The use of hydrogen as a transport fuel has the potential to deliver significant benefits to the UK in four distinct areas:

Decarbonising road transport
The UK is committed to meeting its long term emission reduction target of an 80 per cent reduction in greenhouse gas emissions by 2050 and, in order to achieve this, the UK needs, over the coming decades, to decarbonise road transport. Hydrogen Fuel Cell Electric Vehicles (FCEVs) are one of a range of low carbon technologies that offer a practical mass-market solution to help meet this objective.

Diversifying energy supply and enhancing energy security
Hydrogen can be produced from a wide range of primary energy sources such as conventional fossil fuels, solar and wind, to mention just a few. This is a major advantage when considering the diversification of the UK energy market. Hydrogen could also contribute to increasing energy security in the UK by reducing the UK’s reliance on imported fossil fuels.

Creating new economic opportunities for the UK
The emergence of a hydrogen-based transportation system could bring significant economic benefits to the UK through the creation of new employment opportunities across the entire supply chain from vehicle manufacture, development of new components, fuel production, distribution and supply to infrastructure deployment.

Reducing the local environmental impacts of road transport
Hydrogen FCEVs are ultra low emission vehicles (ULEVs) with water vapour being the only emission from the tail pipe and therefore offer a means of improving local air quality. In addition, FCEVs are also quieter than conventional internal combustion powered vehicles, thereby reducing noise pollution.

All of these socioeconomic benefits make hydrogen a viable option for fuelling the vehicles of the future. However, rewards do not come without challenges and as recent experience with other fuels such as LPG, electricity and CNG has shown us, the introduction of a new transport fuel and vehicle technology is beset with challenges and obstacles.

The idea of using hydrogen as a transport fuel is not new; numerous organisations and academic institutions across the world have invested substantial amounts of money and resources over many years, designing, developing, manufacturing and using hydrogen refuelling technology. Evidence of this can be seen at refuelling stations in Germany, the UK and many other countries around the world. As a result of this ongoing effort a significant number of the technical challenges to getting hydrogen into vehicles have been addressed. The issue is now more about how to roll out this new fuel and vehicle technology to the mass market. It is on this matter that key industry stakeholders together with UK government are presently focused.

The most obvious challenge to the introduction of any new fuel and vehicle technology is the cost and the high levels of investment necessary, not only to produce and supply the fuel and vehicle, but also to build the nationwide network of refuelling stations.

The costs involved in establishing and operating a nationwide hydrogen refuelling station network of around 130 stations are estimated at around £170 million, excluding the additional cost of hydrogen production, distribution and supply.

When you compare this figure with recent investments made in mobile phone and rail infrastructure, it may not seem huge. However, the risks for the investors are much greater when you consider that a network of critical size needs to be in place ahead of the vehicles in order to give the consumer the confidence to adopt the new technology. It’s the classic ‘chicken and egg’ conundrum.

In the early years of the network there
will be only a small number of vehicles and a low demand for hydrogen, so not enough to enable the early infrastructure providers to recover their investment. Added to this, there is the challenge of 'first mover disadvantage'. As the market takes off and demand for hydrogen grows, new entrants will be able to come into the market unburdened by the need to recover the investment made in the early stations.

Beyond the obvious financial challenges, there are a multitude of practical issues that need to be addressed in rolling out a network of vehicle refuelling stations and introducing a new transport fuel.

Finding the right number of suitable sites to locate the hydrogen refuelling stations is a key practical issue. A common concern with battery electric vehicles (BEV) is whether there is sufficient charge in the vehicle to cover the distance between recharging points, often referred to as ‘range anxiety’.

Fuel cell electric vehicles, by comparison, offer a similar range to that of conventional fossil fuel vehicles, making FCEVs more attractive for inter-urban journeys. However, the consumer’s concern of being able to find an appropriate refuelling station is still an important factor in their decision to opt for the new technology.

It is not just the number of stations and the distance between station locations that is important, it is also where the stations are located. Evidence suggests that unless a new technology offers the consumer substantial benefits over the existing technology, then customers are unlikely to change their behaviour significantly in order to accommodate the new technology.

The benefits of hydrogen fuelled vehicles are predominantly societal – consequently, in introducing hydrogen, any changes in consumer behaviour need to be minimised. This means that hydrogen refuelling predominantly needs to be undertaken at existing fuel retailing sites such as supermarkets and standalone refuelling stations. More radical solutions such as home refuelling are therefore unlikely to be attractive propositions in the early stages of the market’s development.

Introducing hydrogen onto the forecourt of an existing fuel retail site creates an additional set of challenges that need to be addressed. Forecourt sites are often already congested, so finding sufficient space for the necessary equipment required to refuel a hydrogen vehicle will be challenging. Secondly, there needs to be the minimum level of disruption to existing site operations. The emissions from the tail pipe of a FCEV are harmless water vapour. However, if the hydrogen supplied to the vehicle has been produced from a carbon intensive process, then the emissions problem has simply been shifted further up the supply chain.

A significant challenge in introducing hydrogen as a transport fuel is to ensure that the hydrogen comes from low carbon ‘green’ sources of production. Establishing the right mix of hydrogen production methods, avoiding being locked in to carbon intensive production technologies, to deliver significant CO₂ reduction both now and well into the future is a further challenge that needs to be overcome on the journey to mass market hydrogen mobility.

There is a significant amount of activity going on across industry, academia and government to address the challenges mentioned above as well as the many other challenges not covered within this short article to make hydrogen mobility a reality. Despite all these efforts, the final arbiter in deciding whether hydrogen succeeds as a mass market transport fuel will be you and I – the drivers of the new FCEVs.

Understanding consumer attitudes and perceptions to hydrogen as a transport fuel is critical in shaping plans for a nationwide roll-out of the technology and ensuring the successful adoption of the technology.

The UK government has stated its desire for the UK to be at the global forefront of the design, development, manufacture and use of ULEVs and FCEVs, and the associated hydrogen refuelling infrastructure has a role to play in achieving this objective.

Leading the effort in addressing the many challenges and issues to rolling out hydrogen based transport is UK H2 Mobility, a joint project involving key stakeholders from the industrial gas industry, the automotive industry, the fuel cell and hydrogen technology sectors and the UK government.

As car drivers, we all have first-hand experience of the challenges and risks associated with a long car journey: traffic jams, bad weather, flat tyres, restless children, and breakdowns – the list goes on. Yet regardless of these issues, millions of us take to the roads every day. Similarly, despite the long list of challenges and risks for hydrogen mobility, the journey towards a future with hydrogen based transport has started.

Hydrogen mobility will become a reality generating significant benefits for society, there are just a few potholes and tailbacks to be negotiated before we get there.

For more information contact
andrew.winship@boc.com or visit
www.UKH2mobility.co.uk