Cyfoeth Naturiol Cymru
Natural Resources Wales

Smart Living Programme
Climate Change Division
Welsh Government
Cathays Park
Cardiff
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Email: decarbonisationmailbox@gov.wales

**Dear Smart Living Programme,**

**Re: Hydrogen in Wales**

Thank you for the opportunity to comment on the above consultation.

Hydrogen has emerged as an important part of the low carbon energy mix needed to ensure a sustainable future. It offers part of the solution and has the potential to be a fuel of the future, particularly for cleaning up certain hard-to-decarbonise sectors of our economy.

Given the scale of the energy transition required, and the opportunity, for the energy sector to support UK and Wales' Net Zero target, hydrogen is likely to have a vital role in this equation and it needs to be assessed and amended as necessary to help achieve this ambition. It is important to understand the wide range of opportunities, from home heating to fuel cell vehicles, and to carefully consider how best to pursue them. **Thus, in pursuing with the 'hydrogen economy', it is vital to understand and address, both technological and environmental challenges of the hydrogen technology.**

In pursuing this, there are two high-level issues that needs to be addressed. Firstly, cost effective, scalable and **sustainable production methods** need to reach mass market and so targeting investment towards reducing the high cost of producing large volumes of low carbon hydrogen is crucial. Secondly, a **comprehensive and systemic approach** is essential to determine the most appropriate application(s) of hydrogen within the economy. This is because the different uses for hydrogen are likely to be highly interconnected and this will have implications for the environment and the energy system.

Natural Resources Wales (NRW) therefore, welcomes the 'Hydrogen in Wales' consultation which provides a comprehensive list of activities that will take place in the short term. We see the benefit of focusing on short terms actions whilst starting to plan for larger-scale projects in the mid- to long-term which will ensure Wales is well positioned, when there is more clarity and

certainty at the UK level strategies and policies. However, we are mindful of the long term implications of technology-lock as a result of short term decisions.

**The Role and Purpose of Natural Resources Wales**

Our comments are provided in the context of our purpose to ensure that the environment and natural resources of Wales are sustainably maintained, sustainably enhanced, and sustainably used. Natural Resources Wales has multiple roles in supporting the delivery of energy schemes, through our advisory, regulatory, landowner and land manager roles. NRW's formal regulatory responsibilities in relation to hydrogen encompasses the production of the hydrogen (and any carbon capture of carbon dioxide where this occurs) as well as the utilisation of hydrogen in combustion and/or industrial applications. The hydrogen manufacturing process, as well as its subsequent utilisation, is critical to the overall environmental impact.

- We have a statutory duty in relation to permitting a wide range of energy and industrial facilities. This varies according to the types of facility – including a range of electrical power generation facilities to steelworks to intensive poultry farming.
- We are a statutory consultee in the planning process, which would include commenting on schemes where these projects are proposed.
- We own land in various parts of Wales where energy development may take place. We also manage the Welsh Government Woodland Estate (WGWE) where we help enable the deployment of energy projects.

NRW is currently working with other UK regulators to examine the potential environmental impacts from the different production routes for hydrogen. This work will help provide clear evidence and the likely environmental benefits and impacts which will help in setting/improving a regulatory regime for hydrogen development in Wales. This work is currently in progress and we look forward to working with the Welsh Government and UK Government departments in reflecting devolved and non-devolved functions. However, NRW welcome early and continuous engagement for hydrogen projects as they develop as this would encourage the adoption of a more proactive, rather than reactive, approach to regulation.

We have set out our comments in relation to some of the consultation questions and recommendations below.

In doing so our focus is on how hydrogen technology can continue to support decarbonisation, optimise the sustainable management of natural resources and minimise adverse environmental impact.

I hope you find our comments useful and constructive. Please contact Kalpana Balakrishnam on Kalpana.Balakrishnam@cyfoethnaturiolcymru.gov.uk or Karl Shepherd on Karl.Shepherd@cyfoethnaturiolcymru.gov.uk if you would like to discuss in detail.

