

Renewable Energy Strategy Consultation Fuel Cells UK Response

1. Introduction

This paper represents the response from Fuel Cells UK to the Government's Renewable Energy Strategy Consultation. Fuel Cells UK is the UK trade association for the fuel cell sector and represents leading UK fuel cell companies as well as organisations from the academic community and other stakeholders with an interest in fuel cell technology and the associated elements of the supply chain.

This response has been produced through consultation with our members and presents the Association's responses to those questions in the consultation of most relevance to our members.

A list of our members is shown in Annex A.

2. Fuel Cells UK's response to selected questions

2.1 Chapter 2 – Saving Energy

Question 3: In light of the EU renewable energy target, where should we focus further action on energy efficiency and what, if any, additional policies or measures would deliver the most cost-effective savings?

A comprehensive package of energy efficiency measures should encompass support for both conventional techniques, such as cavity wall insulation, and innovative approaches, such as more efficient power generation.

Fuel cells in Combined Heat and Power (CHP) applications are an excellent example of highly efficient power generation, which can be adopted for a variety of situations, ranging from domestic to community scale, and encompassing industrial, commercial and public sector power needs. Fuel cell CHP units offer efficiencies of 80%–90%, compared to ~35% for conventional generation. In other applications, non-CHP fuel cell installations (e.g 1MW plus fuel cell units, with 60% to 70% electrical efficiencies) also compare well with conventional generation, especially when located in sensitive urban areas as part of a distributed generation / energy network.

It is important to note that any improvement in the efficiency of the UK's energy infrastructure will have a direct, positive impact on the ability of the UK to meet its EU renewable energy targets, since a reduction in overall energy consumption will result in a relative increase in the proportion of energy supplied by renewable sources, even if actual renewable output remained constant.

Recent research, supported by BERR, has indicated that if adequate support is provided, fuel cells could help cut CO₂ emission by 5% in the future and provide 18% of the UK's energy demands through microgeneration alone. The use of financial support mechanisms, such as feed-in tariffs, is vital if the benefits of low carbon technologies are to be realised. Whilst feed-in tariffs offer particular benefits for small scale generation, larger, commercial installations would also be stimulated by this type of support. Fuel Cells UK believes that the most suitable and cost effective approach to promoting the uptake of energy efficient technologies would be to set a limit of 10MW on feed-in tariffs, such that all low carbon generating capacities below this would be eligible for support under a feed-in tariff scheme, with higher capacities being covered by the existing Renewables Obligation. This would represent a similar approach to that adopted elsewhere in Europe, particularly under the German EEG system. Our position on microgeneration is discussed in greater detail in our response to Question 20.

Another key area where fuel cells offer significant benefits is in transport. In 2004, 27% of CO₂ emissions were produced by the transport sector. Results from a full lifecycle

analysis, comparing CO₂ emissions from a traditional petrol internal combustion engine, with CO₂ emissions from a hydrogen powered fuel cell vehicle, show that the internal combustion engine accounts for 167g/km, while the fuel cell system produces from 0g/km (when fuelled by renewably generated hydrogen) to 85g/km (when fuelled by hydrogen generated using fossil fuels) (Source: Well-to-Wheels analysis of future automotive fuels and powertrains in the European context, Well-to-wheels Report version 2b, May 2006).

An important support mechanism for the introduction of low carbon vehicles is the formal adoption of Forward Commitment Procurement (FCP) to help provide greater security in the market and a guaranteed demand for products to justify the scale up needed to drive costs down and make new emerging energy technologies, such as fuel cells, commercially viable. This issue is discussed in greater detail in response to Questions 24-26.

2.2 Chapter 3 – Centralised Electricity

Question 8: Taking into account decisions already taken on the offshore transmission regime and the measures set out in the Transmission Access Review, what more could the Government or other parties do to reduce the constraints on renewable development arising from grid issues?

Energy storage technologies have a key role to play here. The issues associated with grid constraints are arguably one of the largest challenges posed by renewable energy expansion. Fuel cell systems, in combination with electrolysis (to convert electricity to hydrogen) and hydrogen storage, can help to overcome grid constraints by managing and smoothing power outputs, reducing frequency and voltage fluctuations that might otherwise overload the grid, and allow a greater amount of power to be fed into the grid than would be possible without this control, thus deferring capital investment in new infrastructure. Alternatively, the benefits of this strategy could be strengthened if fuel cell systems were linked to other promising storage technologies, notably NaS batteries. See also our answer to Question 12.

When considering issues such as this, it is important to recognise the potential future congruity between stationary power and transport. As fuel cell powered vehicles become commercially available, use of renewably generated hydrogen has strong prospects of providing competitive CO₂ reductions.

