Large stationary fuel cells - pre-read in advance of workshop

This project aims to drive sustainable economic growth in the UK hydrogen and fuel cell industry in the period to 2025 and beyond

- **Public-private project** steered by Innovate UK, the Department of Energy and Climate Change (DECC), Transport Scotland, Scottish Government, Scottish Enterprise, Scottish Hydrogen and Fuel Cell Association (SHFCA), UK Hydrogen and Fuel Cell Association (UKHFCA), and the Knowledge Transfer Network (KTN)
- **Delivered by E4tech and Element Energy**, in consultation with the Steering Board and wider stakeholders
- Launched in January, due to be completed in early June
- Consists of **11 mini roadmaps**, on different sectors of hydrogen and fuel cell use, which will be brought together with an overall national case

WP 1 – kick-off workshop

Aligning on scope, timescale, governance

↓

WP 2 –Analysis of individual roadmaps

↓

WP 3 – Consultation

Workshops + bilateral discussions

↓

WP 4 – Revision of individual roadmaps

- Based on feedback and evidence received from consultation, revise individual roadmaps and benefits assessments

↓

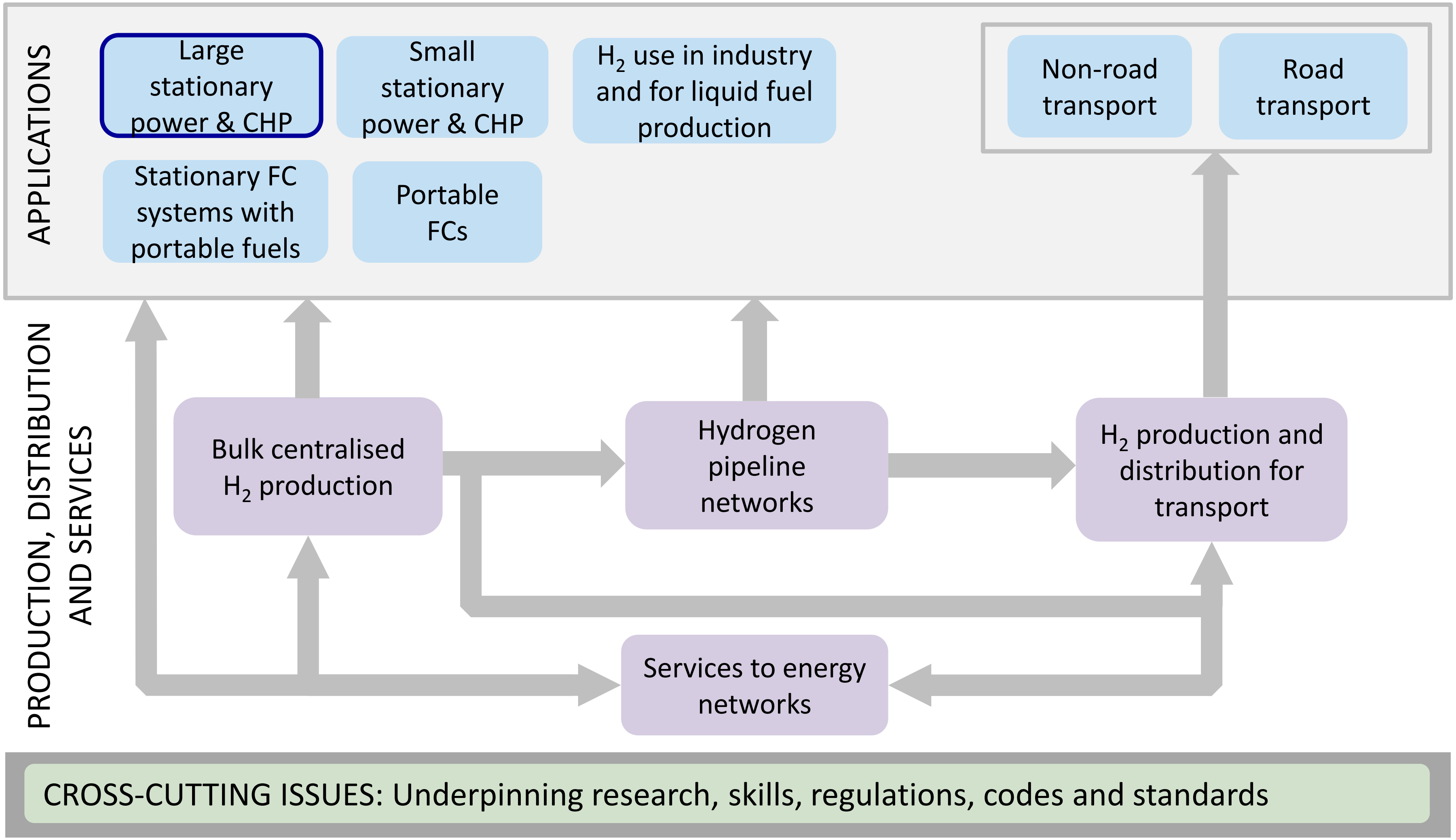
WP 5 – Understanding the overall national case