Yours sincerely,

Mary Lewis – Manager, Sustainable Communities, Land and Sea.
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**Summary of our views and recommendations**;

1. We acknowledge that if the UK and Welsh Governments are to meet their net zero and energy targets, certain barriers to the clean energy transition need to be overcome. These include;
    - decarbonising hard to abate sectors such as heat, transport and industry.
    - increasing the amount of renewable energy.
    - integrating increasing amounts of variable renewable energy into the system.
    - finding ways to store large quantities of energy to act as system buffer, a role that is currently mostly fulfilled by fossil fuel, including rapid response diesel arrays and diesel farms.

    We acknowledge the potential for hydrogen to help overcome these challenges in meeting the net zero target and transitioning to a low carbon economy, including recognising the importance of specific local circumstances relating to the electricity grid, gas grid and other infrastructure networks, which will determine what mix of decarbonisation options are deployed. We, however, continue to urge that the wider environmental impacts of hydrogen are not overlooked in its pursuit to replace the more damaging fossil fuel and that the opportunities for hydrogen are explored within the context of whole systems approach to energy.

2. To date, due to the limited application of hydrogen, the possible environmental consequences of hydrogen as an energy source has had less attention than other sources of energy. As stated in the State of the Natural Resource Report (SoNaRR), all sources of energy, both conventional and renewable sources, have an impact on the natural environment and its ecosystems. On this note, we highly recommend careful environmental assessments and life cycle analysis to be considered and employed at each step for the differing hydrogen technologies, from production to utilisation to ensure all environmental concerns and pollutions are minimised and that the full potential of hydrogen as a clean fuel is being realised.

3. The Area Statements and 9 principles of Sustainable Management Natural Resources (SMNR) and ways of working as set out by the Future Generations Act encourage decisions that deliver SMNR. NRW recommend that the nine principles of SMNR are used throughout hydrogen related process and decision making to help ensure a consistent approach to ensure schemes are sustainable and does not impact ecosystem resilience.

4. Natural Resources Wales' State of the Natural Resource Report (SoNaRR) and Area Statement profiling are our structured and innovative way of setting out opportunities for ecological enhancements and environmental benefits which could support hydrogen development in Wales. It has the potential to add value to inform the decision-making process in relation to the location or layout of hydrogen developments or projects by providing information on the ecosystem resilience and benefits of place. These products

can support innovative ways of engaging with communities explaining the benefits of hydrogen development (among others) and how development can support wider economic, social and environmental well-being at the local level whilst delivering national decarbonisation targets.

5. We encourage continuous and early engagement with NRW when developing plans, policies and guidance in relation to hydrogen activities. This will help ensure we are able to support the development of the hydrogen technology and associated sectors through our various roles in a more systemic manner. NRW currently represents the South Wales Industrial Cluster (SWIC) and HyCymru which is a positive engagement for the hydrogen sector.

## 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?*

   Yes, NRW is supportive of a hydrogen pathway for Wales. We recognise that hydrogen has significant potential in addressing some of energy and climate challenges. We also recognise the potential for hydrogen in helping to address the challenges in some of the hard to decarbonise sectors in Wales/UK such as industry, building and transport.

   We see the benefit in developing a pathway/roadmap as it defines an integrated plan with the activities needed to better assess the potential for hydrogen. It identifies the short-term actions needed to advance deployment and defines the research areas with the highest priority and the applications where demonstration projects are most needed. It will also serve as knowledge base for further work, such as shaping the hydrogen policy for Wales and determining the role for hydrogen in national/regional energy planning and climate policy.

   We also appreciate the context behind a short-term plan, as long-term strategy requires national level policy direction on the role of hydrogen and associated sectors (e.g. UK Hydrogen Strategy, Heat & Building Strategy, Industrial Decarbonisation Strategy) which is currently underway. However, it is important that the pathway is developed with a vision for hydrogen in Wales.

