to help realise development plan objectives.

Securing Sufficient Information to Determine Planning Applications	• Develop supporting guidance notes to detail typical information needs for pre-application discussion and planning applications for energy storage technology • Ensure that information needs are proportionate
Pre-Application Stage	• In considering proposals for all renewables types consider the potential for associated energy storage technologies and transitional technologies within the site or accessible nearby sites • Consider the scope to link renewable energy storage to community initiatives • Ensure that key consultees are given the opportunity to be involved in pre-application meetings / site visits • Ensure that early advice is given on whether schemes require an EIA
Determining Planning Applications	• Encourage new developments to plan for energy centres incorporating transitional technologies which give the potential for energy storage linked to renewable storage at a future date • Ensure that key consultees are involved in application meetings and site visits to help overcome constraints where possible • Planning authorities should draw on the following technical information and guidance on energy storage in determining applications and in designing local solutions.

Technical Information for Energy Storage

Hydrogen and Fuel Cells

Process of Storing Hydrogen and Role of Fuel Cells: Hydrogen is an abundant element in the atmosphere, that can be used to produce electricity and heat for domestic and non-domestic properties, together with powering vehicles and aviation without emissions. Hydrogen can be produced through electrolysis of water, from an external energy source; it is then combined with oxygen via fuel cell technology to produce electricity, heat and water.

Using Renewable Energy Sources: Traditionally fossil fuels, hydrocarbons, bio-fuels or digester gases have been used in power generation or combined heat and power plants, starting by being broken down at an early stage in the process to generate hydrogen, before electrolysis occurs. This results in unwelcome by-products. Renewable energy sources, such as wind and the fermentation of biodegradable waste, however, can also be used to power the electrolysis processes, producing hydrogen. The hydrogen produced can either to go into hydrogen storage as an interim measure, or directly to fuel cells to produce clean electricity or heat.

Benefits: There are multiple benefits derived from linking renewable energy to hydrogen production and fuel cell technology:-

- The main advantage of using renewable sources such as wind to power the electrolysis processes to produce pure hydrogen for fuel storage or fuel cells, over other fuel sources, is that the only by product is water, there are minimal emissions and the process has an extremely low carbon footprint.
- Fermentative hydrogen from biomass using energy crops, sewage sludge, food waste (which requires energy recovery by virtue of EU directives (See Energy from Waste online advice) also offers a route to potentially low cost hydrogen.

- Hydrogen fuel storage and fuel cells have scope to counter the intermittency of certain renewable sources, such as wind, which increases the dependability of the source.
- There is capacity to power the electrolysis processes during off peak hours and store excess power at times of high production. Fuel cell systems within this process have the added advantage of being flexible, in that they can input directly to the grid, can operate separately and can switch from one to the other.
- The range of potential hydrogen and fuel cell operations is wide, with smaller scale operations potentially providing a means for dispersed rural communities to become energy self-sufficient. Systems can also be used on a larger scale as backup for critical infrastructure such as the grid and telecommunications.
- Hydrogen fuel cells are approximately twice as efficient as internal combustion engines in converting fuel to power. Additionally, by virtue of the electrochemical processes involved, there are no moving parts to generate nuisance derived from noise or vibration.
- Stored hydrogen can be transported or delivered via pipeline which further increases spatial planning options.

Typical Planning Considerations in Determining Planning Applications for Energy Storage

Hydrogen and Fuel Cells

Design considerations: The scale of plant associated with hydrogen storage and fuel cell varies relative to the scale of operation. Hydrogen tends to be stored in steel cylinders or bottles and fuel cells tend to be contained within boxed housing. Connecting pipes, cooling units, electrical units and separating walls are also a feature. Overall it is industrial in appearance and would normally require attention to screening or building design.

Locational requirements: There is a degree of flexibility in hydrogen storage which can be remote from the renewable energy source or location of demand, although connection/delivery may affect commercial viability. Plant and transmission line may be required for connection to the grid.

By Products: The only by product from producing electricity from hydrogen and oxygen is hot water, which on a large commercial scale gives possibilities for district heating.

Hydrogen Fuel Stations: Hydrogen fuel stations that have been developed on the continent to date have followed a standardised project design. However, further discussion may be required with operators to ensure design fit with sensitive or traditionally designed localities.

Safety / public health considerations: Demonstration projects have shown that hydrogen storage is a safe technology subject to some limited locational considerations, despite negative public perceptions. Planning authorities are expected to consult with HSE and Scottish Environment Protection Agency (SEPA) on location.

Noise from Plant Equipment: The mechanical process of hydrogen storage is not expected to create any noise nuisance.

Access and Deliveries: Some hydrogen storage facilities may result in vehicular delivery of hydrogen to other sites. Suitable access provision should be provided and conditions over the volume of pick-ups should be considered.

Decommissioning: Given that some operations might not be contained within buildings, might have an industrial appearance which could be conspicuous in certain locations if screening deteriorates, planning authorities may wish to consider a decommissioning condition in the event that equipment becomes redundant.

Useful References / Links:

The Hydrogen Office: A demonstration project on the role of hydrogen and fuel cell technology

Scottish Hydrogen and Fuel Cell Association

HSE: ' Fuel Cells – Understand the hazards, control the risks'

Institution of Mechanical Engineers: Electricity Storage