- Understand interdependencies between roadmaps and critical decisions on each roadmap
- Agree on a prioritisation
- Assess required support
- Calculate national benefits

↓

WP 6 - Draft and final reports

The 11 mini roadmaps cover uses of hydrogen and fuel cells, and production and distribution of hydrogen



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End-use roadmap Supply chain roadmap

Today's workshop is to get your feedback on the draft mini-roadmap on **large stationary fuel cells**

- The draft mini-roadmap shows **aims** for each application for 2025, **barriers** to achieving those aims, **actions** that need to be taken to overcome the barriers, and **benefits** of doing so

- Today we are interested in **your views on**:
  - The current costs and cost trajectories of hydrogen fuelled fuel cell CHP units
  - Are the aims for 2025 appropriate? What level of deployment is feasible?
  - Are the important barriers included and are they well explained?
  - Will the actions proposed be enough to overcome the barriers? If not, what else is needed?
  - Who should be responsible for these actions? How much will they cost, and how long will they take?

- Note that today we are focusing on **actions to 2025**, not the long term vision for the hydrogen and fuel cell sector. The longer term vision will be articulated in the overall national roadmap

- We also want your views on cross cutting issues that could affect more than one mini-roadmap

We welcome your views on cross cutting issues that could affect all mini-roadmaps

Underpinning research
e.g. What breakthroughs could change the outlook for several roadmaps?

Safety
e.g. What further work is needed?

Skills
e.g. Is education and training needed that spans several of these areas?

Financing
e.g. are there financing mechanisms that could help in several sectors?

Regional activities
e.g. Can pioneer regions be valuable in deploying several HFC technologies together?

Manufacturing and supply chain
e.g. joint design, production or procurement of certain components

Regulations, codes and standards
e.g. What further work is needed?

Marketing
e.g. how can one sector help another?

Market structure
e.g. ways to monetise value to grid of CHP could also apply to electrolysis

Joint initiatives between sectors
e.g. would these be useful?

Draft roadmap:

Large stationary fuel cells

This roadmap focuses on gas and hydrogen fuelled fuel cells for stationary power with capacities of 100kWe and above

- Large stationary fuel cells for generation of power are among today's most mature fuel cell technologies. Globally, 100's of MW's of capacity have been installed, and two companies have been producing 10's of MW per year for past few years (Fuel Cell Energy making Molten Carbonate cells and Doosan making Phosphoric Acid fuel cells). This scale suggests the technology has reached a high level of technological maturity relative to most other fuel cell opportunities.
- This section outlines the potential for these international developments in large stationary fuel cells to benefit the UK. A filtering exercise concluded that the roadmap should focus on:
    - **Gas fuelled CHP for buildings** – as these are commercially very mature and offer considerable carbon savings to large commercial buildings
    - **Hydrogen fuel cells for prime power generation** – making use of waste hydrogen streams from existing industrial processes. Though this is less technically mature, in AFC, the UK has one of the leading companies developing products for this market.
- These large fuel cells systems offer low noise and virtually emission free generation of power near the point of use. The commercial systems' efficiencies are equal to or above those of best in class reciprocating engines. Future system efficiencies could exceed best in class combined cycle gas turbines (>60%).
- Other options not analysed in detail here, but which have considerable market scope include large scale generation of prime power using fuel cells (plants up to 60MW in size have been constructed using gas fuelled fuel cells) and the use of fuel cells in CCS applications, where an SOFC or MCFC fuel cell can provide low cost carbon capture (considered to be relevant beyond the 2025 study horizon).

Example natural gas fuelled phosphoric acid system housed in a Transport for London building. Two Molten Carbonate and one Phosphoric Acid systems are installed in London (from installer – Logan Energy)

Image of the AFC alkaline fuel cell being assembled at a chemical works in Stadt, Germany

1: International Energy Agency: *Combined Heat and Power: Evaluating the benefits of greater global investment*

Large scale fuel cell systems are achieving some early market traction, but fuel cells for these markets have little UK content

- The **gas fuelled CHP market** has achieved initial market traction:
  - 75MW of Molten Carbonate Fuel Cells were shipped in 2015 - Fuel Cell Energy made $130m of sales in 2016 for their 300kW+ range of MCFC systems
  - 24 MW of Phosphoric Acid fuel cells were shipped in 2015 – in recent months, Doosan have announced sales of over 100 products
  - In the US, Bloom Energy continues to sell 10's of "energy server" products in prime power mode
- All of these sales are based on technology developed and built outside the UK.
- The opportunity for the UK is in the benefits of technology deployment and potentially in the creation of inward investment opportunity
- By contrast, for the **hydrogen fuelled systems**, the UK has one of the global leaders in developing alkaline fuel cells (AFC) and could build a strength in this field
- However, the hydrogen fuelled market is less technically mature and is inevitably limited by the availability of low cost streams of hydrogen.
- To compensate for this issue, AFC are also developing other concepts linked to ammonia (as a fuel) and waste gasification with hydrogen clean-up.