   We also recommend, the pathway and/or any future work to consider the nature of production and use of hydrogen, including storage and transport and to understand and explore if this may be different geographically across Wales, noting the industry make-up, access to infrastructure (electricity/gas grids, deep ports, carbon storage). Options may be preferable in different parts of Wales over different timescales, noting these

geographical differences, and that some approaches may want to progress at pace. Developing regional support programmes may allow incentivising of local investment based on their energy circumstances.

We believe there is potential for this consideration under the WG's Regional Energy Planning.

2. *Why are you supportive/not supportive of Wales pursuing hydrogen opportunities?*

   *If supportive, what actions can you / your organization, take to contribute towards the development of the hydrogen sector in Wales (and under what conditions)?*

i. NRW is supportive of Wales pursuing hydrogen opportunities to decarbonise the economy. It can contribute to energy security by providing another energy carrier with different supply chains, producers and markets. This also helps to diversify the energy mix and improve the resilience of the system (including as an energy storage medium). It can also reduce air pollution at point of use when used in fuel cells, with no emissions other than water. Hydrogen has the potential to promote economic growth and job creation given the large investment needed to develop it as an energy carrier from an industrial feedstock.

   We also recognise the potential role for hydrogen in some sectors especially where there are no emission-low alternatives and where other advantages outweigh the current high cost of hydrogen. For example, heavy industries which requires high temperatures that hydrogen can deliver better than electricity, although noting that challenges remain with respect to other emissions to air (such as oxides of nitrogen).

   However, NRW would encourage focussing on the development of 'green hydrogen' as the preferred type of hydrogen for production and use in Wales, and where possible prioritise a mechanism to presume 'green hydrogen', potentially as Best Available Technique (BAT). Green hydrogen production through electrolysis (with electricity from renewable sources) is consistent with the net-zero route, which allows the exploitation of synergies from sector coupling, thus decreasing technology costs and providing flexibility to the power system.

ii) NRW has remit and experience in regulating industrial scale applications, and consideration of the wider environmental issues other than just impact of greenhouse gases. All commercial hydrogen production is subject to the Environmental Permitting Regulations (EPR), hence will need a permit from NRW prior to commencement of operations. The objective of EPR is to prevent, minimise and render harmless emission to the environment.

   We encourage continuous and early engagement with NRW as and when projects and plans are developed to ensure we can support the development of hydrogen in Wales through our various roles. Given the no de-minimus provisions for commercial hydrogen production, NRW note the importance of a proportionate regulatory approach, and would welcome engagement with Welsh Government as to how this might need to work in future. By NRW understanding the direction of travel and scale, we will be better placed to ensure that the regulatory frameworks are proportionate whilst remaining protective.

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?*

There are several approaches that merit further consideration. For every approach, technology & techniques ventured we would highly recommend for a full life cycle analysis and environmental assessment to be considered.

We recommend a rapid exploration of green hydrogen potential in Wales. This technology may attractive to those parts of Wales which lack ready access to large scale carbon dioxide disposal routes (for example, the industrial cluster in South Wales). It may also be useful to conduct a cost-benefit analysis and full life cycle analysis to explore and understand if imported green hydrogen is a more cost effective option than domestic green hydrogen or domestic blue hydrogen, in particular once UK Government has come forward with the financial frameworks to support decarbonisation. NRW also acknowledge there may also be security of supply issues which may also be material.

There are many potential routes to hydrogen production, which have reached a wide range of technological readiness, as shown in The Royal Society Policy Briefing "Options for producing low-carbon hydrogen at scale", published in 2018[1] . Although the pathway looks in the short and medium term, which may prefer technologies with high readiness levels, this may potentially ignore less well developed technologies which may be better suited to the geographical issues of Wales. These considerations may also look at the use of hydrogen for ammonia as a further energy source / storage medium.

It may therefore be useful to examine the widest range of existing and emergent technologies, and examine these in the context of a number of geographic locations in Wales to see if this suggests some focus on an approach that is less favourable elsewhere in the UK. This might also include for comparison the use of green hydrogen importation.

