Ofgem Project TransmiT Consultation
UK Hydrogen and Fuel Cell Association Response
Tuesday, 16 November 2010

This paper represents the response from UK Hydrogen and Fuel Cell Association to the Ofgem's Project TransmiT Call for Evidence. UK Hydrogen and Fuel Cell Association aims to accelerate the commercialization of fuel cell and hydrogen energy technologies. It represents leading UK hydrogen and fuel cell companies as well as organisations from the academic community and other stakeholders with an interest in these clean energy solutions 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 aspects of the consultation of most relevance to our members. A list of our members is shown in Annex A.

Whilst we are not directly concerned with electricity and gas infrastructure charging regimes, we do wish to draw specific attention to the needs of the future energy and technology mix, in areas which both support and challenge the current status quo.

The submission stresses the enabling role we see Ofgem performing. We are particularly concerned that Ofgem does not in any way disable the potential for hydrogen to play an important role in the UK's future energy mix. We would welcome further consultation in respect of technical and access issues regarding infrastructure and energy markets because they are important in realising the potential for hydrogen and fuel cells in the UK.

- **We accept that the future electricity, heat and transport demand in the UK will be de-carbonised.**

  The Committee on Climate Change has recommended that, in order to establish the right trajectory towards the statutory 80% reduction in UK emissions by 2050, the power sector will need to be largely decarbonised by 2030. We assume this will comprise a mix of renewable energy, nuclear and fossil fuel power and CHP plants equipped with carbon capture and storage. The Office for Carbon Capture & Storage has estimated the need to build upwards of 40GW capacity of fossil power equipped with Carbon Capture and Storage (CCS) to be fully on stream within the 2030s.

  We also note that industry has diverse ways of using fossil fuels and, to maintain and develop the UK's industrial base, they will require either substitute energy vectors, changed processes, or post combustion CCS. We support low cost CCS in various forms as it can provide negative emissions through use of biomass.

- **Adequate CO_2 value needs to recognised to enable de-carbonisation**

  The UK has been a consistent supporter of market forces establishing a CO_2 cost per tonne with the EU ETS. Whilst as businesses we support a transparent market, it is now generally recognised that the distortions by national interests has given a weak cap and does not, and will not - until at least the 2020's - produce a market price in line with the social cost of green house gas emissions. Indeed, Europe may require a boarder duty on embodied carbon coming into the EU, and a duty rebate on low embodied CO_2 products leaving the EU, to ensure there are no carbon leakages and there is a level playing field for our globally competitive industries.

  The UK Government is currently considering a floor price for CO_2 and an emission performance standard, as they are obviously concerned that the right signals are given in the UK sooner rather than later. Generally, simple mandating and banning current emissions does not seem to be considered, as the new technologies have not reached scale economies and achieved a simple competitive advantage with fossil fuel use.

  The approaching choices about reforming the electricity market and valuing green-house gases will determine whether they either enable new growth and UK competitiveness, or there is continued taxation of industry and consumers to add to general revenue.

- **A reformed electricity market and adequate CO_2 value will provide hydrogen that is a competitive energy vector.**

  Renewable energy in off-grid locations is already an attractive electrical source for charging small electrical storage and for conversion and storage as hydrogen for transport and heat.

  We see some transfer of this to grid applications. As the penetration of intermittent renewables increases, and if the scale of base load nuclear power increases, we foresee sector shifting of electrical energy to heat and transport, with hydrogen as an important step in that process.

  The most large-scale and-cost effective shift we see is that arising from the application of pre-combustion CCS. The primary energy arising from removing carbon from biomass, waste, coal, oil and gas is H_2. Now that high-H_2 feed for gas turbines is proven - and if the pure CCS part of the process is matched by the CO_2 value - then H_2 becomes a substitute energy vector for a wide range of primary energy resources (including a role as a valuable source of carbon-free hydrogen fuel for fuel cell transport and other applications).

  The importance of scale economies of CCS means that support for the current CCS demonstration projects must follow through into support for CO_2 infrastructure and general deployment. Fortunately the UK has competitive advantages in CCS and we urge TransmiT to help ensure that is and continues to be the case.