TARGETS:

The targets for gas fuelled CHP depend on strategic decisions which will need to be taken during the roadmapping phase:

Deployment of gas fuelled CHP

- OPTION 1 – Large volume deployment (10's of MW per manufacturer) linked to inward investment in UK based large fuel cell manufacturing plant
- OPTION 2 – UK ready to receive the technology once it is commercialised elsewhere (i.e. to benefit from its application but not manufacture)

Commercialisation of hydrogen fuelled cells

- Reliable, affordable and long-life UK technology developed for sale to waste hydrogen markets by 2020

1: COGEN Europe / DELTA Energy & Environment: *The benefits of micro-CHP*
2: H2FCSUPERGEN: *THE ROLE OF HYDROGEN AND FUEL CELLS IN PROVIDING AFFORDABLE, SECURE LOW-CARBON HEAT*

Three large scale fuel cell CHP systems are operational in London (the largest installed capacity of an European city)

Crown Estate – Q3

- The crown estate in Regent's Street (~270,000 square feet) was equipped with a 300kWe molten carbonate fuel cell by Logan Energy
- Though installed by a UK company, parts came from within the UK and from Germany, the Netherlands and the USA[1]
- The system has low noise and pollution levels: less than 1 tonne of CO per year, less than 0.1 tonnes of No_x and around 65dbA of noise, along with availability above 95%

The New Building ('The Walkie-Talkie')

- A second molten carbonate system was installed in the New Building in Fenchurch Street
- In this location, the fuel cell CHP was evaluated as the best option to ensure compliance with London planning regulations requiring local generation
- The building developers estimate that the fuel cell system will reduce the CO_2 emissions of the building by a minimum of 270 tonnes per annum

The Palestra Building

- Logan installed a CHP system in Transport for London's Palestra building: a 200 kWe phosphoric acid fuel cell unit
- The system cost £2.4 million and cut an estimated 40% of CO_2 emissions, along with around £90,000 per annum in cost savings
- At peak energy use the CHP can generate 25% of the buildings power
- The Absorption chillers use the waste heat for the building's cooling system in summer

1: All Energy: *Stationary Power Fuel Cells A Case Study – Quadrant 3 for The Crown Estate*
2: Land Securities: *20 Fenchurch Street: Sustainability in an urban context*
3: Renewable Energy Focus: *Largest fuel cell in UK to generate greener energy at Transport for London*
Photos: PropertyEU (top), the Times (middle), CoStar UK (bottom)

The UK is not well represented within the supply chain for large gas fuelled systems

UK companies active and other UK activity in the sector

- **AFC Energy** is at the prototype stage of a large alkaline fuel cell system designed for waste hydrogen streams. The first 200kW unit has bene operational since early 2016. Manufacturing output is currently in the 100kW's per year (compared to the 10's of MW for the leading gas fired manufacturers).
- A number of system integrators have emerged – **Logan Energy** have installed the UK's existing PAFC and MCFC systems, **Fuel Cell Systems** and the joint venture **Doosan Babcock** are all preparing further integration activities
- UK has some supply chain activity via **Johnson Matthey** as well as speciality materials providers for molten carbonate stack manufacture
- Fuel cell activities at **Rolls Royce Fuel Cells** have mostly left the UK and are now carried out in the US and Korea.
- UK research institutes **St Andrews, Birmingham, Newcastle and Imperial** have research capabilities in specific aspects of these applications.

UK latent potential

- The UK's construction and engineering sectors are well placed to take up the challenge of fuel cell integration and deployment (Doosan Babcock is an early example of this)
- UK players in the generation space such as Rolls Royce, Aggreko, or specific utilities could become involved in wider technology deployment
- There is little manufacturing activity in this sector in Europe. A number of **companies are offering inward investment in production, in return for more secure markets**

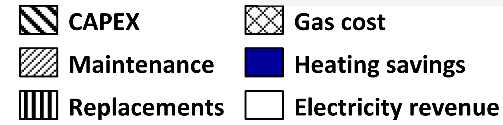
Measures to support the market

- No regrets measures include:
  - Ensuring fuel cells receive fair treatment in building and other relevant regulations
  - Ensuring that air quality guidelines for stationary power generation are either enforced or enhanced
  - Promoting fuel cell CHP as one of a number of valuable decentralised energy options as part of the continued push for decentralised energy

