

engineexpo2007

How Fuel Cells can increase efficiency and lower emissions



Conserving biodiversity while offsetting carbon emissions

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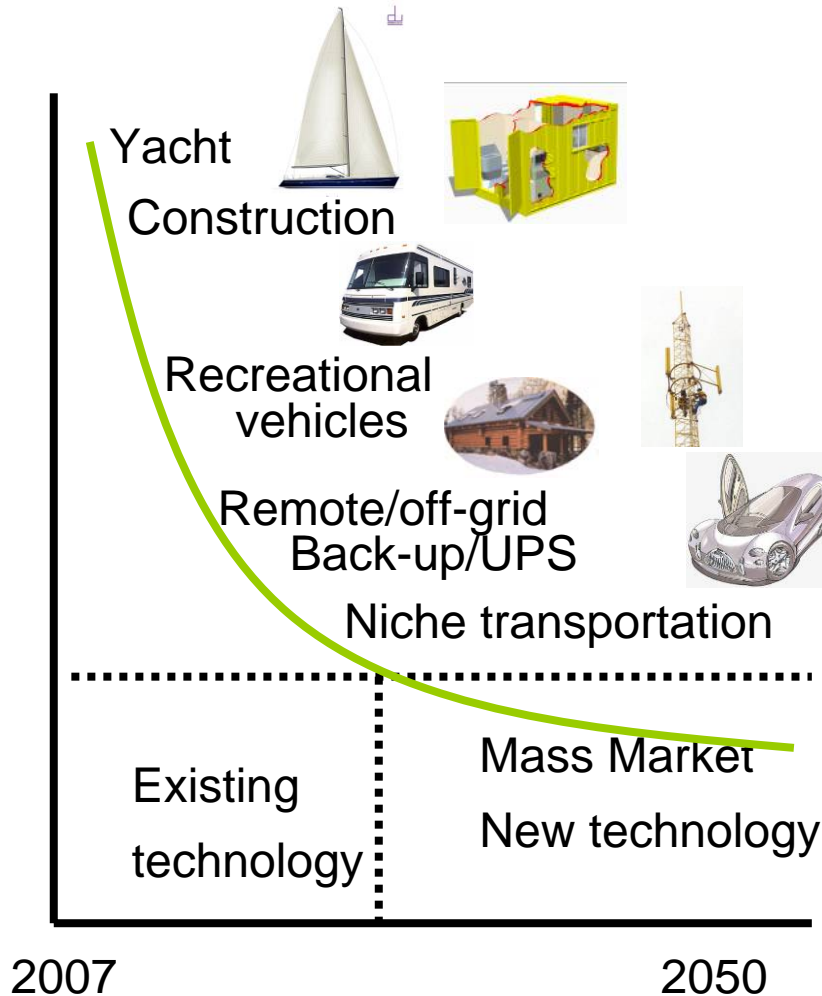
Voller Energy Group PLC (LSE:VLR)

- Founded 2002
- Clean energy solutions for a lower carbon economy
- Based Basingstoke, UK
- Floated on AIM (London Stock Exchange) in February 2005



Initial focus on niche markets transition to mass markets

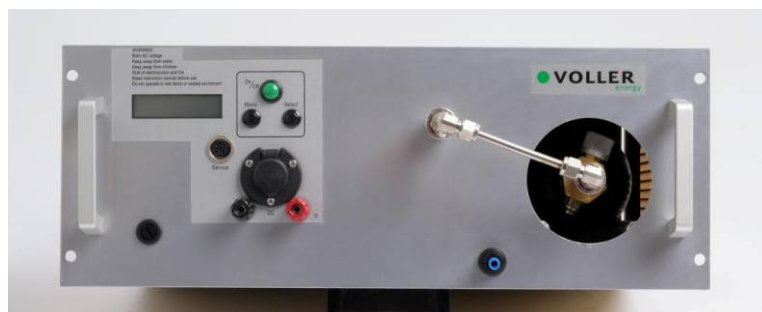
price



- Target niche, early adopter markets where the benefits of fuel cells outweigh their high cost.
- Develop systems which use widely available fuels with existing distribution and storage infrastructures.
- Use initial entry into niche markets to leverage entry into mass markets.