- **Development of new H_2 infrastructure will attract additional investment.**

  Enabling commercial activity, way-leaves and sufficient scale and vision for new infrastructure is a classic way to help new investment to locate and grow. New CO_2 infrastructure has shown how it influences location of new investment and, historically, Teesside was helped by H_2 pipelines and storage. Now Teesside and other areas could grow based on new H_2 sources, like large scale pre-combustion CCS, to reach new demand for low carbon, low cost H_2 across sectors.

- **Inland fossil power and industrial plants, together with their infrastructure may become stranded assets unless served by de-carbonised H_2.**

  For existing power and industrial plants sited at inland locations, it may be difficult to warrant the expense and the environmental impact of providing long onshore pipeline connections for relatively small annual tonnages of CO_2. This could mean, in the longer term, that existing or new gas inland fossil fuel powered plants become stranded assets, with consequent local imbalances of power and gas transmission capacity. However, if CCS is employed with pre-combustion capture and H_2 is piped to these more isolated or smaller power plants and industrial plants, then they and the associated infrastructure will maintain their full value.

- **Consideration needs to be given to the infrastructure needs of offshore wind and its fossil back-up.**

  Construction of more wind farms will mean that the amount of supply variation will increase. Electricity demand side management is a small help when looked at scales of a few days. E.ON's modelling of the winter anti cyclone in February 2006 against the future planned high wind installed capacity gives a 8TWhr[1] short fall to demonstrate the very occasional scale of future reserve generation and storage.

  Danish experience suggests that interconnecting grids alone will not solve the economics of high wind penetration[2]. Storage at different timescales and direct short-term substitution of electricity for heat will need consideration. The incentive to build and operate power plants with

[1] Example often used and included in the Transition Pathways briefing 2nd November 2010 at the Royal Academy of Engineering.

[2] The Ecogrid Study Group has concluded that extrapolating the future from the past is not feasible, so that if the extra wind power is achieved, drastic re-engineering of the whole system will need to take place and international connectivity is no panacea. http://www.energinet.dk/en/forskning/Energinetdk-research-and-development/EcoGrid/Sider/default.aspx

CCS in the mid to low merit range will also be a crucial component of future electricity markets.

Whilst there are various technical ways for CCS-equipped plants to be more responsive, with some of them involving storage of various sorts, the best approach is to decouple the CCS process from the power island using the pre-combustion attribute of a H_2 energy vector. This can then mimic the flexibility of the natural gas system, by line-packing and storage, in meeting the variations in heat load.

For the short term, extreme events, single cycle natural gas plant can be expected to displace the present oil fired generation, whilst variable proportions of H_2 and natural gas are used for CCGT's and stationary fuel cell power supplies. This mix of fuels will also allow for variations in the economics of fuel and CO_2 costs over time, improving the UK's energy competitiveness.

In addition, the implementation of combined heat and power systems in commercial and residential installations can provide a further capacity buffer, especially when combined with smart metering that would allow surplus electricity to be fed back into the grid at times of high demand. Fuel cells are very well suited to installations close to population centres (silent, non-polluting with good transient response characteristics), avoiding the need for disruptive and expensive district heating systems. A fuel cell CHP system operating on bio-gas or hydrogen is fully carbon neutral. In the transition, a fuel cell CHP system can also deliver significantly lower carbon compared with central generation, with reductions of 40% achievable compared with conventional alternatives even when operating on natural gas.

In the context of central hydrogen generation, and to help de-carbonise natural gas supplies, it would be very prudent for regulations to enable the adding H_2 into natural gas pipelines - in principle, if not in immediate practise - at this time. As the specification cost to include H_2 in new facilities is minor, this would be a prudent consideration.

Initially local H_2 infrastructure is expected both for economic and for energy policy development. We are not advocating an immediate and national H_2 infrastructure, but that TransmiT should explicitly facilitate and not directly hinder such infrastructure growth.

