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Energy Systems Catapult Response: Hydrogen in Wales consultation

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About Energy Systems Catapult

Energy Systems Catapult was set up to accelerate the transformation of the UK's energy system and ensure UK businesses and consumers capture the opportunities of clean growth. The Catapult is an independent, not-for-profit centre of excellence that bridges the gap between industry, government, academia, and research. We take a whole systems view of the energy sector, helping us to identify and address innovation priorities and market barriers, in order to decarbonise the energy system at the lowest cost.

Our response to your consultation questions:

Strategic Vision

1. Public and private sector representatives are developing a hydrogen pathway for Wales based on evidence that hydrogen will be required to play a part in the future energy mix if we are to meet our climate change aspirations. Do you agree this activity is needed to ensure Wales is well positioned to take advantage of potential opportunities arising from use of hydrogen? If not, why? Do you have any evidence to support these views?

ESC Response:

Creating a clear pathway for the development of a hydrogen sector in Wales is important. Our whole energy system analysis scenarios show that hydrogen will play a major role in reducing GHG emissions from hard to decarbonise sectors like industry, aviation & transportation. It also has great potential to complement renewable energy technologies like solar and wind. For an 80% reduction target hydrogen was a strategically important energy vector, but the overall quantity for the UK was typically limited to around 100TWh in 2050. For Net Zero, this now increase to 200-300TWh¹.

As such, our analysis supports early action in the 2020s to develop hydrogen production at scale. This will bring several benefits:

- First, gathering the learnings needed to enable a hydrogen system will take several years. This information will be needed for Government and Industry to make informed decisions on key infrastructure pathways in the 2020s and 2030s and to remove the current barriers to hydrogen use.
- Second, if a UK hydrogen system which can generate, transport and use 250TWhs of hydrogen per year is then to be created this will require sustained investment for the following years to 2050. This is an ambitious undertaking and starting the transition at scale by 2030 makes sense.
- Third, early deployment may bring benefits for the economy in Wales beyond just decarbonisation by creating expertise in an important future global industry.

¹ <https://es.catapult.org.uk/reports/innovating-to-net-zero/>

Due to the lack of certainty around the shape of a future hydrogen economy, a clear action plan in Wales which can help manage this uncertainty and enable action in the short term is needed. These activities would benefit from alignment with the UK's wider Hydrogen and Net Zero Strategies.

There are large potential benefits from creating opportunities for hydrogen projects in Wales, as this could be become a valuable global sector. There is also risk in not acting as, if Wales is to reach its Net Zero target at lowest cost, different decarbonisation options must start to be developed and understood now.

Furthermore, hydrogen is already expected to play a key role in Wales and has a significant role in the Milford Haven Energy Kingdom project and the South Wales Industrial Cluster (SWIC) among others.

3. Do you have any evidence on the best sources of energy for low carbon / renewable hydrogen production? Should Wales seek to generate hydrogen within the country or seek import opportunities, or pursue both options?

ESC Response:

The optimal mix of hydrogen generation technologies is uncertain. The cost optimal mix of hydrogen generation in 2050 is likely to be a mix of:

- Biomass gasification with CCS - very important as it produces negative emissions which benefit the wider energy system.
- SMR/ATR with CCS - has residual emissions but is likely be lowest cost in the short to medium term.
- Electrolysis - electrolysed hydrogen is needed across scenarios for Net Zero due to the alternative residual emissions from SMR/ATR with CCS. The relative use of electrolyzers to SMR/ATR with CCS will be determined by the future fall in costs of both technologies and the availability of residual emissions for SMR/ATR with CCS. In that case, electrolysis is preferred, but at higher cost this makes hydrogen less appealing overall.
- Advanced nuclear for hydrogen production
- (there is also likely to be global market for hydrogen).

This is consistently found across modelling scenarios ran with ESC's Energy System Modelling Environment (ESME). ESME is an optimisation model and finds the least-cost combination of energy resources and technologies that satisfy UK energy service demands along the pathway to 2050. Constraints include emissions targets, resource availability and technology deployment rates, as well as operational factors that ensure adequate system capacity and flexibility. Importantly, ESME includes a multi-regional UK representation and can assess the infrastructure needed to join up resources, technologies and demands across the country. This includes transmission and distribution networks for electricity and gas, and pipelines and storage for CO₂.

Therefore, **we support different technologies being developed in the next decade to maintain optionality**. Once cost trajectories and system value are clearer due to both international and domestic learnings, technologies can compete. Furthermore, current modelling suggests a combination of different technologies could be cost optimal.

