



### Overview

Highview Power Storage is a privately owned, award-winning technology company. It has developed, and owns the IP to, a novel, large scale, long duration energy storage and power system using liquid air as the energy storage medium (Liquid Air Energy Storage, LAES).

The system is low cost; scalable without constraints; has long lifetime; uses proven components, and no scarce or toxic materials. The system can simultaneously convert low grade waste heat to power e.g. from co-located industrial or utility plant.

Highview has a 350kW/2.5MWh LAES pilot plant in operation on the UK's national grid (*pictured below*) hosted by Scottish & Southern Energy, one of the UK's leading utilities. The plant has been operated successfully for more than one year, and has proven capable of meeting technical standards demanded by National Grid international grid operators.

With extensive on-grid demonstration and testing concluded, the company is undertaking funded design and feasibility studies for commercial scale plants. Our business model is to provide engineering service and IP licensing/knowledge transfer, working with in-country delivery teams (EPC, supply chain, owner/operators) and thereby building up in-country system expertise.



Highview's pilot plant at Slough

### Highview's Intellectual Property

Highview has several patents lodged in key markets, covering the basic processes as a whole and certain key components within it, such as the thermal store. As development work continues and the technology transitions to commercial scale and is developed for a broad range of applications and integration, additional IP / patent opportunities are being processed.

### System Advantages

With Liquid Air Energy Storage, Highview brings a new approach to energy storage that offers grid-scale solutions, at a lower capital cost than pumped hydro and at a scale and cost that batteries find hard to achieve. The system is non-combustive and uses no scarce materials; it is fully recyclable at end of life (40+years).

**Low Technology Risk:** The technologies at the heart of Highview's system combine mature components from the industrial gas and electricity generation industries assembled in a novel process. Along with providing a mature global supply chain, Highview expects this to provide a shorter product validation period and lower technology risk than most new technologies being introduced in the clean tech and energy storage space.

**Large Scale:** One of only a few technologies which can be delivered today at the 10-100MW + hundreds of MWh scale (and with proven components).

**Efficient Waste Heat Harnessing:** While a large-scale long duration energy storage system, the thermodynamics of the cycle enable the system also to harness waste heat (including low grade heat), converting it into electricity at high levels of efficiency: 50-60%; this is significantly more efficiently than Organic Rankine Cycle systems. The ability to harness low grade waste heat simultaneously offers a number of economic opportunities when deployed, for example, alongside thermal generation or industrial processes.

**Flexibility:** Not constrained by geography or geology (unlike Pumped Hydro or CAES), systems can be located near demand where they are required. Configurable to suit application (charging rate v amount of storage v discharge power), allowing optimised economic performance.

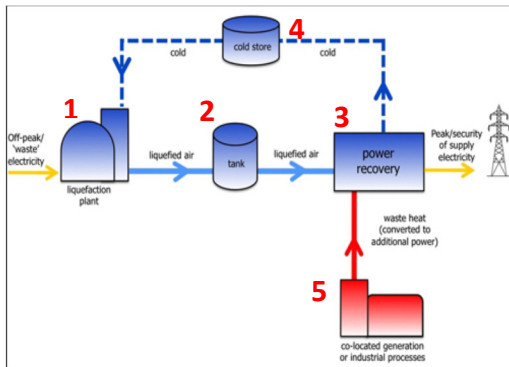
**Footprint:** Good energy density compared to many other systems, allowing relatively large installations in smaller sites (400x greater than pumped hydro at 100m head and around 4x greater than above ground compressed air at 200bar).



## Highview's Technology

Highview's technology uses off-peak or 'wrong-time' power to liquefy air (710 litres of air becomes one litre of liquid air) (1 on chart), which is then held in a tank (2) until electricity is required. The liquid air is then returned to gaseous form, expanding 710 times, to drive a turbine (3), while extreme cold is recovered and stored (4) to assist with subsequent liquefaction, thus greatly improving the overall efficiency of the system.

If waste heat is available (e.g. from a neighbouring power plant or industrial process or data centre) then this can be introduced at the expansion phase, creating additional system efficiency (5).



## Commercial Plant / business model

Energy storage is a multi-billion \$ global opportunity, with both grid and industrial demand. Large scale, long duration energy storage is a primary, and as yet unsolved, demand within this market.

With the pilot plant having undergone extensive testing and due diligence, the company is now in a position to work with in-country partners to deploy first commercial reference plants at multi-MW scale (MWs to 10s of MWs) using mature components and supply chains.

## Senior Management Team

Highview has a strong management team that has been working together for a number of years, following Highview's founding in 2005. Toby Peters, one of the founders of the Company and co-developers of LAES, is COO.

The executive team is led by Gareth Brett, CEO, a veteran of the utility sector involved in the development and successful execution of many IPPs in the UK, continental Europe and the United States. Gareth has worked with Highview since 2006 and became full time CEO in December 2008.

## Liquid Air as a New Energy Vector

Liquid air is a storage technology that could play a key role in the low carbon energy future. **The Centre for Low Carbon Futures**, supported by ARUP and the Messer Group, published on 9<sup>th</sup> May a report: *Liquid Air in the energy and transport systems: Opportunities for industry and innovation in the UK*. Contributors include Arup, Ricardo, Messer Group (the world's largest family-owned industrial gases company) and academics from the Universities of Leeds, Birmingham, Strathclyde, Brighton, Queen Mary University of London and Imperial College. **The Liquid Air Energy Network (LAEN)** is a newly created forum for the advocacy and development of liquid air as an alternative way to harness waste and surplus energy within power and transport [www.liquidair.org.uk](http://www.liquidair.org.uk)

## Contact Details

**Matthew Barnett, Business Development Engineer**

E: [matthew.barnett@highview-power.com](mailto:matthew.barnett@highview-power.com)

T: +44 (0) 207 872 5800

	LAES
Capacity ( MW)	10 – 200+
Duration	Up to 12+ hrs
Efficiency	55 – 90+%
\$/kW	< \$1,000 commercial
Life (yrs)	25+
Maturity	Early commercial
Scale	Industrial / Grid peak / reserve

## Operating and Testing

The pilot plant complies with all the regulations and inspections necessary to be allowed to connect the system to the UK grid. It has successfully undergone a full testing regime, including automated performance testing for the US PJM electricity market. It has in practical terms operating hours equivalent to three years of UK Short Term Operating Reserve service; last winter the plant was successfully operated for seasonal TRIAD management.



**theENGINEER**  
TECHNOLOGY & INNOVATION AWARDS 2011



Winner of the Energy & Environment award  
Winner of the Grand Prix Prize