

Minister for Business, Innovation and Energy  
Minister for Transport and the Islands

## **HYDROGEN AND FUEL CELLS ROADMAP FOR THE UK**

### **Purpose**

1. To advise you of publication of Hydrogen and Fuel Cells: Opportunities for Growth: A Roadmap for the UK.

### **Priority**

2. Routine

### **Background**

3. This is an independent report by consultants E4tech Ltd and Element Energy, commissioned by Innovate UK, Department of Business, Energy and Industrial Strategy (BEIS), Transport Scotland, Scottish Enterprise, Scottish Government, UK Hydrogen and Fuel Cell Association (UKHFCA), Scottish Hydrogen and Fuel Cell Association (SHFCA) and Knowledge Transfer Network (KTN).

4. The Roadmap provides an overarching strategy for hydrogen and fuel cells to play a greater role in the UK's future energy mix. In developing the Roadmap the consultants conducted detailed analysis and a series of workshops (including events in Edinburgh and Glasgow) as well as bilateral discussions with a wide range of stakeholders.

### **Key Messages**

5. Hydrogen and fuel cells could be a major component of the UK's low carbon energy system, providing a range of services including energy storage, grid balancing, enabling increased renewable energy deployment, heating homes and businesses, and powering vehicles. Crucially, hydrogen and fuel cells present options for integrating the traditionally distinct electricity, heat, and transport sectors.

6. Co-ordinated activity by the public and private sectors over the next five to ten years is required to maximise economic value and long-term environmental benefits ahead of potentially rapid and large scale roll out of hydrogen and fuel cell technologies from the mid-2020's.

### **Next Steps**

7. Scotland is home to emerging hydrogen and fuel cells sector as well as a small number of significant, public-sector-supported, demonstration projects. Officials will continue to work cross-divisionally and with delivery partners to monitor

and learn from existing projects, as well as considering options for supporting and engaging with future projects.

8. The opportunities for hydrogen and fuel cells, and our approach to ensuring that the option exists for these technologies to play a greater role in Scotland in the future, will be a key consideration in the development and implementation of Scotland’s Energy and Transport strategies.

9. The SG and its agencies will build on the links established with the other organisations that supported the development of the Roadmap. As an early example of this, officials will take part in a SHFCA strategy workshop in January, which will consider insights from the Roadmap and look at specific Scottish opportunities.

10. Officials will brief Ministers further as we develop proposals for our strategic approach to this diverse sector.

**Recommendation**

11. That you note the contents of this submission.

[REDACTED]  
Local Energy and Consents  
[REDACTED]

**Attachments:**

Annex A (pages 4-5): Summary of Hydrogen and Fuel Cells Roadmap

Copy List:	For Action	For Comments	For Information		
			Portfolio Interest	Constit Interest	General Awareness
Minister for Business, Innovation and Energy			x		
Minister for Transport and the Islands			x		
Cabinet Secretary for Economy, Jobs and Fair Work			x		
Cabinet Secretary for Rural Economy and Connectivity			x		

Energy and Climate Change BMU [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] [REDACTED] Communications Economy Press, Transport Scotland [REDACTED] [REDACTED]
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[REDACTED]  
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Transport Scotland Directors  
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## Hydrogen and Fuel Cells Roadmap: Summary

### Structure and Themes

The main report brings together the key points and actions from eleven mini roadmaps which cover market segments such as Bulk Hydrogen Production, Large Stationary Fuel Cells, Small Stationary Power and Combined Heat & Power, Services to Energy Networks, Hydrogen Pipelines, and Road Transport.

The main report links these sub-sectors around four overarching themes:

#### 1. Hydrogen as a major component of a future low carbon energy system.

Hydrogen can bring significant benefits as a low carbon route to energy supply, and through providing services to energy networks. For example:

- The gas network could be converted to hydrogen, to provide low carbon heating.
- Hydrogen could enable more widespread penetration of renewable electricity, as a way to store large amounts of intermittent electricity supply for use as required and enable its use in other sectors, such as heating and transport.
- When combined with Carbon Capture and Storage (CCS) hydrogen production can provide a route to low or even negative greenhouse gas emissions.

The actions recommended are to prepare the UK to take advantage of these potential solutions when they are available at the scale required to deliver major energy system benefits. There is a need for major energy system decisions (e.g. whether to phase out or repurpose the gas grid; the extent to which electricity can be expanded to meet needs of other sectors) to be taken at a national level in the coming years. Evidence needs to be provided to underpin those decisions.

The Roadmap states that the overall cost of each of the measures described under this theme is relatively low and/or can generally be borne from existing programmes (e.g. the existing innovation budgets for the gas pipeline conversion option). There is a need to ensure that existing programs include hydrogen options. There may also be a need to prepare additional national scale programs to support the required deployment activities (e.g. for testing the links between electrolysis and renewables).

Although these measures will stimulate job creation and development of innovative UK products and services before 2025, much larger benefits from these measures in terms of GHG savings and economic benefits will be seen in the long-term, of the order of tens of billions. In each case, the rationale for providing support from public and private sector actors is to ensure that the option exists to use hydrogen to create a lower-cost, low carbon energy system in the future.

#### 2. Hydrogen in transport: helping to improve air quality and contribute to decarbonisation

Hydrogen could be a key component of the future transport fuel mix, potentially delivering substantial greenhouse gas and air quality benefits. While application in cars is important, hydrogen is also well suited to heavier vehicles operating daily duty cycles. The UK could

benefit from a focus on developing larger buses, trucks, vans and even boats, where there is already significant industrial strength. The main action here is to support UK companies producing these vehicles and their components, complemented by actions to prepare the UK market for the introduction of hydrogen-fuelled vehicles of all types.

### **3. Fuel cell Combined Heat and Power (CHP) : improving the efficiency of energy use today**

These systems can run on natural gas cleanly and efficiently in the short term, and bio-based gases or hydrogen longer term. Actions here include supporting UK companies in validating and introducing small scale fuel cell CHP, creating a fair playing field within regulations, and developing business models that capture some of the wider benefits of fuel cell CHP systems.

### **4. Fuel cell products: bringing functionality benefits in portable and specialist applications**

Portable power, remote power using portable fuels and unmanned aerial vehicles each have a potentially important role to play in commercialising hydrogen and fuel cell technologies. Actions are concentrated around showcasing the products, awareness-raising amongst potential buyers, as well as removing unnecessary barriers.

#### **Benefits**

The principal benefits outlined in the report are:

- **Environmental** – Adoption of hydrogen and fuel cells will improve air quality today, and following the actions described could reduce UK CO<sub>2</sub> emissions by tens of millions of tonnes per year.
- **Economic** – By 2025, tens of millions of pounds and 1,000s of jobs could be created directly in the supply chain. These would underpin future growth in key UK manufacturing sectors such as automotive and energy-intensive industries as the world adopts tighter environmental targets.

#### **Publication / link to full report**

While Innovate UK (the lead partner in the development of the Roadmap) awaits confirmation of a publication date on .gov.uk, the report was published on the website of the consultants E4Tech on 21 November:

- Main report: <http://www.e4tech.com/wp-content/uploads/2016/11/UKHFC-Roadmap-Final-Main-Report-171116.pdf>
- Mini-Roadmaps (appendix to the Roadmap report): <http://www.e4tech.com/wp-content/uploads/2016/11/UKHFCRoadmap-Final-Appendix-11-Mini-roadmaps-170816.pdf>

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Energy and Climate Change

30 November 2016