How to extend range and maintain zero tailpipe emissions of electric vehicles with fuel cells.

Joanna Brahova - Intelligent Energy

Delivering local low carbon transport and power solutions through hydrogen and fuel cells: opportunities for the public sector and supply chain

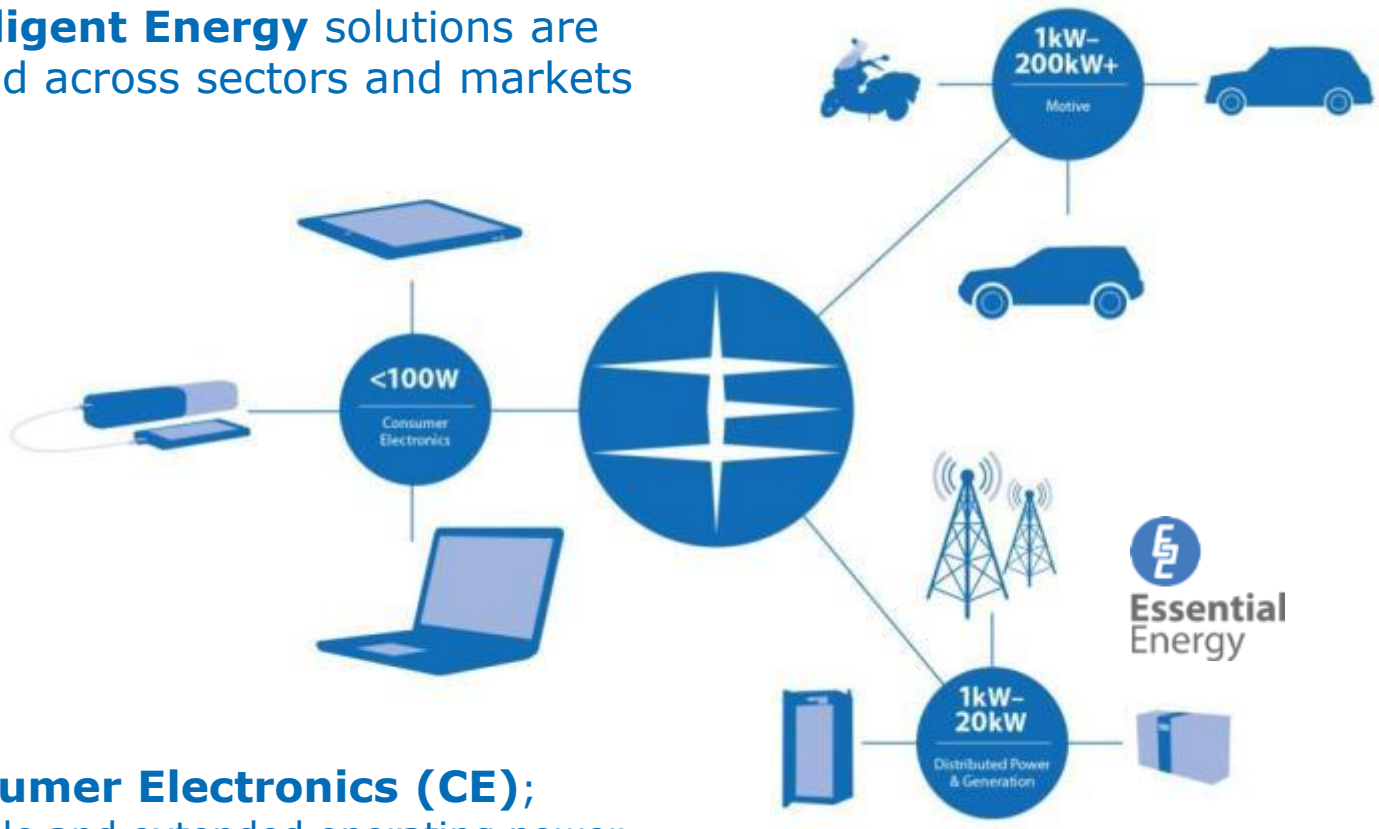
Intelligent Energy: global footprint, listed in London