€420bn+
market
by 2050

The History of Fuel Cells



Fuel cell bus trial
2004

Fuel Cell ABC and RBC
2006

2007

2005
- 1st fuel cell system with CE Approval



2003



Voller VE100

-1st commercially available portable fuel cell generator with internal metal hydride canister and 230v or 110v inverter

-Three versions of the VE100 were donated to the London Science Museum in December 2006



Voller Emerald APU

-1st commercially available LPG fuel cell generator

1996



Mercedes NECAR

- 1st hydrogen power test vehicle

1965



NASA Gemini and Apollo space programmes used fuel cell technology

1958



Francis Thomas Bacon began experimenting with alkali electrolytes in the late 1930s

1839

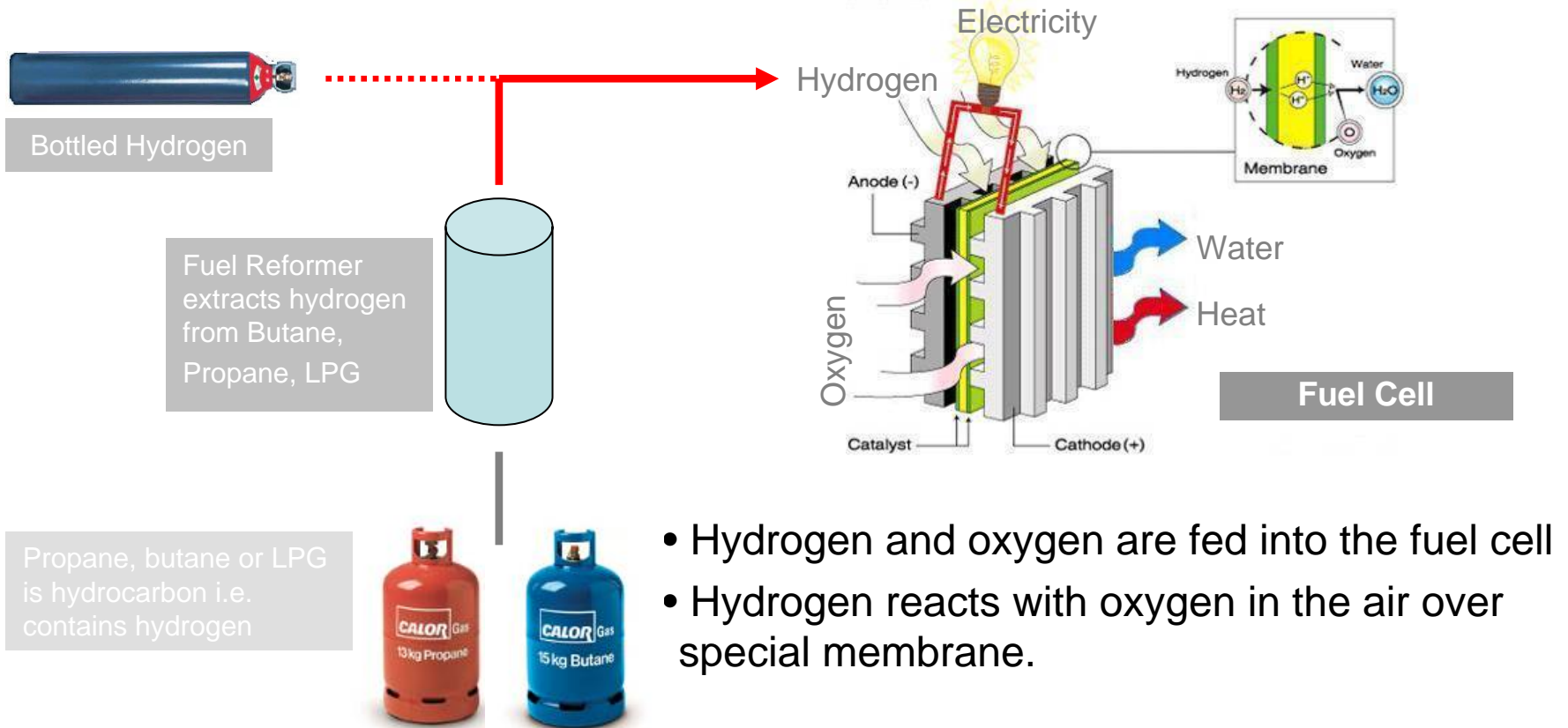


Sir William Walter Grove first fuel cell developed



Hydrogen from existing fuels energy efficiency up to 70%

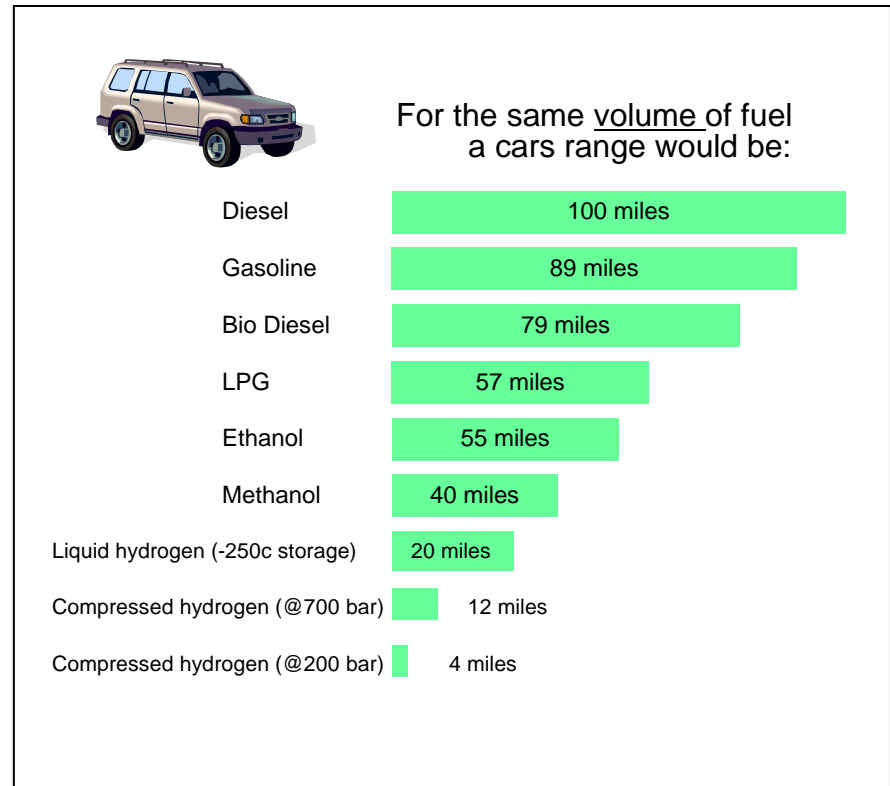
This produces electricity, heat and water.



- Hydrogen and oxygen are fed into the fuel cell
- Hydrogen reacts with oxygen in the air over special membrane.

The “hydrogen economy” may be an answer but significant challenges remain

- Hydrogen has a lower fuel density than fossil fuels, this creates practical usage and storage problems.
- Cost and logistics of building an infrastructure remain an issue.
- California Fuel Cell Partnership currently has a network of 25 hydrogen refilling stations - compared with an existing network of 10,000 gasoline stations.



Technology Gap

The increased interest in LPG

- The wider availability of LPG has led to an increased interest in LPG as a primary fuel for commercial and domestic vehicles.



- Tax incentives or congestion charges; both are promoting the use of alternative and cleaner fuels.
- With cities like London working to reduce their carbon emissions, increasing numbers of commercial vehicles are adapting their engines to use LPG.

The wider use of LPG

- Other vehicle types are also switching to LPG as the main fuel. In some cases these vehicles have the need for auxiliary power units (APU) to supply their electrical needs.



- LPG Gensets have fewer emissions than their diesel/petrol counterparts but only about 10% to 20% of these vehicles use LPG.
- These gensets are typically converted petrol systems with an electrical efficiency typically lower than 15%.

Why is a genset efficiency so low?

- It's not primarily the engine running inefficiently, often the generator only needs to run at less than 50% of its rated capacity.
 - Used in this way, generators rarely run at their most efficient. Typically their electrical efficiency is between 10% and 20%.
- Unless the genset is water cooled (very few small gensets are water cooled) no use can be made of the heat coming from the combustion process, so there is little opportunity to improve the energy efficiency.



An LPG battery charger

- With the main engine off, any systems still running will take power from the batteries.