Question 12: What (if any) changes are needed to the current electricity market regime to ensure that the proposed increase in renewables generation does not undermine security of electricity supplies, and how can greater flexibility and responsiveness be encouraged in the demand side?

The need for changes to the current market regime will be minimised through the adoption of energy storage technologies to operate alongside new large scale renewable generators. Fuel cell systems coupled with other storage systems can address two important issues here - the specific ability to store energy (to cope with intermittent production) and, as discussed in our response to Question 8, the ability to manage and deliver power (both to help overcome grid constraints and to control power output to prevent power generators dropping offline or overloading the grid infrastructure).

Energy Storage: Fuel cells, in partnership with electrolyzers and hydrogen storage systems, can help to address situations when electricity production from renewables exceeds demand, using excess electricity to produce hydrogen, which can be stored and then used in a fuel cell to meet demand for either stationary power or motive power for a fuel cell powered vehicle.

Storage, in combination with fuel cells, can also be used to assist with peak shaving when demand is high and renewable electricity production is insufficient to meet demand. In addition to increasing the reliability of supply, this negates the need for traditional spinning or standing reserve, which tend to be either open gas turbine generators, or fossil fuel power plants that are used as back-up to provide emergency power at peak times. This traditional approach has negative implications both in terms of carbon emissions and the renewable energy challenge.

Power Management: Power outputs and loads associated with some renewable energy projects, particularly those based on wind, can create problems for the grid since they can create significant fluctuations in frequency, either overloading the system if frequencies are too high or dropping off the grid if frequencies are too low. Managing this output with a fuel cell / battery hybrid system will smooth power outputs, reducing thermal loads, voltage variation, frequency variation and fault currents, so allowing the same cables to carry more power without the need to upgrade. Such combined fuel cell and storage systems would be particularly attractive in a distributed generation scenario where power demand can fluctuate substantially.

An example of a working fuel cell installation in this type of application is the PURE Project on Unst in the Shetland Islands. The system consists of two 15kW wind turbines, a high pressure hydrogen electrolyser, high pressure hydrogen storage device and a fuel cell. An inverter is used to convert the DC output from the fuel cell into AC which provides power and heating for five businesses on the island. The stored hydrogen is also used to power fuel cell / battery hybrid vehicles.

2.3 Chapter 5 – Distributed Energy

Question 19: do you agree with our analysis of the mechanisms for support of small-scale renewable electricity?

As our answer to Question 20 highlights, support across the full range of low carbon generation technologies offers the best way forward to the achievement of carbon reduction policy objectives. Demonstration programmes and forward commitment initiatives (see Questions 24-26) are key mechanisms which will help ensure that technologies such as fuel cells (see Questions 3 and 20 for more details on the specific benefits of fuel cells) deliver against their potential. We support the introduction of feed-in tariffs for all low carbon technologies up to 10MW (see Question 3).

Question 20: Given the analysis on the benefits, costs and potential, in what way and to what extent should we direct support to microgeneration electricity?

Microgeneration is an area which numerous studies have shown offers significant benefits in terms of carbon savings and energy security. Analysis has demonstrated that the introduction of greater financial support would lead to increased uptake of a wide range of microgeneration technologies, including fuel cells, biomass, solar PV, wind and stirling engines. This uptake could contribute to a reduction in CO₂ levels of up to 30Mt by 2030, (equivalent to 5% cut in total 2006 emissions or an 8% reduction on the 1990 levels set out in the Kyoto Protocol), with much of the savings delivered through currently immature technologies. Some estimates have predicted that fuel cell installations alone could provide a 5% reduction in CO₂ emissions by 2050, more than any other microgeneration technology looked at in isolation.

The way in which financial support is designed and targeted will be critical if these benefits are to be realised. While some renewable microgeneration technologies are eligible for support under the Renewables Obligation, low carbon technologies are not and a recent report, commissioned by BERR and conducted by Element Energy, concluded that international experience suggests that the introduction of feed-in tariffs for the full range of microgeneration technologies would have a “genuine impact on

Fuel Cells UK Renewable Energy Strategy Consultation

reducing CO₂ emissions". A key issue for microgeneration is the fact that the administrative burden associated with households registering under the Renewables Obligation to issue Renewables Obligation Certificates and then seeking a buyer and negotiating a price is seen as a major disincentive. Comparatively, feed-in tariffs offer a far simpler and more cost reliable incentive.