- Total market capitalisation of $1.1bn valued on LSE
- London's biggest pure technology flotation for the last 5 years
- 350 patents granted, 450 patents pending
- Offices in the UK, US, India and Japan
- Established in 2001, with a history of over 25 years fuel cell innovation
- Headquarters and main operation in Loughborough, UK, offices in London, California, Bangalore and Osaka

Applications across multiple market sectors

Motive Power; Two-wheeled vehicles, automotive, commercial vehicles

Intelligent Energy solutions are applied across sectors and markets



Consumer Electronics (CE); Portable and extended operating power

Distributed Power and Generation (DP&G); CHP, backup and emergency power

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World Firsts in 'other transport applications'

First manned fuel cell aircraft

First purpose built fuel cell motorbike

First fully road approved fuel cell scooter

First PEM fuel cell black cab

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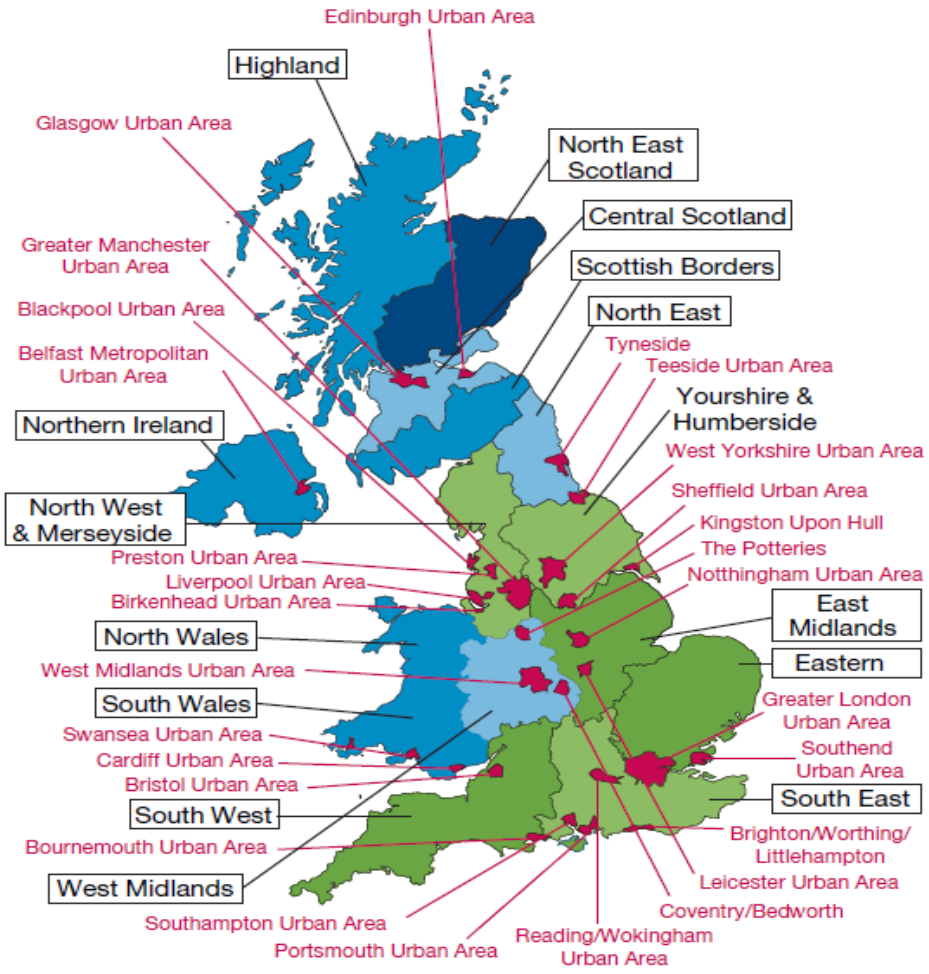
Hydrogen potential to improve air quality



EU Commission takes action against UK for persistent air pollution problems.