  There is a decision required as to whether it is worth supporting the market before a truly commercial product made outside the UK is made available. This will depend on the ability of technology promoters to make a watertight case for inward investment.
- The alkaline technology still needs to advance from TRL ~6 to a mature proven product. This can be supported via technology development programs and trials, which should aim at:
  - Proving reliability
  - Broadening the sources of hydrogen and associated syngases which can be used (improved purification, CO/CO_2 filtering etc.)
  - Ensuring cost potential can be achieved

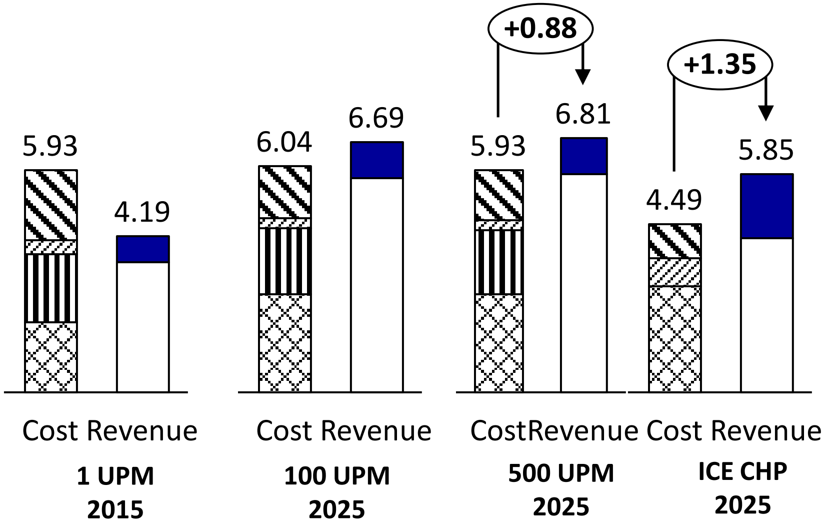
[1]Ceres Power
[2]Renewableenergyfocus.com

Ownership costs for today's gas fuelled technology means improvements in cost and efficiency are needed to compete with other options



- The analysis of the ownership costs illustrates that the high capital cost of today's fuel cell systems prevents competition with either a gas fuelled boiler, or alternative distributed generation options, such as Internal Combustion Engine (ICE) CHP on an unsubsidised basis
- Instead, today's systems compete where other options are not allowed due to regulation, in particular for urban locations which both require on-site power generation and are sensitive to the air pollution emitted from stationary generators (OR where subsidies exist (e.g. the US/Korea)
- Projected improvement in cost and efficiency can bring the technology to the point of competition with conventional boiler and grid based options. This is believed to require annual production of 100's of MW per year per manufacturer
- In addition, fuel cell systems are highly modular and larger installations benefit from economies of scale. For example, Fuel Cell Energy have deployed a fuel cell district heating system in South Korea consisting of 21 units generating a total 59 MW capacity – this may be another route for improving fuel cell cost effectiveness, though at higher scales, the incumbent also benefit from scaling advantages
- Finally, further improvements in efficiency are expected (e.g. some manufacturers are targeting over 60% efficient systems using hybrid cycles), it is conceivable that these fuel cell products could become viable for power only applications - these efficiency levels are comparable to best in class gas generators and have the advantage of generating locally and would generate close to the point of use helping alleviate grid constraints.

Lifetime Cost and Revenue for 400 kWe system[1] – Million GBP



Assumptions	1 UPM	100 UPM	500 UPM	Comb. Engine
CAPEX - £ / kWe	4,600	3,500	3,200	2,200
Efficiency (electrical, thermal)	46%, 35%	49%, 35%	50%, 35%	37%, 54%
Run hours	6000 per year			
Proportion of useful electricity and heat[2]	100%			
System life / years	17	18		15
Lifetime stack replacements	3			0

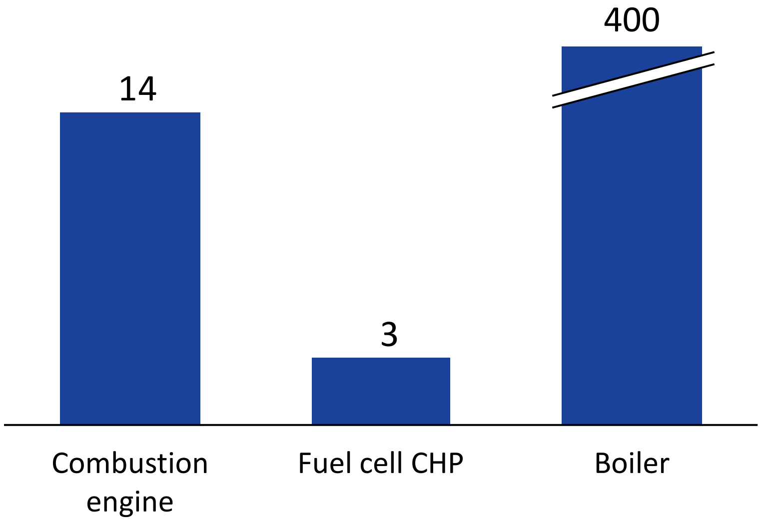
1 Based on Roland Berger: *Advancing Europe's energy systems: Stationary fuel cells in distributed generation*
2 Note: heating savings are based on the assumption that a gas-fuelled boiler would be generating this heat in the CHP system's place at an efficiency of 90%

