APPG on Hydrogen Inquiry Response

The role and potential of hydrogen in the Downstream Oil Sector

UKPIA represents eight oil refining, distribution and marketing companies that operate the six major oil refineries in the UK – which are some of the biggest industrial producers and users of hydrogen in the UK - and source over 85% of the transport fuels used. UKPIA members also own around 1,250 of the UK's 8,476 filling stations in the UK including some of the early adopters of hydrogen for transport provision.

The role and potential of hydrogen across the downstream oil sector

The importance of hydrogen in meeting Net-Zero by 2050 is clear from the Committee on Climate Change's (CCC) 2020 report to Parliament:[i] in it we see that hydrogen may have a role in the decarbonisation of various sectors including industry, buildings, and transport.

The CCC's Sixth Carbon Budget report[ii] quantifies an opportunity for scale up of low-carbon hydrogen production to 90 TWh by 2035 under their "Balanced Pathway" scenario. Within this context, UKPIA views that downstream oil will have a significant role in both production and use of hydrogen in meeting Net-Zero. The UK's refining sector is the main producer and user of hydrogen in the UK, having done so at scale for more than 60 years, and is experienced in dealing with the associated hazards.

For the refining and downstream oil sector, hydrogen has an important role to play in replacing refinery fuel gas (RFG) as a source of energy in the refineries themselves, but also to meet other demand from transport and industrial commercial and domestic heating. Examples include the Gigastack project[iii] in the Humber region, where hydrogen produced from wind-powered electrolysis will be used within the Humber refinery (operated by Phillips 66), and Shell's development of hydrogen filling stations[iv] and upgrades to existing forecourts[v] to supply hydrogen to transport users.

As identified in UKPIA's recent report "Transition, Transformation, and Innovation: Our role in the Net-Zero Challenge"[vi] (the TTI Report), the refining and downstream sector is already a major hydrogen producer, producing around 800 tons/day (44 MMcfd) for its own use. The main points regarding current refinery hydrogen production are as follows:

- Around 47% of the hydrogen produced is obtained as a by-product from catalytic reforming processes and is produced with negligible associated CO_2 emissions.
- Around 31% is produced using steam or autothermal reforming, leading to CO_2 emissions of around 900 ktpa, although here there is potential for use of carbon capture to abate these emissions, as will be demonstrated by the HyNet project planned at Essar's Stanlow Refinery.[vii]
- Refinery hydrogen demand is increasing as biomass and waste-derived materials are used to reduce the carbon footprint of fuels such as petrol and diesel; this leads to opportunities for decarbonising refinery hydrogen production using additional low carbon production.
- The main use of hydrogen - nearly 75% - is for treating product streams to improve product quality and performance, but the balance is used as a component of RFG used to fire furnaces and boilers providing heat for refinery processes.

Looking forward, the HyNet and Gigastack case studies mentioned above provide early insights into the ambitions of the UK refining sector – to implement early hydrogen production using electrolysis and renewable electricity and through gas reforming with (blue hydrogen) CCUS. Initially projects will decarbonise refinery hydrogen production, but then may develop further through the following options:

- Decarbonisation of refinery hydrogen production and increased supply for use in production of existing products
- Decarbonisation of heat through substitution of RFG/NG in refinery furnaces and boilers
- Decarbonisation of heat in industrial clusters with creation of localised hydrogen markets
- Supply of hydrogen for road transport use
- Supply of hydrogen for decarbonisation of gas networks

Emerging issues identified for hydrogen production, transmission, distribution and storage

As regards the development of the hydrogen sector, in the absence of an enduring and supportive business environment, it will be difficult to realise the potential for hydrogen in the energy transition – something the APPG has already recognised.

During the recovery from COVID-19, a **financial** balance will need to be struck that can support both current levels of employment and investment and the additional investment required to achieve the energy transformation, in particular as sectors seek to recover from impacts caused by the pandemic and reduced levels of demand, continued low margins and increasing costs (for example, carbon prices under the UK-ETS and electricity). A further potential barrier to adoption of industrial hydrogen is around **skills** with potential skills shortages having been identified by the ECITB for hydrogen among other technologies (including CCUS which is often associated via blue hydrogen).[viii] The UK has a long-recognised shortage of uptake of STEM subjects which will need to be improved to meet such shortages.

A number of business and **regulatory issues** must be addressed, including but not limited to:

- The risk of policy uncertainty – this is mitigated by the strong cross-party commitment to Net-Zero, however, where business models are implemented they will need longevity.
- The dependence on central government funding and competition for projects, this can be a particular issue for making progress in Devolved Administrations although there are dedicated funds for allocation in Scotland (under the Industrial Energy Transformation Fund, IETF).
- Risks associated with changes in Ofgem regulation of electricity transmission and distribution and regulation gas networks, particularly for industries new to that form of gas-market regulation such as the downstream.
- Limited supply of renewable electricity and access to CO_2 storage to facilitate production of low carbon hydrogen.