Brussels, 20 February 2014

The UK Supreme Court has declared that air pollution limits are regularly exceeded in 16 zones across the UK: a letter of formal notice has been sent.

Fuel cell electric vehicles
+
Hydrogen from renewable sources
=
Cleaner air

+ Noise reduction
+ Energy grid balancing
+ Skilled jobs retained/created
+ Local economy developments

http://europa.eu/rapid/press-release_IP-14-154_en.htm

Zero emissions technology options

Fuel Cell Electric Vehicle

FCEV

- Emissions ✓
- Noise ✓
- Range ✓
- Cost/TCO ✗

Battery Electric Vehicle

BEV

- Emissions ✓
- Noise ✓
- Range ✗
- Cost/TCO ✓

FC Range Extender

REEV

- Emissions ✓
- Noise ✓
- Range ✓
- Cost/TCO ✓

Battery Electric Vehicle with Intelligent Energy's Small Range Extender Fuel Cell Engine

=Novel solution for commercial vehicles=

Focus on fuel cell range extender for EVs

ADVANCED PROPULSION CENTRE UK

The APC scope developed through close partnership between industry and government.
Both parties committed £500 million each over the course of the next decade.
The APC focuses on development of low carbon propulsion systems.

Project Partners

Intelligent Energy · British Gas Looking after your world · MILLBROOK · DHL · EVSYSTEMS Electric Vehicle Integration Specialists · cenex

Advisory Group

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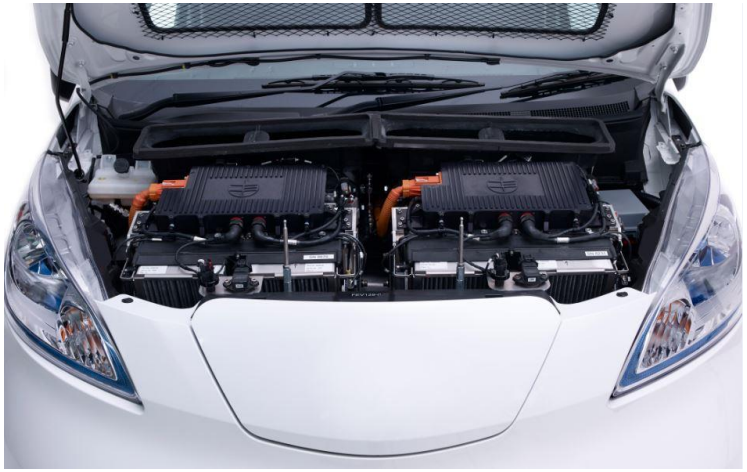
Fuel cell range extender for electric vehicle (REEV) Concept Demonstrator

Retrofitted 2 x 4kW FC power units within a Nissan e-NV200

4kW Fuel Cell Power Unit	
FC Stacks	2 x AC64
Cooling	Air cooled
Rated continuous net power output	3.9kWe
Maximum net power output	4.3kWe peak (90s)
Voltage	150-70V DC
Mass	<20Kg
Maximum dimensions	450 x 445 x 280mm

On-board Hydrogen	
Hydrogen Specification	ISO14687:2 Grade D
Hydrogen tanks	2 x 0.9Kg, 35MPa (<5mins fill)
Fuel consumption	0.442Kg/hr @ rated power
Delivery Pressure	450mbarg



Keeping the TCO low

- Zero Emissions
- Quiet operation
- ICE comparable range
- Low total cost of ownership (TCO)

Zero Emission Range Extender for BEV

- Low cost fuel availability
  - Predictable usage
  - Designed to demand
  - High capacity utilisation

Clustered approach

Regions and cities play significant role in early market encouragement

Role of Regions

Policy support – some level of public support for hydrogen transport is needed to make a region an attractive launch market for the technology.

Clarity – local regions need to decide whether or not they wish to be early adopter areas for hydrogen transport.

Continuity – Support mechanisms for hydrogen transport need to be designed recognising the expected timescales of the transition. Long-term, stable mechanisms are most effective.