Give fuelled FC CHP systems are likely to need create value from a number of benefits in order to secure early markets

Very low NO_x emissions and noise levels

- Poor air quality has been estimated by the WHO to cost European economies £1.1 trillion[1]
- Because fuel cells generate energy from natural gas via an electrochemical reaction, the electricity and heat generated produces **very low** concentrations of pollution such as NO_x and SO_x. Cogeneration via internal combustion creates significantly higher emissions of pollutants (see right)
- Hence large fuel cells can be an ideal option for use in crowded urban areas and public spaces
- Large fuel cell systems will benefit where local authorities require and enforce low air pollutant emissions from stationary power applications, as well as promoting local decentralised energy applications.

NO_x Emissions[3] - mg NO_x / kWh_{fuel}



Wider energy system benefits

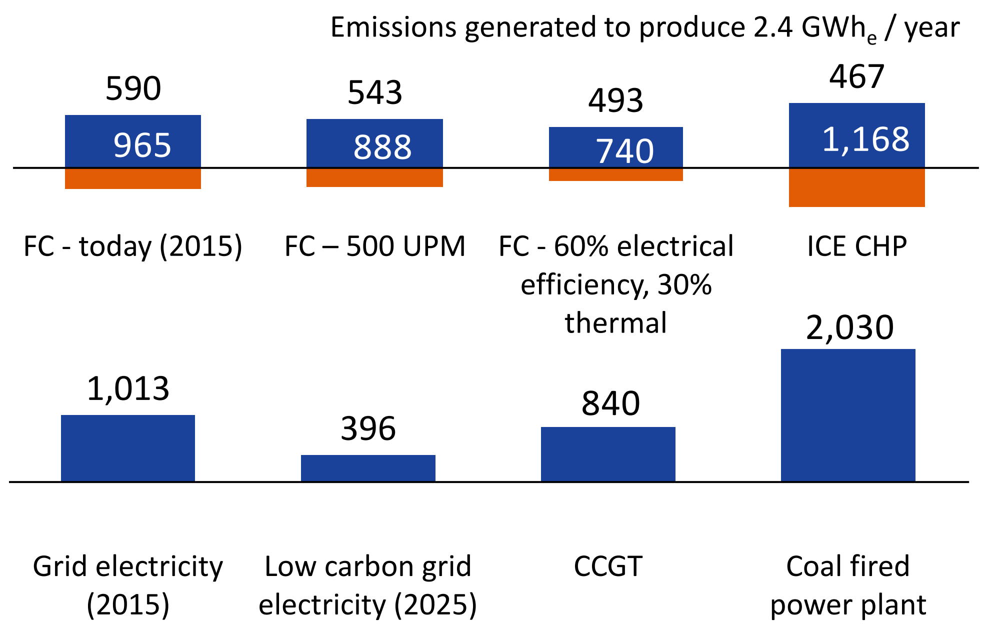
- The ability to deploy large capacity local generation in urban centres could reduce the extent of grid reinforcement required as pressures on urban grids grow from population rises and a shift to more electric appliances (e.g heat pumps, cars). The ability to generate locally will reduce the power flows through cities and avoid major infrastructure costs.
- At present, these benefits are not valued in the UK energy system either explicitly (via payments from distribution grid operators to generators) or indirectly through subsidies s paid to decentralised generators. Efforts to quantify and then monetise these benefits would greatly facilitate the case for the large gas fuelled fuel cells considered here.
- The gas fuelled fuel cells being developed to date can be readily converted to operate on hydrogen as a fuel and so can play a part in any medium term switch to the use of hydrogen in gas grids,

1: WHO: *Air pollution costs European economies US $1.6 trillion a year in diseases and deaths, new WHO study says*
2: FuelCell Energy, INC: *Combined Heat and Power Applications of Direct FuelCell® Powerplants*
3: Roland Berger: *Advancing Europe's energy systems: Stationary fuel cells in distributed generation*
4: National Grid Electricity Plc: *Special condition 2K.4 – Transmission Losses Report*

FC CHP has the potential to reach higher electrical efficiencies and unlock significant CO_2 emissions savings

- Compared to internal combustion engine CHP, today's FCs have comparable or better electrical efficiencies.
- Analysis indicates that with production on the scale of 500 units per manufacturer, fuel cell electrical efficiency could improve to 50%. which results in significantly lower emissions per unit electrical power produced by fuel cell systems (see right).
- This may be an underestimate: a number of companies are already developing or have developed fuel cell generators with electrical efficiencies pushing towards 60% (such as hybrid MCFCs in development by FCE[4], and SOFCs already developed by Bloom Energy, GE, FCE), which would provide enhanced further reductions
- DECC projections for grid carbon intensity suggest that by 2025 centralised generation could have emissions intensities of 165 g CO_2 e / kWh of electricity, which are lower than the expected emissions from any FC CHP
- However, achieving such a reduction in intensity will still require low carbon electricity generation from natural gas and the fuel cell CHP option will be one of the lowest carbon options for providing this power.
- This suggests fuel cell CHP using gas has a medium term potential to contribute to the UK energy system, with the long term benefit coming from using decarbonised gas.