- A remote APU style fuel cell system is a hybrid system that works in conjunction with a battery bank.
- The fuel cell system only runs when required. It will run at full power to recharge the battery bank and then shut down until the bank reaches a pre-set voltage level when it restarts again. This voltage level can be set according to the requirements.

- What if your battery charger also produced heat that you could use. What if it had an intelligent Combined Heat and Power (CHP) potential.

Drivers for adoption

Conventional Generator v Fuel Cell Generator

- Noisy
- High emissions, and smells
- Vibration
- Liquid fuels
- High maintenance
- Mature technology, low cost



- Quiet
- Low emissions
- Low vibration
- Gas fuels
- Low maintenance
- New technology
- Efficient
- Combined Heat & Power



Voller Energy's latest development is the Emerald.

- Fully automatic Combined Heat and Power (CHP) battery charging system with remote monitoring and control capability via a GSM link.
 - Developed for use in remote and mobile environments, runs on LPG with up to 650W electrical output at 12V or 24V available via a simple connection to the available battery set.
 - 1.5kW of heating available as hot water or hot air
- If the full efficiency potential of the Emerald system is used in conjunction with a relatively clean fuel, (LPG), the benefits arising from lower emissions and a high energy efficiency of up to 70% are worth investigating further.



Fuel use and emissions

86hrs of full power operation from 1x13kg LPG supply

Fuel use and emissions from generating 0.6kW continuous for a 10hr period.

| | Diesel Genset | LPG Fuel Cell |
|-----------------|---------------|---------------|
| Fuel | 11kg* | 1.5kg |
| CO ₂ | 34.1kg | 4.5kg |
| NO _x | 1.68kg | 0.0014kg |
| SO _x | 0.865kg | trace ppm |
| CO | 0.437kg | trace ppm |
| PM | 0.21kg | none |



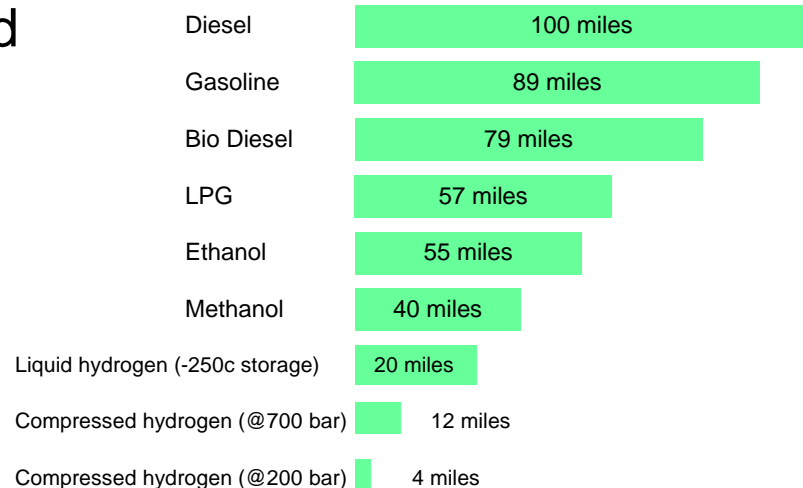
* Using average diesel fuel consumption and emissions data values published on the web by suppliers for 50% power levels.

Can other hydrocarbon fuels be used?

- Any hydrocarbon fuel can be reformed and used. The cleaning of the fuel, the reforming of the fuel, the cleaning of the gas (to give an almost pure hydrogen) and the removal of the carbon deposits are some of the difficulties still to be overcome.

- There is a lot of R&D going on to use other fuels, it is just a matter of time before success is achieved.

For the same volume of fuel a cars range would be:



- There are savings that can be achieved now and using LPG is a good beginning.

Why Voller ?

- Leaders in systems integration
- Flexible development approach allows use of best of breed components
- Patents, Intellectual Property rights supported by extensive know-how gained from 5 years experience in developing hydrogen fuel cell systems.
- Market focussed new product development process and team
- Experienced Board of Directors
- Fuel cell products available today



Summary

For every 1ltr of diesel you would have used, you can save 3kg of CO₂ by changing to an LPG powered fuel cell system.

There is a fuel cell alternative to the diesel/petrol genset, it runs on LPG and it is called the
Emerald



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