Comments from REDACTED REDACTED, REDACTED, Cambridge Carbon Capture Ltd. Formerly: CTO CMR Fuel Cells plc; head energy consulting Sagentia plc; technical & business expertise in fuel cells

To achieve a low-carbon electricity supply in the UK based on natural gas, DECC should consider mechanisms to promote power generation via fuel cell systems, particularly for distributed power. High-reliability, large fuel cell systems are commercially available to convert natural gas to electricity at higher efficiency than turbines; generate less CO2/kWh; inherently produce pure 100% CO2 as exhaust; some system types can generate high-grade combined heat (and cooling) without compromising efficiency; some system types can produce solid carbonate minerals instead of CO2 and release additional 10% electricity:

Virtually all types of commercial fuel cell system can operate on natural gas (either as a direct feed of natural gas, as in high-temperature SOFC & MCFC, or via a reformer system providing pure H2 to low temperature PEM & AFC types of fuel cell). Depending on specific designs, fuel cell systems (including reformer system) do not allow fuel or air to mix within the system and therefore typically exhaust separate streams of pure CO2 and depleted air. Fuel cell systems therefore provide inherent CO2 capture with no additional equipment, cost or energy penalty.
Fuel cell systems provide a very high efficiency electrochemical route to conversion of natural gas to electricity, typically higher than any thermal combustion system. They are therefore cheaper to operate than gas turbines and produce less CO2 per MWh.

Despite common perceptions, series-manufactured 200kWe up to multi-MWe-scale commercial fuel cell systems are available, sold, installed, warranted and operated around the world without any subsidy. There is a significant global market (>£1billion) currently for such systems. The main commercial driver for customers to purchase such distributed power systems is that lifetime operating costs are lower than conventional thermal power generation systems.

Capital costs of fuel cell systems have reduced hugely over recent years as technology has matured and manufacturing volumes increase. Long-term fuel cells system cost reduction learning curves are very similar to those measured for photovoltaic modules - cost per kW decreases by ~22% for every doubling of kW volume. As fuel cell systems are modular, this cost reduction curve applies across the power range of applications. Current capital costs are not much higher than for conventional thermal generator systems and the learning curve shows that capital costs will certainly decline below those of competing thermal power generation systems once kW sales volumes are high enough.

Suitable high-reliability, cost-effective and market-proven fuel cells systems are available commercially over a wide range of power scales from many manufacturers around the world. UK industry (& academia) has world-class expertise & know how in the fuel cell supply chain, it has a very small number of fuel cell installer companies and a very small number of FC system manufacturers - development of a market for natural-gas fueled stationary FC power systems would inevitably initially be serviced by the major EU, US and Asian system manufacturers, but there would be excellent scope for UK jobs & industry growth in this sector.

While capex costs of large fuel cell systems remain higher than gas turbine based power gen systems, and market knowledge and experience remains very low, a barrier will remain to implementation and market adoption of FC power generation systems. DECC will need to address this market failure with appropriate policy instruments if it wishes to see the UK take advantage of the CO2, efficiency and cost benefits of fuel cell systems.

My own company, Cambridge Carbon Capture Ltd, has additionally developed technology that enables fuel cell systems to generate ~10% additional electricity from the further exothermic reaction of CO2 to solid carbonate. This enables a profitable point-source distributed solution to CO2 sequestration with the materials output of the process going into low carbon construction materials. It is one example of what a shift to electrochemical-based power conversion could enable.

We would strongly recommend a competetive international tender to build and operate, say, 500MWe of distributed natural gas fuel cell power generation systems in the UK with >90% pure CO2 exhaust (i.e. sequestration ready).

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Cambridge Carbon Capture Ltd
Hauser Forum, Charles Babbage Road,
Cambridge, CB3 0GT, UK
Tel: REDACTED
Email: REDACTED
www.cacaca.co.uk