Annual CO_2 emissions – tonnes of CO_2e / year



Assumptions:
Efficiencies: unless otherwise quoted are the same as slide 4
Heat generation savings: are measured relative to a gas fired boiler operating at 90% efficiency
Grid emissions intensities: are assumed to be 422 g CO_2 / kWh (Grid electricity (2015)) and 165 g CO_2 e / kWh (Low carbon grid electricity (2025))[1]
Power station emissions intensities: are assumed to be 846 g CO_2 e / kWh for a coal fired power station[2] and 350 g CO_2 e / kWh for a CCGT[3]

1: DECC: *Updated energy and emissions projections 2015*
2: UK Parliament: *Carbon footprint of electricity generation*
3: Mott MacDonald Ltd: *CCGT with CCS – integration options*
4: VTT: *Next-generation fuel cells are ready for low-emission electricity production*

The high cost of hydrogen in all but a limited number of hydrogen fuelled applications will also limit uptake

Analysis of the cost of energy from a large stationary fuel cell illustrates that there are three parameters affecting the viability of the hydrogen fuelled option:

- The cost of hydrogen
- The capital cost of the fuel cell stack
- The rate at which the stacks need to be replaced (i.e. stack lifetime)

Hence, for these applications to be viable in the near term, developers are searching for low cost hydrogen streams. These tend to occur at existing chemical works where hydrogen is produced as a bi-product (e,g. chlor-alkali plants). In these applications the thermal value of hydrogen is often valued (i.e. the ability to raise steam), which places a lower bound on the cost of the fuel.

Longer term, developers will require a larger market, which can come from other sources of hydrogen (e.g. waste gasification, natural gas reformation). Here, the value of hydrogen will be higher and this illustrates the challenge for creating a viable market for the technology.

Technology progress is expected with both volume (mainly for cost) and to a certain extent efficiency of these products….
More data on the expected technology trajectory is needed here

We would like to discuss cost data for hydrogen fuel cell CHP that could be shared by stakeholders

Specific barriers facing the gas fuelled large CHP options

Non financial barriers facing gas fuelled fuel cell CHP deployment (as opposed to manufacture) in the UK include:

A need for greater awareness – in the near term, the gas fuelled option is likely to be viable only in specific locations where planning permissions issues or specific air quality issues apply. This in turn implies that the awareness of the product with building professionals needs to be high (to ensure that when these opportunities exist, the fuel cell option is identified). At present awareness of the practical viability of fuel cells is limited to a limited number of building professionals.

More mature supply chain – knowledge of how to install, then maintain and operate a fuel cell is very limited within the UK. In practice only one firm has experience of installation and maintenance of fuel cells at this scale. This skills base will need to expand for the fuel cell CHP option to ensure competition (and hence progressively reduced costs) for operational and maintenance of large fuel cells in the UK.

Skills and training – linked to the point above, there are a limited number of individuals with the skills to install, maintain and operate a fuel cell CHP – this can create inefficiencies within the supply chain and also raise costs. Whilst the underlying skills are similar to those of a heating/electrical technician, there are specialist aspects which would benefit from more specialised training courses and skills development programs.

More stringent air quality regulations – the early market for fuel cell CHP deployment rests on non-financial aspects of the fuel cell. These include low noise, vibrations and in particular low emissions of local air pollutants. Current legislation in this area is relatively weak, but legislation (and enforcement) to encourage improved air quality in stationary generators, particularly in urban areas would be beneficial. Currently, outside air pollution limits are set by two European Directives. In 2011 nine UK cities broke their PM10 limits[1]. Hence there is a pressing need in these cities for more stringent and more effective air quality regulation – at present this is focussed on the trans[ort sector (the major contributor), but it can be expected that this will spread to buildings soon.

General need for continued decentralised energy promotion – the market for fuel cell CHP systems at this scale is dependent on the continued promotion of decentralised energy as a central component of UK energy policy. This will require continued commitment to district heating and building regulations promoting the use of CHP systems for larger buildings.

