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Hydrogen transport in the UK

Current status and future outlook

Element Energy

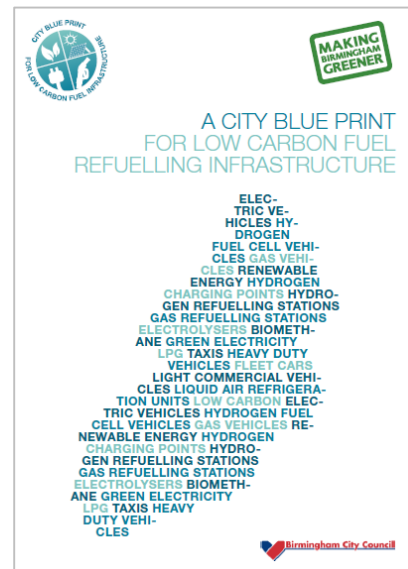
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Hydrogen transport in the UK: current status and future outlook

About Element Energy

Element Energy has been providing independent, evidence-based analysis and advice to clients across the low carbon energy sector for more than a decade. Transport currently accounts for around a quarter of total greenhouse gas emissions in the UK and Element Energy has led a number of important studies into alternatives to traditional modes of transport, including battery electric vehicles, biofuels, and hydrogen-fuelled vehicles. An example of our strategic work in this area is the recently published [City Blueprint for Low Carbon Fuel Infrastructure](#) (for Birmingham City Council). Other relevant publications include [A Fuel Roadmap for the UK](#) (for the LowCVP), and a comprehensive study of the [Cost and Performance of Electric Vehicle Batteries](#) (for the Committee on Climate Change). Further publications are available on our [website](#).



Element Energy’s hydrogen transport activities

Hydrogen offers many advantages as an energy vector and there is growing interest in the role of fuel cell electric vehicles as one of the potential means of reducing road transport emissions locally and globally. Hydrogen transport spans a number of sectors as the fuel can be made from a wide range of primary energy sources (including renewables), and Element Energy has been applying its multidisciplinary skills to this complex area since the start of the last decade. In addition to undertaking a range of techno-economic and



strategic studies, Element Energy has actively supported the delivery of hydrogen transport in Europe and is pleased to report on the latest milestones on the transition to zero emission motoring in the UK. Element Energy has provided both strategic consultancy and implementation support for all of the projects described below, which together represent a significant step towards securing a hydrogen future for the UK.

With the opening of new publicly accessible hydrogen refuelling stations in London and Aberdeen, and three more under construction in the capital, the UK's preparations for further zero emission mobility are gaining momentum.

Developing hydrogen transport clusters in London and Aberdeen



This week (March 10th) saw the opening of a new hydrogen refuelling station at Sainsbury's in Hendon, north-west London. The facility is alongside the existing forecourt and the provision of hydrogen in such proximity to traditional fuels represents an important milestone on the path to creating a network of refuelling stations to serve a growing number of hydrogen-fuelled vehicles. This is the third station to be built by Air Products in London: Stratford and Heathrow host existing stations, serving London's fuel cell buses and a range of other vehicles respectively.

Three more hydrogen refuelling facilities are due to be installed by ITM Power during summer 2015 as part of the GLA-led [HyFIVE project](#), which is creating similar hydrogen transport clusters in Copenhagen and in an area comprising southern Germany, western Austria and northern Italy.

Meanwhile, a new hydrogen production and bus refuelling station has [opened in Aberdeen](#). The station is at the Council's Kittybrewster bus depot and serves a fleet of ten fuel cell buses with hydrogen produced on site using renewable electricity. This facility is also designed to allow public access in order to support further uptake of hydrogen-fuelled vehicles in the city.

In addition, the UK Government is [providing funding for the next wave of hydrogen refuelling station deployment](#), which will deliver a network of up to fifteen stations by the end of 2016.

Increasing vehicle choice

Following the success of earlier fuel cell vehicle deployment, such as a fleet of [hydrogen-fuelled buses](#) operating on London's route RV1 since 2010 and five fuel cell taxis running in London since 2012; 2014 saw the delivery of the first UK-registered fuel cell cars from a global manufacturer. The handover of Hyundai's *ix35 Fuel Cell* cars to the first UK customers in October 2014 marked the culmination of months of effort to prepare the market for these earliest adopters, and a significant step on the pathway to more widespread zero emission motoring. Since its launch in Japan in December 2014, demand for Toyota's *Mirai* has exceeded expectations, prompting [plans to increase production capacity](#) over the coming years. Toyota will begin taking orders for

