

Dearman Engine Company
28th September –
Liquid Air as an Energy Vector

The Dearman Engine Company Ltd
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Decarbonising the grid

- Accommodate intermittent generators in remote locations

How to get power to where it is needed, when it is needed?

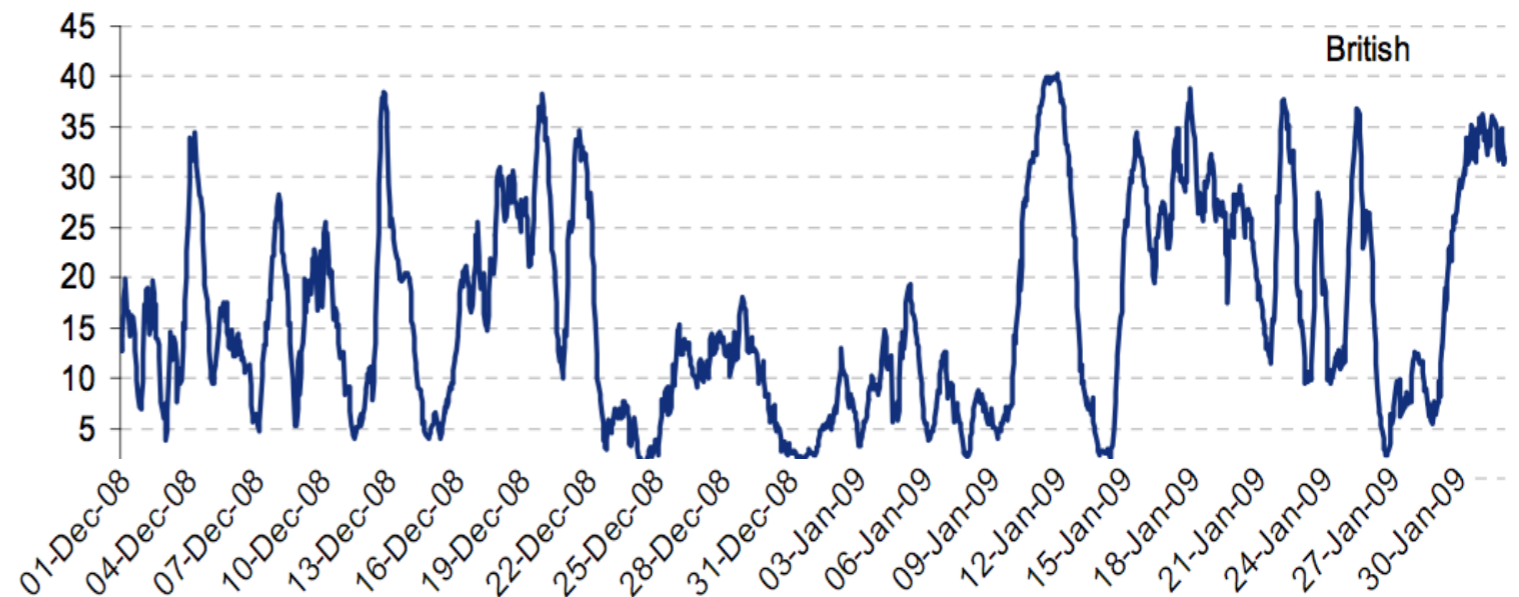
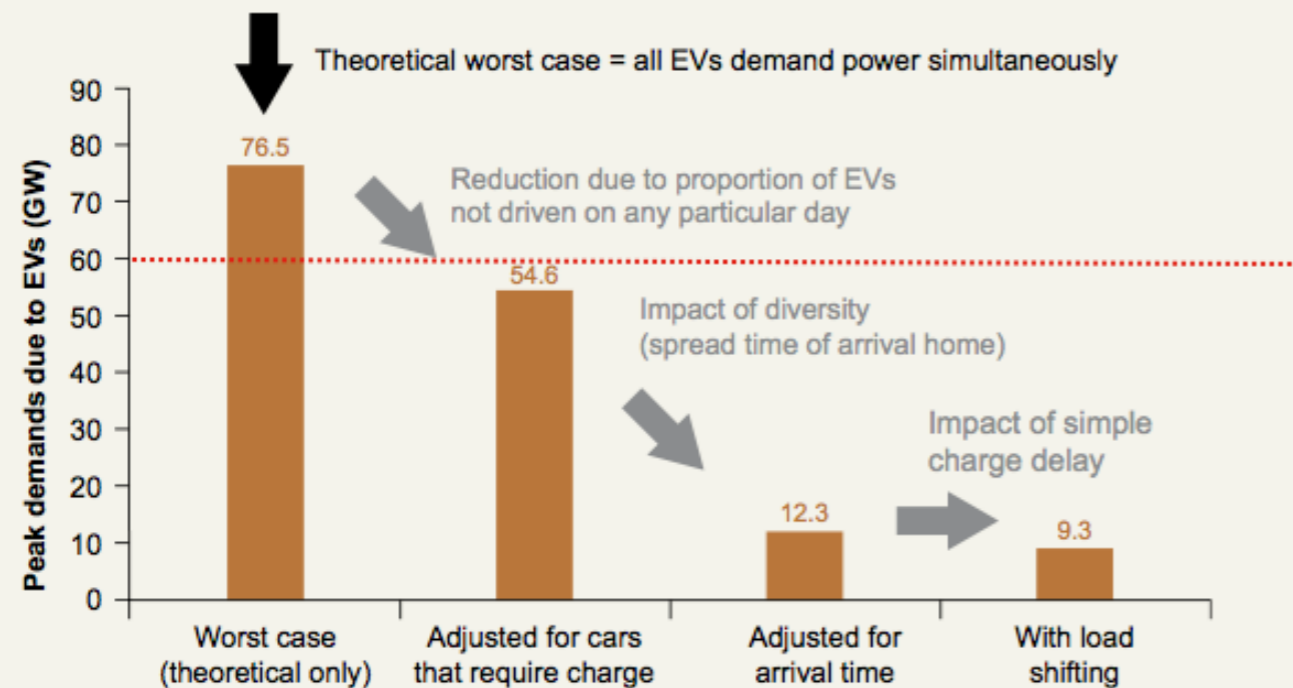