A recent study by the Energy Saving Trust analysed how the growth of various microgeneration technologies would be impacted by the introduction of feed-in tariffs and how different technologies compared in terms of CO₂ reductions and electricity supply. The findings suggested that, by 2050, more than 18% of the UK's electricity demands could be met by fuel cells, providing a 5.5% reduction in CO₂ emissions. This is significantly more than contributions from the other technologies modelled, including micro-wind, biomass and solar PV.

The introduction of feed-in tariffs is critical if these benefits are to be realised. Systems need to be developed to allow householders and businesses who have installed these technologies to feed the excess energy they produce back to the grid and be recompensed at levels sufficient to accelerate the commercialisation of technologies which can offer a significant contribution to carbon reduction, such as fuel cells. This is particularly the case for new technologies in larger residential systems, which, without feed-in tariffs, would not be financially viable due to the quantity of electricity produced being greater than the usage of the average household. Work by Elemental Energy concluded that it is these types of system that offer the greatest environmental benefit and potential carbon savings. Furthermore, feed-in tariffs should apply to all power produced by eligible generators in households and businesses not simply that which is exported (see Annex 2).

Question 21: If you agree that better information will aid the development of distributed energy, where should attention be focused?

The two key areas of focus are:

- Development of standards
- Awareness raising activities.

Progress in these two areas will work towards addressing barriers in industry (.e.g through the development of industry wide standards for installation) and public perception (through awareness raising activities). Work needs to be progressed on both fronts if deployment of low carbon microgeneration technologies is to be accelerated and benefits realised.

2.4 Chapter 6 – Transport

Question 24: How can we best incentivise renewable and low-carbon transport in a sustainable and cost-effective way?

Question 25: What potential is there for the introduction of vehicles powered through the electricity grid in the UK? What impact would the widespread introduction of these kinds of vehicles have on:

- a) Energy demand and carbon emissions***
- b) Providing distributed storage capacity***
- c) Smoothing the levels of electricity demanded in the grid?***

What factors would affect the scale and timing of these impacts?

Question 26: Over what timescale do you think electric vehicles could plausibly contribute to our renewable energy and carbon reduction targets and what could the Government most effectively do to accelerate the introduction of such vehicles in the UK?

We are disappointed to see such little reference to fuel cell powered vehicles in this section. Fuel cells can deliver the full range of benefits described for electric vehicles at ranges which far exceed those of the best battery technologies available (See Larry Burns' comments on Chevrolet Volt versus fuel cell cars at General Motors):

- They produce considerably less CO₂ than conventional petrol or diesel fuelled vehicles, even if the hydrogen is produced from electrolyzers based on today's electricity mix.
- Fuel cell powered vehicles are generally seen as the ultimate low carbon vehicle technology across the range of road vehicle types (cars, buses, vans etc.)
- Hydrogen can be produced directly from a wide range of zero carbon sources such as biomass (at a much lower carbon footprint than second generation biodiesel), nuclear or solar (directly from the heat, not via electricity) as well as from conventional fossil fuels and via electrolysis.
- Greater use of fuel cell powered vehicles could potentially improve the efficiency of the operation of the grid by smoothing the differential between supply and demand of renewable energy. Here, fuel cell powered vehicles have the advantage over electric vehicles in that they could be refuelled at any time, with the energy stored as hydrogen prior to use. Thus, it would not be necessary to adjust fuelling times to directly link these to periods where supply exceeds demand (which is difficult to envisage as a realistic way forward on a sufficiently large scale).
- Through the use of hydrogen as an energy store (with excess electricity converted to hydrogen via electrolysis), fuel cell vehicles can help to mitigate intermittency issues around renewables, thus allowing a greater proportion of renewables to be accommodated. As above, the use of hydrogen as the energy store would provide greater flexibility and avoid the need for the fuelling of vehicles to be linked to patterns of power supply and demand.
- Fuel cell vehicles (powered via hydrogen) could contribute to the 10% renewable transport target.

Furthermore, fuel cell vehicles offer much greater range than electric vehicles, making them more acceptable for the variety to trips typically undertaken in cars in the UK. Even as an intermediate step to full deployment, the use of fuel cells as a range extender for electric vehicles can have a profound impact on their 'usability' and operational flexibility in meeting daily duty cycles, lifting the range of a conventional electric vehicle from around 100km to around 300km between charges. Fuel cell technology is also suitable for the full range of road vehicle types, bringing benefits of zero carbon (when fuelled by renewably generated hydrogen), as well as low noise across the full vehicle fleet.

In contrast to recent media reports, our members' programmes with customers confirm that commercialisation of fuel cell vehicles is actually now underway, with major OEMs moving their fuel cell programmes from research to product development phases, and with large investments being made in real vehicle development. Initial fleet demonstrations are underway and commercial launch plans have been announced: Daimler, General Motors, Honda, Nissan, Hyundai and Toyota each have programmes aimed at commercial launch of tens of thousands of fuel cell vehicles by 2015.