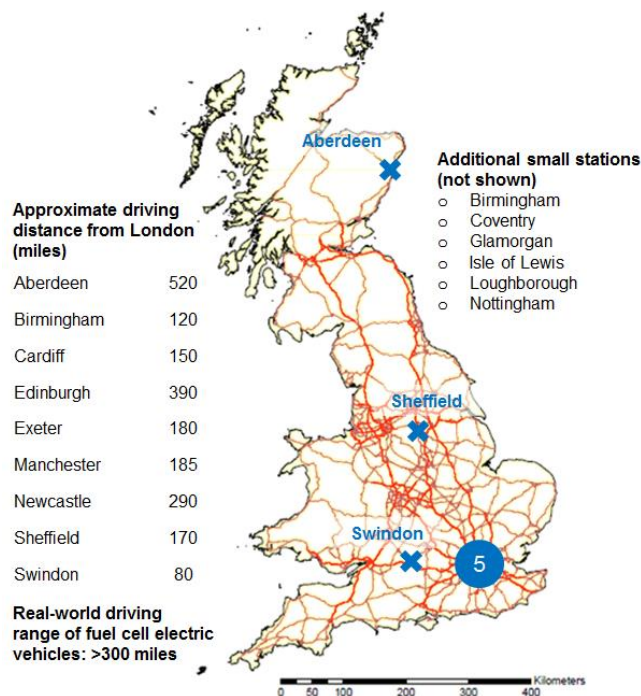


the *Mirai* in the UK from mid-2015, with the first cars expected to be delivered before the end of the year. Other major car companies with plans to bring fuel cell vehicles to market over the coming years include [Honda](#), Daimler (Mercedes), Nissan, General Motors, and BMW.

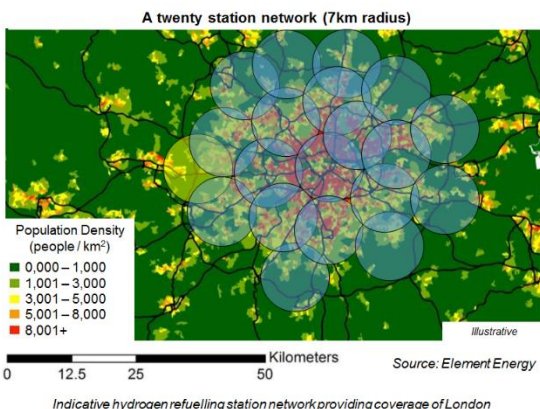
A growing national refuelling network

A key advantage of fuel cell vehicles relative to other zero emission transport options is the long range (350+ miles per tank) and short refuelling times (refill from empty in around three minutes). So, where in the UK can the early adopters of fuel cell cars travel? As the map shows, the number of hydrogen refuelling stations nationally is currently limited. However, plans are in place to provide wider coverage before the end of the decade; for example the public-private joint initiative [UK H2Mobility](#) project envisages a network of around 65 stations by 2020.

Although 65 stations may seem low compared to the existing petrol station network in the UK (according to [UK PIA](#) there were 8,591 in 2014), Britain's advantageous geography means that relatively few installations are needed for full national coverage. Traditional road fuel outlets serve a fleet of around thirty million vehicles, and the number required is related more to capacity, i.e. meeting demand without excessive waiting times, than to requirements in terms of geographic coverage.



Accessible hydrogen refuelling stations in Britain indicated in blue (based on operational stations and those expected to be commissioned by mid-2015)



Recent work to develop a hydrogen transport strategy for London considered metrics such as population density, traffic flows, etc. in planning a hydrogen refuelling network for the capital. This study found that a twenty station network, if sufficiently coordinated, could ensure that all areas in London are within 7km of a station, which corresponds to around fifteen minutes maximum drive time at average London driving speeds.

Outlook for the UK's hydrogen transport sector

2015 has long been an important date for the zero emission transport sector, since numerous companies set this year as a target for bringing fuel cell vehicles to market. With latest generation cars available from Hyundai and Toyota, the opportunity now exists for a select few to be early adopters of these state-of-the-art vehicles. Although the chance to be amongst a small group of fuel cell car drivers will be attractive to some, the current lack of infrastructure means that vehicle sales are expected to be gradual for a number of years.