Finally, **safety and environmental** issues associated with widespread use of hydrogen may emerge, given it is highly flammable and forms explosive mixtures with air. From a safety perspective, it will be important to ensure hydrogen embrittlement of long-serving pipeline networks does not become a threat to public health, although this is an issue relatively well understood and with proven management techniques.

The ongoing pilots of gas substitution for domestic uses such as HyDeploy[ix] will be important to demonstrate the potential and safe use of low-ratio blends of hydrogen and natural gas. We view that local hubs of hydrogen may well emerge, which fits well with the industrial clusters being worked on, but the risks of long-distance transmission/ transportation will still need to be carefully considered.

Substitution of natural gas could cause potential air quality issues with the suitability of gas turbines for hydrogen service, including the potential impact on NO_x emissions which seems not to be a large part of today's discourse, but is a known issue with high hydrogen content RFG.[x] A potential option is the earlier replacement of existing RFG-fired boilers and furnaces with hydrogen-fired units as envisaged under the HyNet project in the North West.

Policies and accelerating uptake

Government support in development of large-scale hydrogen production and use will be essential. Support provided to date via the BEIS Energy Innovation Programme has proved successful in bringing forward the HyNet and Gigastack projects.[xi] Further support provided under the £20m Industrial Fuel Switching competition initiated in November 2018 has provided funding to stimulate early investment in fuel switching processes and technologies, including a hydrogen-fired refinery CHP.[xii]

Further support will be required for implementation of these and similar large-scale projects. UKPIA and its member companies are currently engaged with BEIS on the development of business models to support CCUS and hydrogen products via the BEIS Industrial CCUS Expert Group and the BEIS Hydrogen Advisory Council Working Group on business models. Here, it is understood that new policies for support of CCUS and hydrogen production from the £240m Net-Zero Hydrogen Fund, announced in the UK Government's Ten Point Plan for a Green Industrial Revolution, will be subject to consultation later this year. It is likely that more support will be needed over the next decade given the pace of change required to meet the next Carbon Budgets and Net-Zero before 2050.

[i] Stark, C. & Thompson, M. Reducing UK emissions Progress Report to Parliament. (2020).
[ii] Committee on Climate Change, *The Sixth Carbon Budget: The UK's path to Net Zero*, December 2020.
[iii] See Gigastack website for more details https://gigastack.co.uk/
[iv] Shell press notice on building hydrogen refuelling location at COBHAM https://www.shell.co.uk/media/2017-media-releases/shell-launches-its-first-hydrogen-refuelling-station-in-the-uk.html
[v] LCM Environmental press coverage of November 2020 announcement by Shell https://lcmenvironmental.com/shell-introduce-hydrogen-4-uk-forecourts/
[vi] UKPIA Transition, Transformation, and Innovation Report October 2020 https://online.flippingbook.com/view/111037/
[vii] See HyNet Northwest website for more details https://hynet.co.uk/
[viii] Element Energy, Towards Net Zero: The implications of the transition to net zero emissions for the Engineering Construction Industry http://www.element-energy.co.uk/wordpress/wp-content/uploads/2020/03/20200304_EE_ECITB_Towards-Net-Zero-Report_Implications-for-the-ECI.pdf (2020)
[ix] See HyDeploy website for more details https://hydeploy.co.uk/
[x] Barthe, P., Chaugny, M., Roudier, S. & Delgado Sancho, L. Best Available Techniques (BAT) Reference Document for the Refining of Mineral Oil and Gas. 754 (2015)
[xi] Under the Clean Growth Strategy, the Government established the BEIS Energy innovation Programme, with a budget of £505 million from 2015-2021, with a further commitment made in the March 2020 Budget to at least double the size to £1 billion. Two funding competitions have been held under this Programme for hydrogen supply and use projects; Phase 1 funded 13 feasibility studies, including the Gigastack (£500k) and HyNet (£498k) projects. Phase 2 provided funding for 5 demonstration projects, again including the Gigastack (£7.5m) and HyNet (£7.48m) projects.
[xii] The £20m Industrial Fuel Switching competition was initiated in November 2018 and allocated funding to stimulate early investment in fuel switching processes and technologies. In Phase 2, 7 feasibility studies were funded looking into developing technologies at TRL 4 to 7 to enable the use of a low carbon fuel for a particular industrial process or across an entire site. A FEED study for a hydrogen-fired refinery CHP was included under the HyNet Industrial Fuel Switching project (£299k). Phase 3 is funding 4 demonstration projects, including project design for a hydrogen-fired refinery CHP at Essar Stanlow under the HyNet North West project (£5.24m).