1: World Health Organisation: *Ambient (outdoor) air pollution in cities database 2014*

Specific barriers facing hydrogen fuel cells for stationary power

Non financial barriers facing hydrogen fuelled fuel cells for large stationary power (focussing on manufacture in the UK) include:

Alternative uses for hydrogen – whilst superficially, there is a considerable amount of hydrogen available as a "waste" stream in refineries and chemical works across Europe, much of this hydrogen is already in one way accounted for. The hydrogen is often required for meeting the heat balance in the chemical works, or for alternative chemical uses for hydrogen. Furthermore, if the automotive sector picks up, this hydrogen will be in high demand for automotive use (which has a higher value than those considered in the economics analysis above).

Purity of alternative options for hydrogen – in order to resolve the lack of hydrogen , hydrogen fuel cell developers are forced to look for alternative sources, such as the syngas derived from gasification of waste or reformation of methane. These sources typically do not have the levels of purity required for low temperature fuel cells (e.g. alkaline fuel cells require very low concentrations of carbon monoxide and carbon dioxide) – this implies techniques for low cost purification of hydrogen will be needed for these alterative sources to be viable for this application.

Technology maturity – the AFC Energy technology is currently undergoing field trials to prove the readiness of the technology. At present, this UK technology is being trialled at a 200kWe scale and has only recently achieved full power output. This implies considerable further testing and validation before the technology is ready for commercial sales (i.e. before reaching TRL 8 and above).

Competition from alternatives – In principle, all of the stationary fuel cell systems can be adapted to run on hydrogen as a fuel. This means that as soon as this market is proven with low temperature fuel cell systems, there will be competition from alternative and potentially more mature fuel cell options. To overcome this threat, any UK developed technology will need to prove that it has long term potential for very low cost of manufacture.

Overview of the deployment timeline, technology progress and possible actions for supporting this application

	2016-2020	2020-2025	2025 onwards
Global activities and deployment	100s of gas fuelled units deployed in US, Korea and Europe Limited deployment of large fuel cells systems for waste hydrogen	Increased market traction, as price decreases and efficiency improves Use of additional hydrogen sources increases market size for the hydrogen based products (e.g. gasification of waste)	Widespread deployment as an alternative to existing decentralised energy products
UK market development	Continued support for decentralised energy (of all types) via buildings, planning and district heating policies Very limited additional deployment of gas fuelled fuel cell CHP systems without further incentives	FC CHP competitive with other generators (but with improved CO_2 and air quality)	10's of fuel cell CHP systems installed each year in the UK *Installation of hydrogen fuelled units in the UK - subject to 100% H2 grids progress*
Technology progress	Incremental improvements in efficiency and lifetime for gas fuelled systems Commercialisation of alkaline fuel cell technology (demonstrated reliability cost and performance)	Increased efficiency means FC's increasingly used for large prime power generation., including possible link to CCS	
UK actions	Market preparation – support for training, ensure regulations are fair and promote awareness Discussions with gas fuelled CHP manufacturers about inward investment *Deployment support program (conditional on inward investments)* Technology development program for alkaline fuel cell Alkaline fuel cell commercial validation program	UK market established for fuel cell CHP as an alternative to combustion based generators Mature alkaline FC system ready for global export	