There is the potential for hydrogen imports in the future however, this should not prevent domestic action in the short term. Building hydrogen, supply, distribution and demand will be difficult without supporting this domestically. **Short term domestic action is low regret.** Regular studies should be conducted to understand the potential for low-carbon hydrogen to be imported so that if this opportunity occurs it is capitalised upon. This must be underpinned by a reliable international system which certifies the carbon intensity of different hydrogen sources to ensure international carbon reduction is not undermined.

Also, the preferred production method and location should not be viewed in isolation of the distribution network (including storage) and end uses. Not all production methods will align with all uses, for example due to purity or profile requirements. Therefore, the best sources of hydrogen production very much depend on the requirements of the end use and the pathways.

4. In your view, does the proposed hydrogen pathway complement ongoing and planned hydrogen initiatives across the UK? What other actions should be considered in the hydrogen pathway that would further distinguish Wales, or support other UK activities? Do you have any evidence to support these views which you can share?

ESC Response:

There is lack of clarity about the strategy for progressing the use of hydrogen in the UK. The release of UK Hydrogen Strategy, expected this year, may bring clarification. Without this, it is unclear how well this plan for Wales links with wider developments. This could be progressed through the Welsh Government linking with their BEIS counterparts who are working on the UK hydrogen strategy.

This hydrogen pathway should consider exploring the following:

- Support for biomass gasification with CCS- this is a low regret investment across our scenarios and a key technology to develop. CCS infrastructure could be built to link with other areas of the UK (as considered by the South Wales Industrial Cluster).
- A section on the transmission and distribution of hydrogen- this will be key for securing investment in projects. The transmission and distribution of hydrogen can be difficult, with the potential that transportation and processing can take more than 30% of the energy content in the hydrogen.² (Ammonia to Green Hydrogen Project, *Ecuity, STFC, Engie, Siemens, 2019*) Therefore this cannot be an afterthought when trying to create opportunities for hydrogen investment.
- Clear actions for Wales to remove barriers to hydrogen use- there are many barriers to the use and supply of hydrogen currently. Across Europe, investors are looking for places where regulatory barriers will not hinder projects. Wales could attract investment by having a clear process for removing these barriers for investment. This could range from a clear derogation process to a well-informed critical friend available to help projects understand regulations.
- Considering the synergies between projects- in the short term there may be few opportunities for hydrogen. Joining hydrogen demands and innovation trials together could help projects be investable and would improve understanding of integrating different hydrogen system elements.

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https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/880826/HS420 - Ecuity - Ammonia to Green Hydrogen.pdf

The Welsh Government should consider how they could support joined up thinking across the hydrogen innovation landscape.

- The use of hydrogen as ammonia in shipping.
- A clear way for the work completed by the South Wales Industrial Cluster and the Milford Haven: Energy Kingdom project to feed into the strategy as the projects progress. These areas of strategic infrastructure will have a large impact on how the hydrogen market builds.

The Wales Hydrogen Strategy could support UK activities by considering wider national infrastructure within their planning. For example, by considering the implications for the UK as a whole of the operation of the Milford Haven import terminals or the potential to allow carbon to be shipped from South Wales might enable links with large areas of England. It's also worth considering how in achieving the UK Net Zero target, different areas of the UK could be net negative or net positive. The links to enable this should be established.

A dedicated centre looking at End-to-End hydrogen technologies is needed to make best use to knowledge and for creating national level hydrogen strategies. Recognising the opportunity for investment in hydrogen to support economic recovery and delivering net zero ambitions the Catapult Network is working together to create the Hydrogen Innovation Initiative (Hii) for delivery of an end-to-end programme of innovation to support government and industry in the creation of a UK hydrogen economy and the coordination and alignment of R&D activity. This is proposed to forge the strategic linkages across the value chain and create a focal point and connected innovation backbone.

As the connection between Industry, Academia and Government this new initiative will help coordinate action in this space as bringing together key stakeholders, different areas of expertise and new opportunities.

Hydrogen Pathway Scope

5. Are there other areas where you believe hydrogen and fuel cell technologies have a role to play in Wales in the short term (period to 2025)?

ESC Response:

There is the potential for a substantial role for hydrogen in shipping before 2025. The shipping sector could decarbonise using hydrogen-based fuels (ammonia) in large internal combustion engines (ICE). Utilising ammonia in shipping is a relatively straight forward swap and ICE manufacturers and shipping operators are exploring the potential of deploying this in the short term (before 2025).

'It is estimated that the Welsh Maritime Sector directly supported £493 million through business turnover, £256 million in GVA and 4,067 jobs in Wales in 2017. The shipping industry is the largest constituent industry within the Welsh Maritime Sector in terms of economic activity, directly contributing £248 million in turnover, £127 million in GVA, and directly supporting approximately 1,379 jobs in 2017.' (The economic contribution of the Maritime Sector in Wales, 2019, Cebr.)