UK support to date has critically allowed UK companies to participate in fuel cell development programmes and to maintain expertise in this technology, both at a component and at stack level. Further measures to encourage deployment and market pull are now urgently required to stimulate OEM suppliers to include the UK in vehicle trials, building on the UK's technology lead in this field. The challenges in achieving this tend to be more around economics and refuelling infrastructure policy than technology development, and there are measures that could be adopted to speed up the process.

Fuel Cells UK Renewable Energy Strategy Consultation

We are extremely disappointed in the approach taken thus far in this regard in the UK. DfT policies in this area currently contribute little to achieving these critical goals. Fuel cell commercialisation is underway and could start to deliver meaningful benefits to the UK's carbon emissions from 2015. This opportunity will be lost (both in terms of carbon emissions and of the current technology lead from the UK fuel cell industry) without the development of an appropriate framework to stimulate deployment.

In addition, a well designed package of continued support from Research and Development (R&D) through to demonstration and market entry continues to be vital to delivering a low carbon future involving UK suppliers and UK produced vehicles (such as taxis or buses) more quickly than it would otherwise occur.

Demonstration programmes are an essential tool to accelerate the development of emerging energy technologies and solutions, including fuel cell vehicles. They offer benefits both in terms of product development and investor confidence, as well as assisting with the creation of supply chains and reduction of production costs.

Fuel Cells UK welcomed the launch of the Government's Hydrogen and Fuel Cell Carbon Abatement Technology (HFCCAT) programme in 2006. The 2nd Call under the Programme has been eagerly awaited since early 2008, with companies keen to take advantage of the opportunity to demonstrate and progress their technologies to a point where they can provide cost-effective solutions to the many challenges facing the UK – climate change, energy security, fuel poverty etc.

We recommend that the Government moves forward with the 2nd and 3rd Calls under the Demonstration Programme without delay. The UK fuel cell industry is extremely well placed to become an important contributor to the UK's economy and new energy mix in the near term. At this critical stage in the industry's evolution, Government support can make a material difference in retaining and growing this nascent industry and its supply chain.

Furthermore, if the benefits of such investment are to be realised and progress capitalised upon, it is crucial that there is a longer term commitment by the UK Government to provide support beyond the initial timescale for this programme. This will help engender confidence in the industry and encourage investment in technologies and infrastructure. It is vital that such support is well designed and tailored to the needs of the industry, and that it dove-tails with support both further up and further down the innovation chain. The Government should learn from successful programmes and strategies adopted overseas.

As fuel cell vehicles continue along their commercialisation path, measures are needed to help accelerate products to market that have proven themselves at demonstration level and need support entering a market, saturated with inefficient, carbon heavy, but low cost established energy technologies. We believe that Forward Commitment Procurement (FCP) represents an extremely effective and low cost method by which to achieve this. FCP is essentially a tool to manage risk more effectively; it creates a guaranteed demand and a degree of certainty in the market that, in essence, underwrites some of the risk for developers and investors, giving them the confidence to scale up production and commit to the intensive product development needed to deliver a product with the right performance at the right price.

The approach has been proven to accelerate development, and is applicable in both the private and public sectors. In the private sector, it can be a way of organisations gaining a competitive edge, acquiring future technology before others in the market. Whilst the same is true for the public sector, there is the added benefit of realising policy goals and accelerating the advancement of technologies that offer social, environmental and economic benefits.

In the public sector, FCP is a process which involves public bodies making a commitment to purchase a product that is not yet commercially available, provided that the product meets some predefined specification. The Environmental Innovations Advisory Group (EIAG), a joint Defra / BERR initiative recognised that forward commitments by public sector procurers offer a powerful mechanism to accelerate the delivery of innovative solutions and policy objectives and provides a clear signal to the developer about what the market wants and what price it is prepared to pay. The result is a win-win situation for both parties, with market certainty for the developer and low cost innovative solutions for Government.

Fuel Cells UK recommends that the Government facilitates the development of a suite of Forward Commitment Programmes to support fuel cells in transport and stationary (see Question 36) applications, thus helping to accelerate commercialisation and bring forward the associated policy benefits.

2.5 Chapter 8 – Innovation

Question 35: How can we adapt the Renewables Obligation to ensure that it effectively supports emerging as well as existing renewable technologies? Are there more effective ways of achieving this?

We support the introduction of a feed-in tariff scheme for all low carbon generation capacities below 10MW, with the Renewables Obligation applying at higher capacities (see Question 3).