Some examples of possible routes for hydrogen production (some of which are mentioned in the Royal Society paper):

- Cracking of methane to hydrogen and elemental carbon to avoid carbon dioxide generation;
- Low carbon ammonia production and generation of hydrogen through cracking of ammonia;
- Use of green hydrogen and oxygen in steam production process for use with steam turbines;
- Advanced photocatalytic chemical reactors;
- Decomposition of water by direct use of heat using a thermochemical process.

[1] The Royal Society. 2018. Options for Producing Low Carbon Hydrogen at Scale. (https://royalsociety.org/-/media/policy/projects/hydrogen-production/energy-briefing-green-hydrogen.pdf)

NRW is happy to support and share any intelligence we have on developing techniques to inform any future assessment of technologies.

4. *In your view, does the proposed hydrogen pathway complement on-going 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?*

Yes, the proposed pathway complements on-going and planned hydrogen initiatives across the UK. It is also good that the activities build on the existing strength of Welsh industry and academia and recognises the need to develop skills, expertise and supply chain to ensure a sustainable growth of the hydrogen technology in Wales.

However, the location of large industries in South Wales is less conducive for access to carbon storage facilities compared to opportunities in England or Scotland. Although we appreciate there may be alternatives methods to address this. This might suggest that Wales may be better focused on the greenest forms of hydrogen from the outset (for instance South Wales), thus avoiding the carbon dioxide disposal issue all together.

The geographic location of activities should be properly considered in the **cost-benefit analysis along with lifecycle analysis of various technologies and techniques**, as these may well be geographically sensitive, and may make some niche technologies more advantageous to develop in parts of Wales (and where Wales can develop a particular set of expertise as suggested in the response to question 3).e.g. utilising local wind turbines to generate hydrogen for use in the local community, which could contribute to WG's renewable energy targets.

The pathway also makes little mention of other emissions that may arise from the use of hydrogen (in particular if this is used in combustion). We believe this should also be considerd. When burned, hydrogen does not produce or emit any carbon products, the high temperature nature of such combustion will still lead to not insignificant emissions of oxides of nitrogen (a pollutant of concern for Welsh Government as set out in the white paper on the Clean Air (Wales) Bill. It is therefore worthy of note that an increased utilisation of plant using hydrogen as a substitute for natural gas in combustion systems could result in higher annual emissions of oxides of nitrogen, if not properly recognised and addressed. Also, early applications of hydrogen combustion are likely to be via a mix with natural gas. This is usually quoted on a volume substitution basis, and it is noted that this is not directly equivalent to the carbon dioxide reduction.

In addition, plant changes, upgrades, or changes in industrial land use as a result of a move to utilisation of hydrogen and development of on site infrastructure may be used to drive other Sustainable Management of Natural Resources (SMNR) opportunities, at the same time and as part of large capital-intensive activities.

## *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)?*

No comments

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

Successful innovation and take up of a new technology often depend on the path of its development – better known as 'path dependency', including the characteristics of initial markets, the institutional and regulatory factors governing its introduction and the expectations of consumers. Often such factors end up favouring incumbent technologies against newcomers (although future UK Government proposals on funding and market mechanisms may be influential). Whilst we understand the reason behind a short term plan and the lack of context for wider long term vision and ambition, it is important to note that short term actions could inadvertently lead to technological lock-in, especially where any technology deployed may have 20-30 years life span.

Moreover, with a move to more circular/regenerative economy, we would expect lifetime and maintenance (and retrofit) of plant to become increasingly attractive, so considerations of future-proofing will need to be made for any short-term interventions. For instance, potential to develop a use for the oxygen produced alongside 'green' hydrogen production.