Figure 6: Peak demands on the electricity grid in Great Britain with 25.5 million EVs in stock (Stretch scenario in 2030) based on average charging rate of 3kW per EV

Estimated peak demands on British grid in 2030 due to EVs under the Stretch scenario

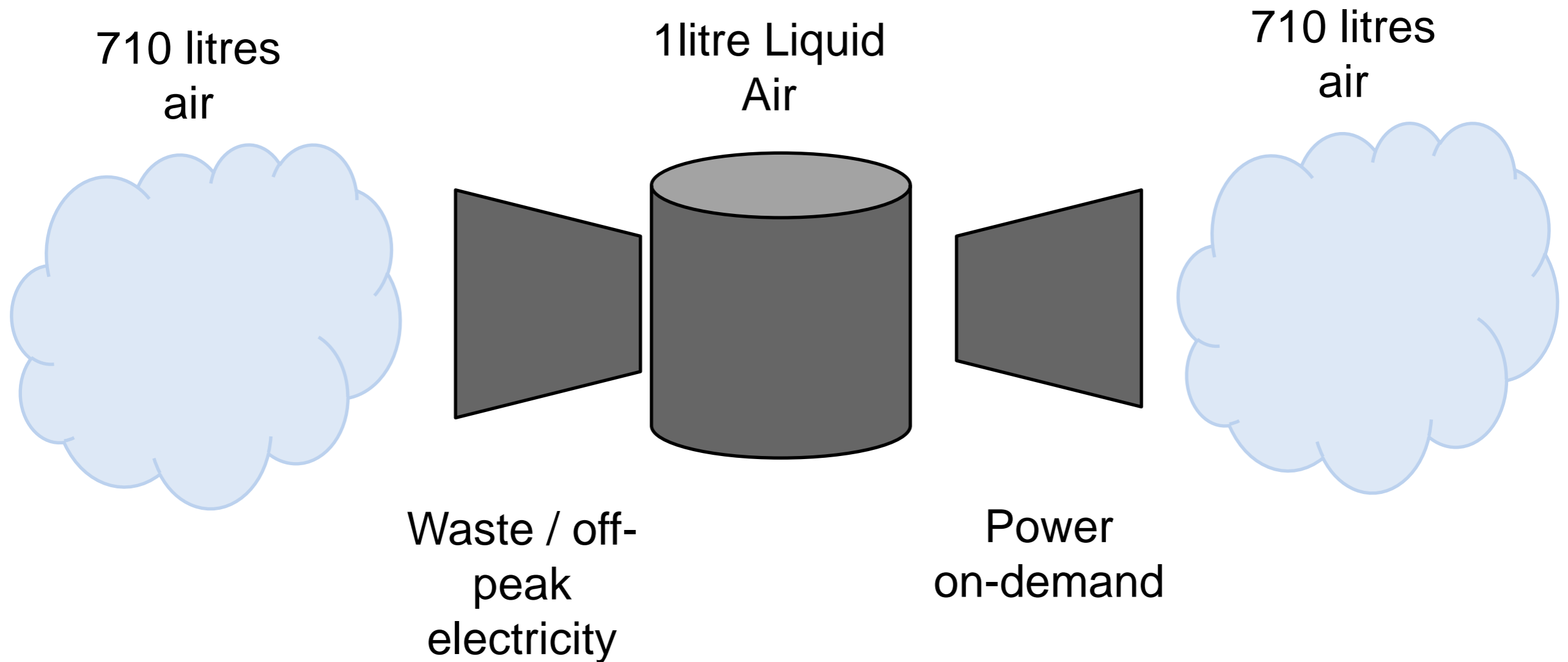


..... UK peak demand for electricity is around 60GW (gigawatts)

Decarbonising transport

- Electrification places further potential strain on the system by requiring more power in new places

Energy Storage can absorb intermittent renewable energy and make it available when it is required.



Integrated process – large grid and industrial applications
Separated process – smaller scale and vehicle applications

Appeal of cryogenic liquid as an energy vector:

- Pre-existing infrastructure;
- Mature supply chain/components with proven characteristics
- No scarce materials
- Low cost bulk storage;
- No geological/geographical constraints;
- Synergy with other industrial processes