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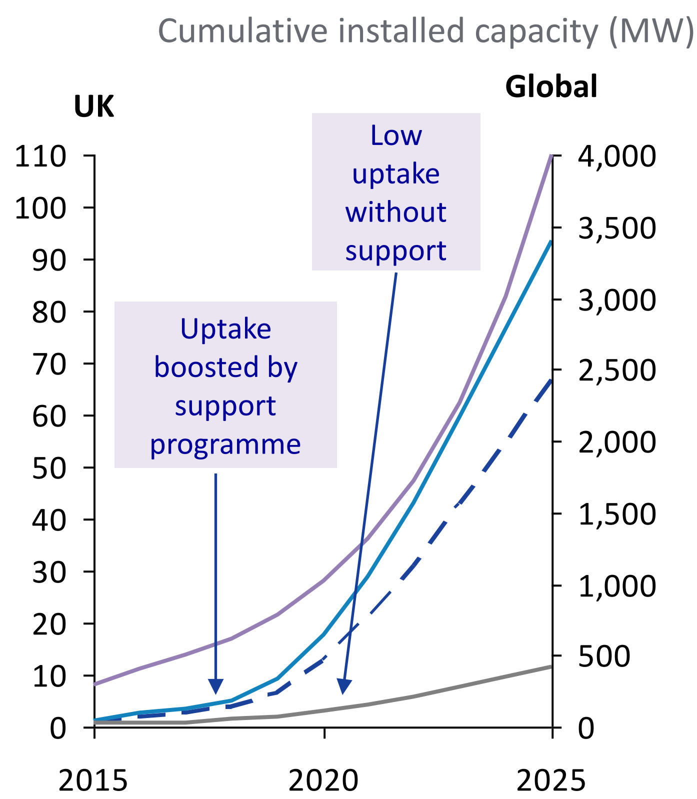
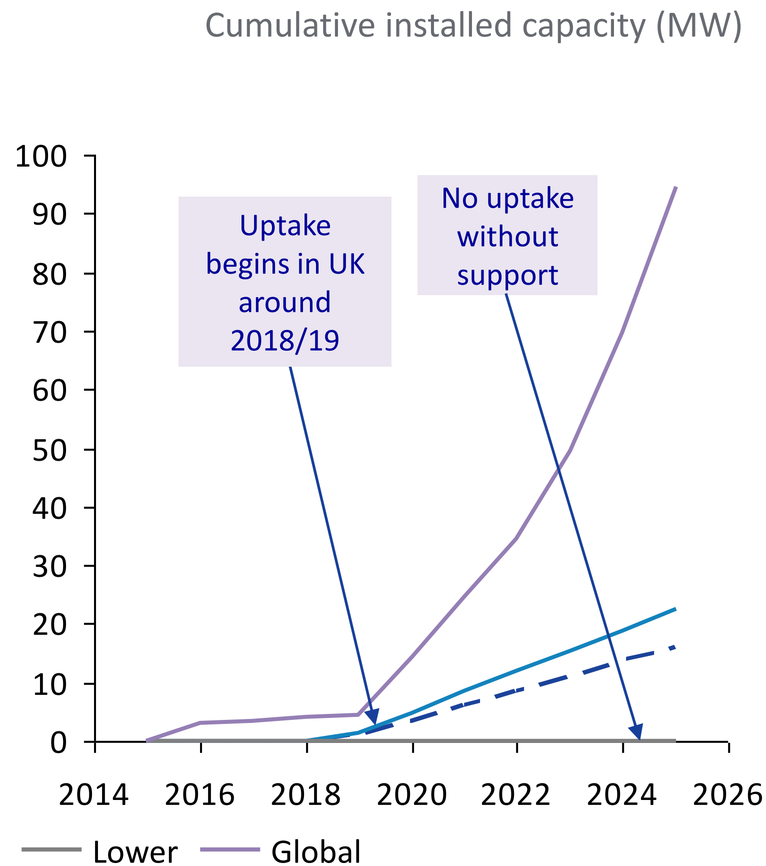
Under the right circumstances, there could be up to ~ 4 GW global installed capacity of fuel cell CHP by 2025

- The graphs below show indicative uptake projections, in the UK (with and without a support programme) and an estimate of global sales projections, based on expectations of the large supply companies

Natural gas fuelled



Hydrogen fuelled



1: COGEN Europe / DELTA Energy & Environment: *The benefits of micro-CHP*

UK deployment of fuel cell CHP may be highly sensitive to the actions previously outlined

<table>
<tr><th rowspan="2">Scenario</th><th rowspan="2">Actions</th><th colspan="3">Installed capacity (MW)</th></tr>
<tr><th>2015</th><th>2020</th><th>2025</th></tr>
<tr><td>High</td><td>Additional actions
• Commitment to UK manufacture from one of more leading gas fuelled technology developer
• New support scheme for large fuel cells, linked to power generation e.g. a feed-in tariff (10’s of MW of capacity needed)
• Very favourable market conditions attracting foreign players to invest in local supply chains
• Enhanced R&D support leading to numerous competitive UK products in the large gas fuelled and hydrogen space</td><td></td><td>30(NG)
3 (H_2)</td><td>200 (NG)
10 (H_2)</td></tr>
<tr><td>Central</td><td>Assumed actions
• Preparation for deployment: training of installers and maintenance professionals
• Development of regulatory framework to allow the monetisation of the use of fuel cell generators to support electricity distribution grids
• Encouraging strict air quality regulations for decentralised energy and heating appliances for building
• Continued support for decentralised energy generally
• R&D and commercial validation programmes for fuel cells aiming at waste hydrogen streams</td><td>1 (NG)</td><td>5 (NG)
1.5 (H_2)</td><td>50 (NG)
5 (H_2)</td></tr>
<tr><td>Low</td><td>Conditions for achieving the low scenario
• No additional action</td><td></td><td>3 (NG)
0 (H_2)</td><td>10 (gas)
0 (H_2)</td></tr>
</table>

What is the UK benefit from reaching the aim in 2025?

UK Market Size

	Gas fuelled CHP (cumulative)	Notes
Global addressable market	Up to ~ 4,000 MW installed capacity	Total market capacity based on growth rates expected for 4-5 largest players
Global addressable market value	~£7 billion	
UK share of tradable global market	Up to 2%	Assuming a limited competitive advantage due to lack of activity to date
Potential value to the UK economy (GVA)	Up to ~£42 million around 10% of which is from within the UK	Assuming 50% of sales displace existing economic activity
Potential UK job creation	100's	

Note: Consultation has indicated that locally favourable market conditions could incentivise technology suppliers to consider local manufacture of units, and the development of local supply chains, which has the potential to enhance the UK GVA