Question 36: Is there evidence that specific emerging renewable and associated technologies are not receiving an appropriate form of support?

As highlighted above, fuel cells in both stationary and transport applications have a key role to play in delivering carbon reduction and supporting the development of renewables. This notwithstanding, historically support from the UK Government has been poor relative to other countries. Whilst recent developments, such as the Hydrogen, Fuel Cell and Carbon Abatement Technology Demonstration Programme (which covers the range of fuel cell applications) and funding from the Technology Strategy Board, have provided welcome steps in the right direction, the need remains for a comprehensive and long-term package of support along the innovation chain. Two areas of particular importance are:

- Large scale demonstration activity; and
- Market pull measures to support the move to commercialisation – specifically forward commitment procurement

The application of these mechanisms in the fuel cell sector is discussed under Question 26. The arguments presented there apply equally to stationary fuel cells in both small and large scale applications.

Question 37: Are there barriers to the development of renewable and associated technologies that are not addressed by current or proposed support mechanisms?

Our answers to earlier questions have highlighted the need to consider the full range of low carbon technologies, not just renewables, if policy objectives around carbon reduction are to be realised as efficiently and effectively as possible. They have also highlighted the importance of a comprehensive suite of support mechanisms which encompass the full innovation chain, including support for demonstration activity, feed-in tariffs applied to all low carbon technologies which can help to deliver policy objectives and forward commitment initiatives.

Fuel Cells UK Renewable Energy Strategy Consultation

Whilst, in theory, there is an increasing range of funding support mechanisms available for energy technology development (as outlined in figure 8.1 of the Consultation Document), there is concern that poor communication between bodies and lack of clear definition of objectives and purpose may lead to confusion. It is vital that, if these programmes are to deliver, their objectives are clearly defined and there is a system for communication to prevent either duplication of work, or gaps in funding developing.

Another key requirement is long term strategies encompassing both funding commitments and regulatory instruments. Uncertainty over future policy direction and financial support risks creating a lack of confidence in the investor community. With strong support available elsewhere (USA, Germany, Japan etc.), investment and technology developers are already focussing on other markets in many applications.

If the UK is to meet its commitments to reducing carbon and addressing the challenges faced by climate change there needs to be firm and sustained commitment to both renewable and non-renewable low carbon technologies.

2.6 Chapter 11 – Delivering the target

Question 41: Do you agree with our overall approach to developing a UK Renewable Energy Strategy?

Although the Government's approach to developing a UK Renewable Energy Strategy is laudable, we believe that it fails to address certain key areas and issues that will be essential if the UK is to meet its economic and environmental policy objectives, decouple economic growth from climate change and move towards a low carbon economy efficiently and cost effectively.

Whilst there is clearly a need for strong support for renewable energy technologies, it is widely acknowledged that many are costly and at an early stage of development. Furthermore, some may not make a meaningful contribution even with Government support to help accelerate commercialisation. It is critical that Government recognises that achieving the legal requirements for renewable energy growth and a degree of energy security and carbon and other harmful emissions reductions will only be realised through a strategy which embraces the urgent introduction of the full range of low carbon technologies as well as renewables.

Fuel cells are unique in their flexibility of application and efficiency, and are proven to reduce carbon emissions substantially in a range of applications, from transport to microgeneration.

They also offer significant benefits in terms of energy security, and can be powered using a wide range of fuels, from waste ammonia to natural gas and hydrogen.

Furthermore, as the UK moves towards greater adoption of renewable energy, there will be a strong demand for energy storage and power management solutions to tackle challenges associated with the intermittent nature of some renewables and constraints associated with the electricity grid. Fuel cells are perfectly placed to answer these challenges.

Fuel cells have a key role to play in the future energy landscape, whether this be in terms of minimising carbon emissions, increasing energy security and / or managing and delivering renewable power.

The Government must make moving towards a low carbon economy a key objective. If the UK is to realise its obligations to reducing carbon emissions a clear commitment must be made to support the full range of low carbon technologies.

**Fuel Cells UK
Renewable Energy Strategy Consultation**

Annex A

Our members are:

Acal Energy
AFC Energy
Bac 2
Baxi
British Midlands
Linde Group / BOC
Calor Gas
Cenex
Ceramic Fuel Cells
Ceres Power
City University
Diverse Energy

E.On
Flexitallic
The Centre for Process Innovation
Intelligent Energy
Johnson Matthey
LOGAN Energy
Philip Sharman
QinetiQ
Rolls-Royce Fuel Cells Systems
Unitec Ceramics
University of Birmingham
Valeswood