Cryogenes are already safely transported on our roads

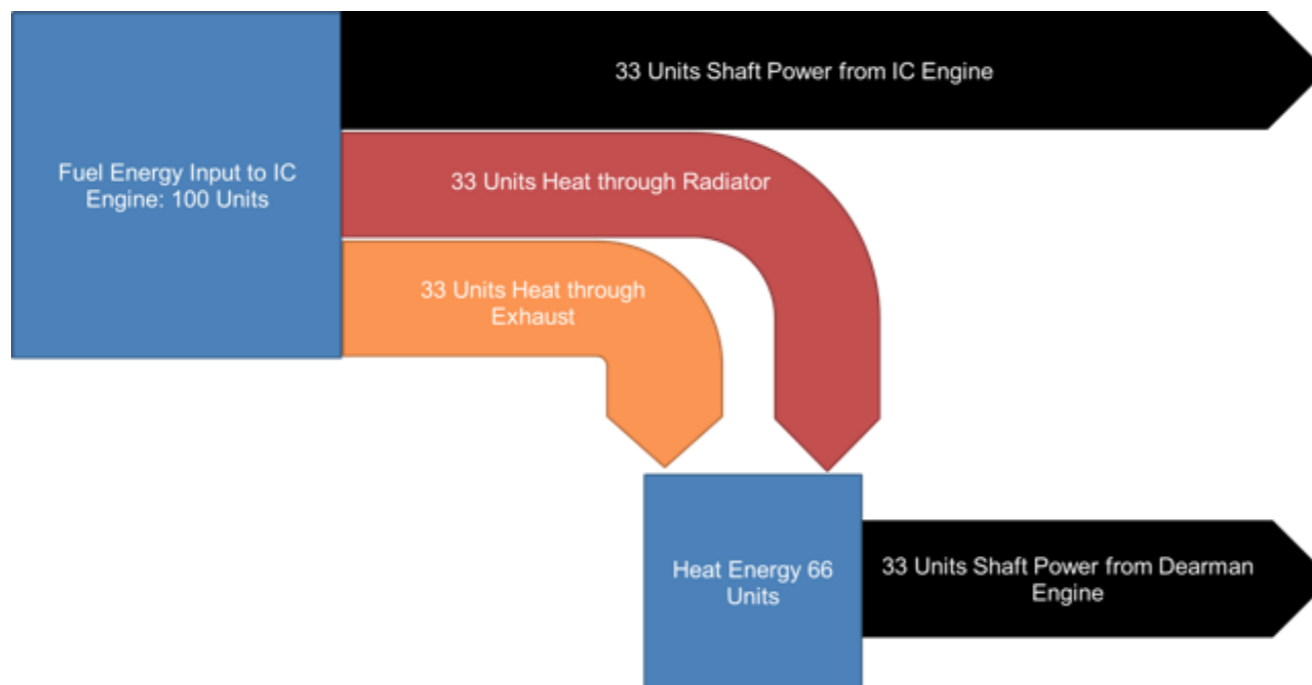
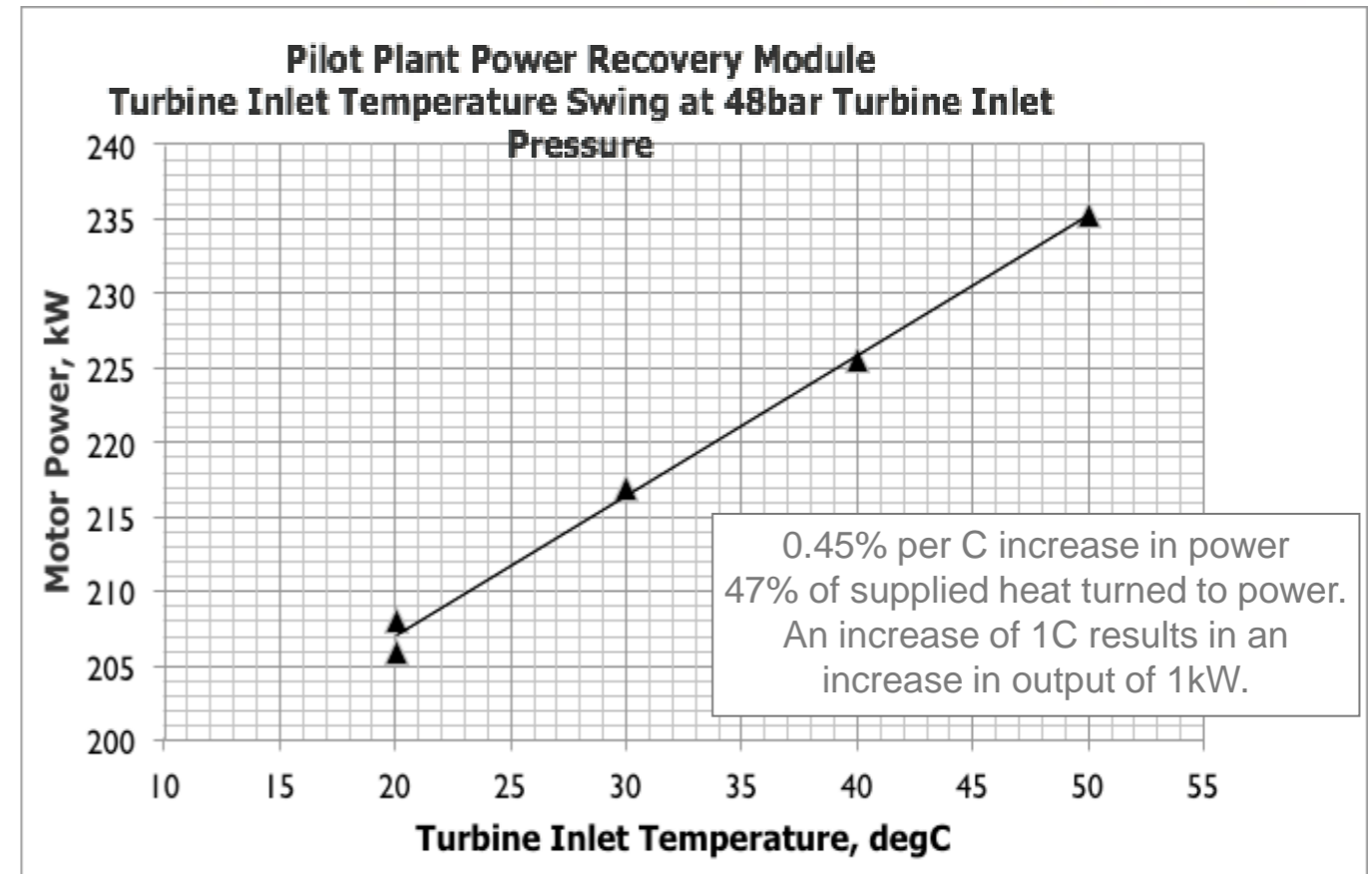