Initial market creation – the public sector can have a role in developing early markets for fuel cell electric vehicles.

Partnership to support the early roll out – public bodies can work with industry to seed initial hydrogen refuelling infrastructure networks and deploy the first fleets of vehicles.
Recent OLEV announcement – new and upgraded stations to be deployed in UK by 2017.

Role of Fleet Owners/Operators

Share **duty cycles** to confirm suitability and future uptake of zero emission range extended electric vehicles.

Provide **customer feedback** on design during development stage

Possibility to participate at **fleet trials**

Gain **knowledge of fuel cell** vehicle technology and its benefits

Actively participate at **funded opportunities**

UK funding opportunity

Government and industry will prepare the UK for the roll-out of hydrogen fuel cell electric vehicles (FCEVs).

The £11 million investment will:

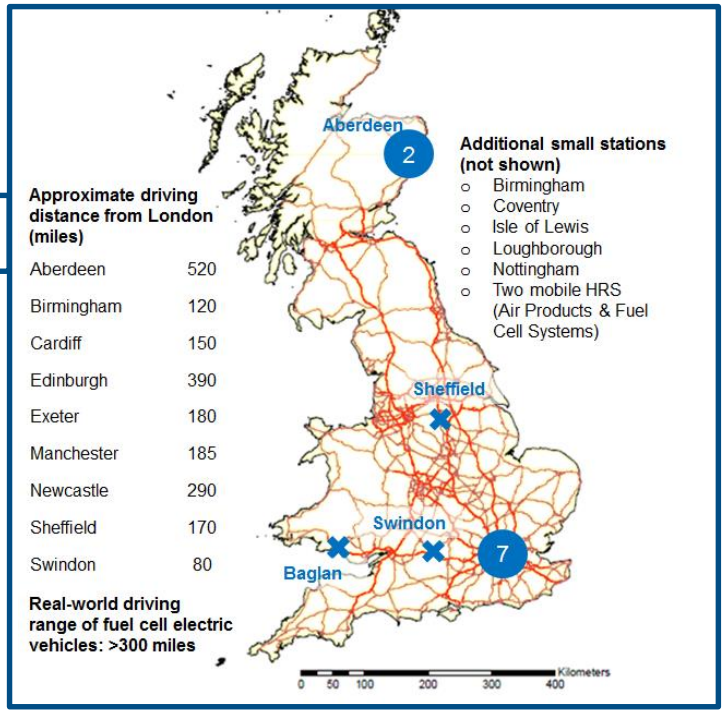
- help establish an initial network of up to 15 hydrogen refuelling stations by the end of 2015
- include £2 million of funding for public sector hydrogen vehicles

This is part of the UK government's drive to become a global leader in ultra-low emission vehicles and follows news earlier this month (October 2014) that Toyota has chosen the UK as one of the first markets for its FCEV when it goes on sale next year.

It is just one of the ways that government plans to decarbonise road transport alongside battery electric vehicles (EVs) and plug-in hybrids with £400 million of support available in the current Parliament and £500 million committed in the next.

Of the £11 million announced today (9 October 2014), £7.5 million will come from government and £3.5 million from industry:

- £2 million of top-up funding to upgrade 6 to 8 existing hydrogen refuelling stations (already operational or under development in the UK) and take them from demonstrator projects to publically accessible sites
- £3.5 million of funding to be matched by industry for 4 to 7 new hydrogen refuelling stations. This will include mobile stations as well as those on stand-alone sites and integrated into conventional petrol forecourts
- £2 million of funding for public sector fleets to encourage deployment of around 40 hydrogen FCEVs in focused geographical clusters.



Announcement pending

www.intelligent-energy.com

https://www.gov.uk/government/news/multi-million-pound-fund-to-get-hydrogen-cars-moving

UK funding opportunity

OLEV announces details of £20m ultra low emission vehicle taxi scheme

Wed 03 December 2014 | Back to news list

The Office for Low Emission Vehicles (OLEV) has published preliminary guidance on how the £20m ultra low emission taxi scheme - first announced in April - will operate. The scheme forms part of the £500m package to grow the market for ultra low emission vehicles (ULEVs) from 2015-20.