## *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?*

Some suggestions which would require further analysis and consideration;

i. To explore and understand, scope and potential use of hydrogen or ammonia for shipping, and the potential for Welsh ports to act as refuelling locations.

ii. To explore the scope for embedding hydrogen networks generated from renewable sources in new housing developments, particularly where these are of a substantial scale, where economy of scale my provide opportunities. All new housing developments to explore the feasibility of provision of renewable energy source. This may also help to promote development of renewable energy and connection infrastructure.

iii. To explore options for small scale hydrogen backed by Distributed Energy Sources (DER) which could help provide micro-grid resiliency to heavy energy users e.g. hospitals, certain types of industries, business park, university campus etc in Wales. This could contribute to WG's local energy target with potential to be collaborate with WG's Regional Energy Planning and supported by other relevant information sources e.g. Area Statements. Some examples from Bright Green Hydrogen | Projects | Levenmouth Community Energy-Hydrogen Office

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?*

It is worth noting that switching to a hydrogen network today is comparable to the UK's conversion from coal/town gas to natural gas 50 years ago. Therefore, an understanding of this historically important process can provide insights into future network transitions and assist in the study and design of new policies and plans.

Some key barriers, risks and challenges;

i. Environmental implication of hydrogen

Hydrogen is portrayed as a fuel that is environmentally clean because its combustion results in the formation of harmless water. Whilst it is better than fossil fuel, it is not without its impact on the environment. On that basis, the introduction of hydrogen technology and economy must be accompanied by the development of hydrogen that is environmentally friendly. Thus, all hydrogen technologies and techniques should be subject to an assessment of the possible environmental impacts of such alternative energy production. It must include a full life-cycle analysis and environmental assessment at each stage.

39na1 (europa.eu)

ii. Hydrogen within a whole system view with energy.

The transition to a low carbon economy coupled with hydrogen economy has significant technological and system challenges. It is important to fully understand that producing hydrogen as an alternative low-carbon energy source which can be used as a replacement in transport, heating fuel and storage has systems implications because these different uses for hydrogen are likely to be highly interconnected. Thus, it is important to take a systems view of the roadmap and any future related work. Assessing the role of hydrogen in isolation from the rest of the energy system may lead to biased inferences. A good example is the launch of EU Hydrogen Strategy alongside the Strategy for Energy System Integration, which proposes concrete policy and legislative measures at EU level to gradually shape the energy system 'as a whole', across multiple energy carriers, infrastructures, and consumption sectors, including development of a new hydrogen ecosystem.

iii. Investor confidence

This is true for all technologies, not just hydrogen. Investor confidence is crucial to ensuring that projects, large and small, attract and maintain investment throughout their development. Government policy uncertainty and lack of government support can detrimentally affect investment in energy. This could mean that projects become more expensive to deliver; as investors demand a greater return on their investment to compensate for increased risk and/or that projects simply do not go ahead. Moreover, any interruption in energy investment could undermine the UK and Wales' ability to meet climate, energy security and affordability objectives. In the case of hydrogen the

importance of policy certainty and government backing is seen in Equinor's announcement on Saltend Chemical Park - seeking urgent national hydrogen strategy and support to install the biggest facility in the world for making hydrogen from natural gas, using capture and storage technology to extract and bury the resulting carbon under the North Sea. Equinor has made it clear that it will only proceed with its blue hydrogen plans for Hull if the government plays its part, sharing the risks of investing in a fledgling industry. Often having government as lead investors, brings in other investors.

Can a hydrogen boom fuel a green recovery for Britain? | Hydrogen power | The Guardian

iv. The challenge of creating both supply and demand for hydrogen.

The consultation rightly considers supply chain at numerous stages and activities. The technological and environmental challenges must be considered alongside the supply and demand challenges. Without growing demand, the large-scale production of hydrogen is unlikely. This demand could come from a number of sources, all of which require a broad range of end user appliances and equipment that is standardised, desirable, safe and affordable. However, without a strong supply chain which acts to reduce the costs of hydrogen and provide confidence in the capability of industry to deliver a secure and affordable fuel, consumers and public and private sector buyers will be reluctant to purchase hydrogen products.

It is also important to try and balance supply and demand if looking for a high proportion of green hydrogen use. If hydrogen demand quickly outstrips green hydrogen supply, lock-in to blue hydrogen production could stall future uptake of green hydrogen. However, this will be highly dependent on the market and market mechanisms created.

v. Adoption of hydrogen / ammonia at scale for shipping to make port facilities economically viable.