Storage of cryogenes is in low pressure containers



General Cycle Features

- Carnot efficiency of c. 70% even though the temperature difference is quite low (213°C).
- High yields for converting low grade (<100°C) waste heat to power



Very large quantities of low grade waste heat available from a variety of sources;

- IC engine coolant loop
- Power station cooling towers
- Industrial processes

Highview Power Storage

large-scale, long duration energy storage system using liquid air as the energy storage.



theENGINEER

TECHNOLOGY & INNOVATION AWARDS 2011

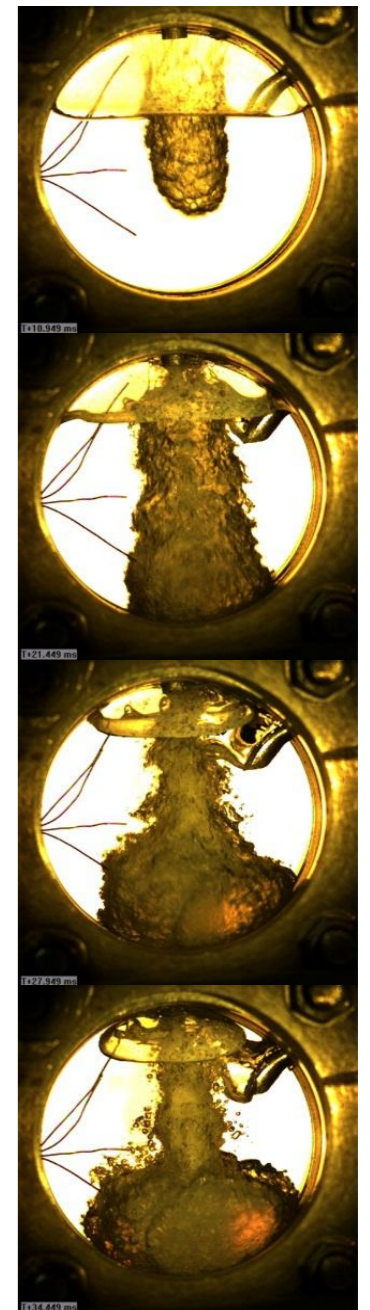
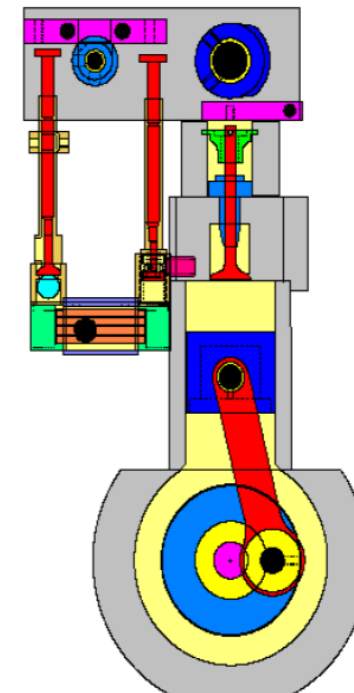
Winner of the Energy & Environment award

Winner of the Grand Prix Prize

RUSHLIGHT AWARDS
WINNER 2011

The Dearman Engine Company

reciprocator engine using liquid air as the 'fuel'.



clean, cool
technology

Energy storage and zero emission transport worth tens of billions of £'s and thousands of jobs - but currently dominated by America and Asia.

