Liquid Air Energy Storage (LAES): from Pilot Plant to Multi MW Demonstration Plant

HIGHVIEW POWER STORAGE
Highview is an award winning designer and developer of utility-scale energy storage and power systems that use liquefied air as the storage medium.

Active since 2005, Highview has secured more than £26 million of private and public funding.

Highview’s 350kW/2.5MWh pilot plant, hosted by Scottish and Southern Energy, has been in operation since April 2010.

The company has a portfolio of patents, granted and pending, that cover the system.

Highview in collaboration with Viridor, has been awarded funding for a 5MW/15MWh Liquid Air Energy Storage (LAES) demonstration project by the UK Government.

Highview has established co-operation agreements with, Messer Group GmbH and Basil Read Energy.

Most recently, the company has signed a license agreement with General Electric to integrate LAES technology with their simple cycle peaker plants.
1. **Charge**
Offpeak or excess electricity is used to power an air liquefier, which produces liquid air.

2. **Store**
The liquid air is stored in a tank(s) at low pressure.

3. **Discharge**
To recover power the liquid air is pumped to high pressure, evaporated and heated. The high pressure gas drives a turbine to generate electricity.
LAES – Standard configuration

Diagram:
- **Power In** to Compression, then Refrigeration, to LAIR Storage, to Evaporation, to Expansion, to **Power Out**.
- **Air In** goes to Cleaning, then to High Grade Cold Store, then back to Compression.
- **Export to Grid** at 60% AC/AC.
LAES uses existing mature components (liquefier, liquid air storage, power turbine), with proven performance, cost, lifetime (25 year+).

- Suitable for large energy stores from about 20MWh to >1GWh, not restricted by geography.

- 60% efficiency in stand alone mode.

- Integrates well with other industrial process plant (utilising waste heat/cold) to enhance performance e.g. 70%+.

- Costs/economics improve with scale (50MW/200MWh < £1,000/kW <£250/kWh).

- Can be integrated at renewable site, but more valuable as a system resource for enabling wider renewable deployment.

- The system is ready for deployment at commercial scale (>5MW/15MWh) in industrial or utility applications.
2005: Research begins with the University of Leeds.

2007: Cold recovery cycle proved viable in lab experiments.

2008: The power recovery cycle demonstrated in lab-scale tests.

2010: Installation of power recovery cycle in pilot plant.


2012: Highview signs co-operation agreements with the Messer group and Basil Read Energy of South Africa.

2013: Highview enters into a licence agreement with General Electric.

2014: Highview in collaboration with Viridor, has been awarded funding for a 5MW/15MWh Liquid Air Energy Storage (LAES) demonstration project by the UK Government.
Highview Pilot Plant Layout 350kW/2.5MWh

1. Cryogen storage
2. Power recovery
3. High grade cold store
4. Cold circulation compressor
5. Recycle compressor
6. Main compressor
7. Air purification unit
8. Main cold box
Fully operational, since summer 2011, the pilot plant is hosted by SSE (Scottish & Southern Energy) at their Slough Heat & Power 80MW biomass plant.
Complies with all the regulations and inspections necessary to be allowed to connect the system to the UK grid.

Successfully undergone a full (self) 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; this winter was operated for seasonal TRIAD management.

Significant independent technical due diligence - engineering, academic, industry and component manufacturers.
In collaboration with Viridor, one of the UK’s leading recycling, renewable energy and waste management companies, Highview has been awarded funding for a **5MW/15MWh** energy storage demonstration project by the UK Government.

The funding, valued at more than £8 million ($13.6m), has been awarded as part of the ‘Energy Storage Technology Demonstration Competition’, run by the Department of Energy and Climate Change (DECC).

It will support the design and testing of a pre-commercial demonstration LAES system alongside one of Viridor’s landfill gas generation plants in the UK.

In addition to storage, the LAES plant will integrate waste heat to power from the landfill gas engines.
Pre-commercial demonstration project

CAD of Highview’s LAES Plant at Viridor’s Landfill Gas Generation Site in Greater Manchester, UK.

1. Cryogenic/liquid nitrogen storage tanks
2. Cryogenic pump
3. Evaporator heat exchangers
4. Turbine/power recovery unit
5. Interstage heat exchangers
6. Thermal storage tanks
7. Landfill gas engines
8. High grade cold store
9. Electrical switch gear
The system, which has undergone extensive feasibility work informed by the pilot plant project, will comprise:

- Energy store – ~200 tons of cryogenic storage capacity (around 15MWh of electricity) which will store liquid nitrogen at low pressure; and
- Power recovery – 5MW of power turbine capacity, which will use waste heat from the landfill gas engines to enhance the liquid nitrogen to power conversion efficiency.

It will use liquid nitrogen (brought in by tanker, then stored on site), to drive a zero emission (at the point of use) generation plant.

The demonstrator will provide a range of storage services to the network, as well as harvesting waste heat from the landfill gas engine cooling systems that would otherwise be rejected to the environment.

It will serve as a trial that could be extended to other waste to energy plants, improving overall thermal efficiency and providing output flexibility to an otherwise inflexible generating unit.
GE Highview Agreement

• In March 2014 GE and Highview announced a global licencing and cooperation agreement.

• GE will explore the opportunity to integrate Highview’s LAES technology in peaking power plants where GE’s gas turbines and gas engines are currently or will be installed.

• LAES systems will help to increase power plant efficiency and flexibility, thereby enhancing grid reliability and the distribution of renewable energy.

• Customers will benefit from significant advantages, including improved start up times and efficiency/heat rates, as well as offering waste-heat-to-power and energy storage capabilities.
1. Compressor house
2. Air cleaner
3. Cold box and cold expanders
4. Liquid air storage
5. Cryo pumps
6. Containerised power turbine and generator (2 x 10MW)
7. Heat exchanger containers
8. High grade cold stores
9. Hot water storage
10. Electrical intake and switch-house

Market entry product 20MW/80MWh
Take a tour of our pilot plant

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