- **Industrial processes and transport can be decarbonised by H_2.**

There is uncertainty as to whether these industrial energy users will use more electricity, substitute primary fuel, or use onsite CCS. For example steel making could become more electricity intensive, more hydrogen intensive, or more reliant on onsite post-combustion CCS. General industrial needs for heat will use piped $H_{2,}$ which is decarbonised (by CCS or from renewable sources), and may benefit from more efficient processes and direct use of H_2 as a chemical.

As described above the implementation of pre-combustion CCS would provide large point-sources of carbon-neutral hydrogen for distribution to fuelling stations. Fleet transport and rail may also pick up usage directly and support re-fuelling points. As back-up or in relatively small individual amounts using decarbonised electricity (from CCS, nuclear or renewables with storage), both are possible via electrolysis with home generation, particularly when using overnight tariffs.

- **The CO_2 from heat problem**

The size and seasonal variation in the UK's use of natural gas for heating is the major decarbonisation challenge in the coming decades.

We do not recommend a single answer to this problem, but to work though the efficiency options, make good use of our biomass, develop the UK's natural resources of wind and marine energy, and coal and gas reserves, and also to develop new technology options.

Assuming we see house insulation improvements, effective SMART meters and grid management, use of heat pumps/ heat storage, reasonable distributed generation, and retention of natural gas storage and HTS to meet peaks, the ability to de-carbonise heat will still need development of de-carbonised hydrogen infrastructure serving industrial, commercial and domestic users. With the help of hydrogen islands and areas without natural gas, the opportunities will come sooner to tackle fuel poverty across transport, heat and power.

(See also comments on fuel cell CHP above)

- **H2 infrastructure**

We see that H_2 pipelines provide the cheapest large scale distribution system. Investment cost is the same as natural gas, though with lower viscosity and also lower volume energy density, there is a slight increase in pumping cost. Besides pipelines, the system requires H_2 generation assets - using wind, biomass, other renewables, fossil fuels with CCS, and in the long term nuclear, as energy inputs - and, like natural gas, some storage.

In a decarbonised world, the expected pathway is local medium and low pressure systems serving key users that will enable distribution to smaller users at low marginal cost. We see such systems driven by local commercial arrangements. In the transition, hydrogen for transport would be supplied by a range of different routes depending on location and daily demand (e.g. increasing demand met by tube trailer, liquid tankers, electrolysers, forecourt reformers and finally by pipelines).

An important step is for Ofgem to recognise the option for H_2 fed into local distribution systems at relatively low percentages. This can be at levels at which appliances are already certified for H_2. This reflects some of our "town gas" history, but without the carbon monoxide problems.

At another level, we do see real potential in replacing natural gas for local areas. This would be based on commercial circumstances and could be used, in early stages, to develop public awareness for the area as part of a demonstration of a zero carbon community. An interim solution is to develop the existing local hydrogen grids that are fed with hydrogen generated by standard reformers. Thia would provide a stepping point along the pathway to delivering a full hydrogen grid.

The development of local system interconnectors and joint storage would be the next step, which may be a stage that the question of a national grid and regulation of a high pressure pipeline system would be worth considering.

As implied by the above concepts, it is considered essential for Ofgem to ensure that regulatory impediments are not inadvertently embedded in their considerations and look to TransmiT to take due account of hydrogen developments in their work. Some aspects are near term, but mostly they are future needs. In parallel, the hydrogen industry is addressing standards, safety and engineering issues. Vigilance is also essential to ensure that arbitrary technical limits based on natural gas behaviour are not used to stop development of hydrogen applications.

Conclusion

Because of the associated ability for storage, low transport costs, and wide process options, we see substantial potential for a H_2 infrastructure, alongside a growth in electrical infrastructure - even if electrical loads are managed to better match supply and demand. However, the exact size and timing of such growth in infrastructures is difficult to foresee, so we just recommend that infrastructure regulation and charging recognise and allow those potential growths. We see Project TransmiT as not covering pure H_2 (or the new CO_2) infrastructures that will develop, but as recognising their value to the UK.

The view expressed in this paper cannot be taken to represent the views of all members of the UKHFCA. However, they do reflect a general consensus within the Association.

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