- UK already has first class cryogenic industry and very strong mechanical engineering expertise.
- Liquid Air as an energy vector could be a major opportunity for UK PLC which requires limited investment in new expertise or manufacturing plant.

“We don’t have a globally significant battery industry in the UK, but we do have world class cryogenics and mechanical engineering sectors. With the right support from government, Britain could steal a march in this technology and capture many of the jobs it would create.”

**Dr Andy Atkins, Chief Engineer of
Technology, Ricardo.**

Liquid Air Energy Group:

- Technology Agnostic
- Explores opportunity of Liquid Air as an energy vector
- Create knowledge and innovation hubs and inform policy makers at Government and commercial levels.

Who is involved?

- Institution of Mechanical Engineers
- Centre for Low Carbon Futures
- SMMT

Industrial academics from
Loughborough; Birmingham
Leeds; Brighton; QMUL
Imperial; Oxford Brookes

“We’re coming out of the cave blinking on this one and we’re only just getting an inkling of how great the energy benefits of liquid air could be.”

Dr Tim Fox, Institution of
Mechanical Engineers



Liquid air: The birth of the nitrogen economy

Everybody's heard of the hydrogen economy, with its promise of limitless low carbon energy. But after decades of R&D, the dream seems scarcely any closer. Apparently still confounded by major technical challenges, the hydrogen economy remains an elusive mirage – always just 10 years away.

But perhaps the hydrogen enthusiasts have simply picked the wrong element. A growing band of companies and independent experts now argue that some of the long-awaited promise of hydrogen could soon be delivered by a different gas – and at a fraction of the cost.

"Hydrogen could bankrupt the country" says Professor Yuesong Ding, Director of the Institute of Particle Science & Engineering at the University of Leeds. "There's a much greater chance we'll see a nitrogen economy."

Hang on a minute, did he say nitrogen? The inert gas that makes up four fifths of the air we breathe? It may sound unlikely, yet Professor Ding and his colleagues are now investigating the potential of nitrogen to deliver a whole range of low carbon energy services – from grid balancing to carbon capture to transport fuel. So too are a number of companies, including a pair of British start-ups, major industrial gas producers such as Air Products, and the global auto-engineering consultancy Ricardo. If the concept takes off, they say, nitrogen could not only help decarbonise the energy supply, but also revolutionise the industrial gases sector.

represent a major opportunity for UK F&E. As such, Ricardo's Chief Engineer of Technology, it could be...

For instance, low carbon electricity can be generated by wind turbines and nuclear power stations, but the wind doesn't always blow when we need power, and nuclear plants can produce too much electricity when demand is low, because they need to run at a constant rate. Both problems could be solved by an effective storage medium to help bridge the gaps between supply and demand. The greater the storage capacity, the more low carbon generation can be accommodated on the grid.

Low carbon transport fuel is another grainy problem. Green electricity is far superior to natural gas or biofuels in cutting greenhouse emissions

"Liquid air as an energy vector could create a market that will dwarf current demand"

in transport, but using it directly... holes means employing batteries that are heavy, expensive and... obstacle...

Perhaps the most important... is the fact electric vehicles... more effective energy vector... like petrol or diesel – allows... or advances. Grid balancing... y challenges we face" says... could help solve both"...

like, unlike hydrogen, it... is not chemistry, which... must be behind Highview... who has done most to... it works...

air into cryogenic... premium product... vector. But in some... liquid air... require to stay... tank. That... is like petrol...

if air need... reducing... to drive... city or...

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20th September
gasworld supplement

2nd October

Launch at IMechE
Professor John Perkins (BIS),
Craig Lucas (DEC) attending

Winter

Round Table events
Analysis, modelling and
report drafting

March
2013

Centre for Low Carbon Futures
Report
IMechE Conference
Initiatives launched

New markets for current products

- Large scale equipment opportunities in utility space
- Large volume opportunities in vehicle space

New applications for expertise

- Technology developers
- Manufacturers
- End Users

Driver to develop new products and processes an IP opportunity



Next Steps:

- Expressions of interest/feedback
- Get involved in the white paper, BCC roundtable event?

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