Outstanding challenges for hydrogen transport in the UK

Despite these early signs of success for the sector, a number of challenges will need to be overcome for hydrogen to gain real commercial traction. These include:

- a) **Establishing early sales of fuel cell vehicles** – in the initial years of the hydrogen roll-out (before 2020), vehicle sales are only anticipated to be in the hundreds per year. However, even achieving these sales volumes is likely to prove challenging. The vehicles will have a cost premium relative to the incumbents and the fuelling network will be immature. Despite the attractive driving experience (low noise, speed of fuelling, long range), it is likely that these negative factors will make selling the vehicles challenging. Failing to sell the vehicles risks under-utilised stations in the early years, which would damage confidence in the hydrogen roll-out. This suggests a concerted effort will be needed from vehicle manufacturers, public funding agencies and large environmentally committed fleets to ensure that a significant parc of vehicles starts to build up in the UK to make use of the fledgling refuelling infrastructure. Creative models linking the sale of vehicles to specific stations (captive fleets), offering incentives to de-risk the refuelling process (e.g. free fuel, or a valeted fuelling service) and targeting particularly noise or emission conscious operations (e.g. deliveries at night time) will also help in achieving the required sales volumes.
- b) **Building investor confidence in fuelling infrastructure** – a UK network of around ten stations by the end of 2015 and perhaps fifteen by the end of 2016 is not sufficient to allow fuel cell vehicles to be sold to private customers in a conventional manner; this will require hundreds of stations up and down the country. Installing this many stations is an investment challenge in the hundreds of millions of pounds. At present any investment in a network of this type is beset with risks which make the investment difficult to contemplate. Public subsidy alone is unlikely to be sufficient to overcome this issue, hence auto companies and potential infrastructure investors need to continue to collaborate to provide confidence in the trajectory for UK sales of fuel cell vehicles to start using an expanding network, and vice versa (i.e. to provide confidence to auto companies that further infrastructure will be built).
- c) **Attracting auto companies to the UK** – global auto companies have a choice of which markets to focus on for the early years of vehicle commercialisation. The speed with which auto companies

make vehicles available in the UK will dictate the rate at which hydrogen fuelling stations can be rolled out, and the access to potential economic advantages from acting as a first mover. Ensuring that the UK is an attractive place to bring early fuel cell vehicles requires a strong UK Government position on the technology, and support from fuelling infrastructure providers to demonstrate the emergence of a plausible station network.

- d) **Integrating hydrogen dispensers into forecourts** – for hydrogen to become a mainstream fuel that is attractive to customers it is expected that the majority of the fuel outlets will be on conventional forecourts. Currently most stations are built as unmanned stand-alone installations with remote operations. The transition to forecourts requires new regulations (the *Blue Book* guidance for petroleum officers in the UK does not yet include a chapter on hydrogen) and will need new attention to the design of stations and the ergonomics of hydrogen fuelling dispensers. The first demonstrations of fully forecourt integrated stations for the UK are expected from 2016.
- e) **Technical issues** – a number of technical issues remain for hydrogen fuelling stations, including achieving ultra-high availability, implementing systems to assure the purity of the fuel being dispensed, improved accuracy of the metering of hydrogen being dispensed from the stations, and designs to minimise the land required by a filling station.
- f) **Competition from other alternative powertrains** – fully battery electric and plug-in hybrid powertrains will compete with fuel cell vehicles for both public attention and Government subsidy. In all likelihood these three technologies will prove to be compatible, with different powertrains appropriate for different duty cycles and all benefitting from the electrification of vehicle drivetrains. However, ensuring that hydrogen achieves a place in the low emission vehicle mix will require sustained effort to explain the benefits of hydrogen (longer range, rapid refuelling, ability to fuel larger vehicles, diverse sources for the fuel, potential benefits for energy storage) alongside the other alternatives.
- g) **Widening consumer awareness** – the mainstream public has either not heard of hydrogen as a fuel or sees it as something for the future. Communicating that hydrogen vehicles are becoming a realistic option for vehicle propulsion will be one of the challenges over the next five years of the roll-out. Achieving this messaging, whilst acknowledging that in the early years vehicle sales will be relatively limited and infrastructure sparse will require a considered approach. However, even in the initial stages of the roll-out it will be important to ensure the awareness of the technology is broadened to secure policy and public support.



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Element Energy is a leading low carbon energy consultancy working in a range of sectors including low carbon transport, low carbon buildings, renewable power generation, carbon capture and storage, energy networks, and energy storage. Element Energy works with a broad range of private and public sector clients to address challenges across the low carbon energy sector and has been instrumental in establishing and delivering many of the initiatives outlined above.

The new hydrogen refuelling station in Hendon was installed as part of the Innovate UK-supported London Hydrogen Network Expansion project.

The [Hydrogen For Innovative Vehicles \(HyFIVE\)](#) project involves fifteen partners from six countries and is being supported by the Fuel Cells and Hydrogen Joint Undertaking.



The new refuelling station in Aberdeen was delivered as part of the Aberdeen Hydrogen Bus Project, which is supported by the UK Government, the Scottish Government, and the Fuel Cells and Hydrogen Joint Undertaking.

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