The published document outlines the principles, and current thinking around how the scheme will be designed but is not a reflection of the final design of the scheme. It marks the beginning of a consultative process with those who have an interest.

OLEV wants feedback from local authorities, taxi and private hire companies and drivers, in particular, on this preliminary guidance, to develop principles so that the scheme can work in the best interests of all potential participants.

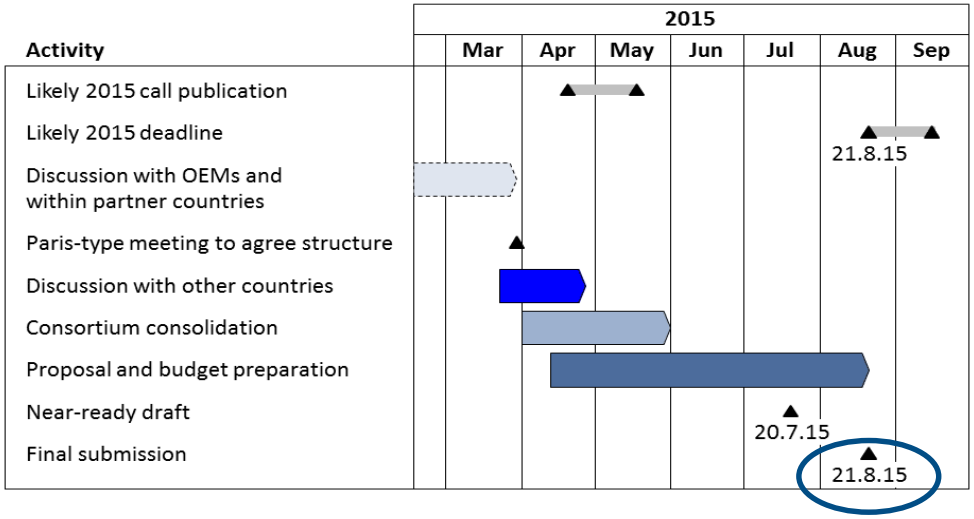
OLEV plans to run workshops in early 2015 about how the preliminary guidance will be developed.

The scheme will be open to local authorities, and will be available UK-wide. OLEV will provide funding for the infrastructure needed to support rollout of ultra low emission taxis in each region, which it anticipates could be used by both taxis and private hire vehicles, depending on localrequirements.

Local authorities are also invited to bid for funding to help offset the additional cost of purpose-built ULEV taxis. The Government plans to get state aid clearance for a maximum funding cap per taxi. ULEV taxis will also qualify for the Plug-in Car Grant, so local authorities need only to "top-up" the grant offered to each vehicle, up to a maximum cap.This "top up" grant will only be available to purpose-built taxis which meet set disabled access criteria, and not regular cars used as private hire vehicles.

http://www.lowcvp.org.uk/news,olev-announces-details-of-20m-ultra-low-emission-vehicle-taxi-scheme_3135.htm

European funding opportunity



c) Overarching Topics (**Topic FCH 3.1 and 3.3**)

Topic 3.1: Large scale demonstration of Hydrogen Refuelling Stations and FCEV road vehicles - including buses and on site electrolysis (IA):

Vehicles

For vehicles, the project will cover the roll-out of a fleet of at least 200 FCEVs. This should comprise multiple OEM supplied passenger cars, utility vehicles (light duty vans, medium duty trucks) and buses. Other vehicles can be included provided they can demonstrate a strong business case a significant market potential (10,000's per year) and have reached a TRL of 7 or above.

Call opened on 5th May

Multiple European countries to propose a joint bid.

Some funding could be directed to UK via UKH2Mobility members

Intelligent Energy is planning to participate subject to sufficient interest from early adopter.

Any city/region fleet owner/operator interested in becoming the UK adopter of Fuel cell range extended vans or taxis please contact:

Joanna.Brahova@intelligent-energy.com M: 07713 567 548

THANK YOU

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