The UK Clean Maritime Plan calls for all new ships for UK waters ordered from 2025 should be designed with zero-emission capable technologies, to cut pollution from the country's maritime sector. Ammonia is expected to play a pivotal role in decarbonising cargo ships and a number of projects are underway around the world (Finland, Germany, Korea, Norway) testing ammonia in shipping. This will be enhanced by green ammonia in the future by companies like Yara in northern Norway.

This may also be coupled with the prospect of carbon dioxide shipping being required for the disposal of carbon dioxide captured from industrial and power plant in certain locations in Wales. It would be desirable that where such transportation is required, the shipping is low carbon, and this may provide some opportunities for port facilities.

vi. Public acceptance

Consumers are at the heart of the hydrogen economy for both UK and Wales. They will drive demand for hydrogen through their purchasing choices. However, the number of national or regional studies evaluating public perception and social acceptance of hydrogen seem limited at the moment. The assessment of public perception and social acceptance of hydrogen energy systems is crucial to avoid reluctance to the deployment of hydrogen technology and infrastructure. Communication is another aspect of this, as effective and transparent communication is vital in changing the behaviour of consumers in encouraging the uptake of the technology.

vii. Clear guidance on the creation of a low carbon economy relevant to small-scale local projects

Clear direction, guidance and support is important to investors and developers, particularly for small scale energy projects for emerging technologies like hydrogen on how it integrates within the low carbon economy and local energy systems. This may also be useful in helping Welsh Government meeting its local energy targets.

viii. Regulation

As noted in the response to Question 2, hydrogen production is a regulated activity. It is anticipated that there is likely to be a wide range of scale of hydrogen production, and that the regulatory framework will need to be proportionate, especially where production plant is small and low impact. As it stands, the regulations may not have fully foreseen the changes arising with hydrogen production brought on by the accelerated drive to decarbonise.

Where hydrogen production is regulated, this would be subject to Best Aavailable Technique (BAT) which has a statutory status. The development of what might be BAT for such technologies and how to go about defining that in the post EU era is a current issue (and will become more so as new technologies emerge). In addition, in Wales, this will need to be mindful of the appropriate considerations to be made in relation to the Well-being of Future Generations Act and Environment Act.

Storage of hydrogen is also subject to the Control of Major Accident Hazards Regulations (COMAH) 2015, and increased awareness of this may be necessary.

NRW is currently working with other UK regulators and industry to produce a guidance in aid permit application process.

## *Welsh Language Considerations*

9. *We would like to know your views on the effects that 'Hydrogen in Wales' and the next steps for developing the hydrogen energy sector in Wales would have on the Welsh language, specifically on opportunities for people to use Welsh and on treating the Welsh language no less favourably than English. What effects do you think there would be? How could positive effects be increased, or negative effects be mitigated?*

No Comments

10. *Please also explain how you believe the proposed opportunities could be formulated or changed so as to have positive effects or increased positive effects on opportunities for people to use the Welsh language and on treating the Welsh language no less favourably than the English language, and no adverse effects on opportunities for people to use the Welsh language.*

No Comments

## *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.*

i. NRW recommends that any future strategies and/or plans that considers offshore energy renewable energy development as an energy source to generate hydrogen should consider the evolving work of BEIS' Offshore Transmission Network Review (OTNR) which aims to encourage greater interconnection but also improved coordination of grid connection between projects. It would sensible for any grid connection required to provide energy for hydrogen to take advantage of grid connection that already exists or that might be proposed as part of a coordinated scenario by the OTNR.

ii. The Area Statements and 9 principles of SMNR and ways of working as set out by the Future Generations Act encourage us all to make decisions that deliver SMNR. NRW recommend that the nine principles of Sustainable Management of Natural Resources (SMNR) are used throughout the process to help ensure a consistent approach to ensure a scheme or project is sustainable and does not impact ecosystem resilience.