Industry could also be a user of hydrogen by 2025, but this is heavily dependent on the incentives to switch to H2. The same applies for the use blended hydrogen by industry and CCGTs.

It is likely that the role of fuel cells will be small in the period to 2025. Fuel cell developments in mobile application have been slow to progress, struggling to reach beyond prototype form in all but a few light duty car applications. In the short term (to 2025) this trend will likely continue with additional trials in heavier duty applications. This could provide opportunities for demonstration sites and facilities.

6. Do you believe the pathway strikes the right balance between being ambitious yet proposing actions which can be delivered?

ESC Response:

There is a need to set ambitious objectives and work towards them if UK has to meet the Net Zero target by 2050. The actions look achievable provided work begins soon. The strategy should consider increased ambition in the areas outlined in Q7.

Hydrogen Pathway Delivery

7. In addition to the points set out in the objectives, are there any other “no regrets” actions that you believe Welsh Government / industry should take in the short term to develop the hydrogen sector in Wales? Do you have evidence you can share in support of that view?

ESC Response:

As previously mentioned, we believe the Hydrogen Strategy for Wales should also consider the following low regret areas:

- Support for biomass gasification with CCS.
 - A section on the transmission and distribution of hydrogen.
 - Clear actions for Wales to remove barriers to hydrogen use.
 - Considering the synergies between projects.
 - The pathway in the report focusses heavily on the use of hydrogen as a transportation fuel (fuel cells). Ambition should be increased for the use of hydrogen in industry and the use of hydrogen as ammonia in shipping.
 - Produce an assessment on the potential of imports.
8. What are the key barriers, risks and challenges to realise the opportunities described? In your view, what measures would help to overcome these and what are the key enabling factors?

ESC Response:

In many instances current regulation is creating barriers to the use of hydrogen or creating uncertainty about how and where it can be used. The following reports explore some of the barriers to specific hydrogen system elements:

- Hylaw- <https://www.hylaw.eu/sites/default/files/2019-01/HyLaw%20UK%20Policy%20Paper%20Final%20December%202018.pdf>

- Hy4Heat, 'Conversion of Industrial Heating Equipment to Hydrogen' Table 1-1 <https://static1.squarespace.com/static/5b8eae345cfd799896a803f4/t/5e287d78dc5c561cf1609b3d/1579711903964/WP6+Industrial+Heating+Equipment.pdf> – Also a great source for dividing up industrial sector and understanding specific implications of using H2.
- Hydrogen policy anomalies- <https://www.imeche.org/news/news-article/hydrogen-policy-anomalies>

There are also wider barriers such as the ability of suppliers and shippers to deal with hydrogen under their license conditions.

Specifically for electrolyzers, there is uncertainty around whether generators with Contracts for Difference or Renewable Obligation Certificates can be collocated with an electrolyser and still receive their support payments from government. There also are not the market mechanisms currently for electrolyzers to access curtailed generation at a lower price than the wholesale price.

The Welsh Government should work to understand the barriers to hydrogen projects (in the broader sense shown by the examples above) and create a clear process for supporting innovation projects through these regulations. This could range from a clear derogation process to providing a well-informed critical friend available to help projects understand regulations. This work could also support the removal of barriers across the UK.

Welsh Language Considerations

No Response on questions 9 and 10

Summary

11. If you have any related comments which we have not specifically addressed in this consultation, please respond under question 11, supported by any relevant evidence.

ESC Response:

Hydrogen will be key for Net Zero however there's still uncertainty around the exact role it will play in some sectors. Over the next 5/10 years the focus should be on developing demand and supply in sectors with few alternatives whilst gathering the information needed to decarbonise the sectors where the future pathway is still unclear.

To enable investment the strategy should consider building a long term market for low carbon products. There is not currently an even effective carbon price across the economy to drive conversion to/ use of hydrogen. (Effective carbon prices are explained and shown across different uses in the box.) It is particularly important for the hydrogen economy that there is a more coherent economy-wide balance of decarbonisation incentives, given the flexibility of hydrogen to play a key role across a range of emitting sectors.

A more coherent economy-wide carbon policy framework will take time to establish. Policy should work towards this so that by the 2030s it is place. This would drive hydrogen usage where it adds most value to the system. This would also enable a move away from centralised, complex layers of policy which can cause distortions and hinder efficient outcomes and innovation. We outline how

this could be introduced in our recent report Accelerating to Net Zero: A sector-led approach to an economy-wide carbon policy framework³. ESC would be happy to work with the Welsh Government to explore how these concepts could be developed and applied in Wales, as part of a wider UK net zero policy framework.

³ <https://es.catapult.org.uk/reports/accelerating-to-net-zero-a-sector-led-approach-to-an-economy-wide-carbon-policy-framework/>