HI-ACT

Hydrogen Integration for Accelerated Energy Transitions

HI-ACT: Unlocking the power of hydrogen integration for the UK's future energy systems

Policy Report 2023

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Newcastle University
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WMG, The University of Warwick

HI-ACT works to support key policymakers in making informed decisions on the future of hydrogen[1]. Our academics regularly engage with both political and industry stakeholders to ensure a collaborative and effective approach to their research. Most recently, HI-ACT hosted a policy workshop to discuss the challenges and opportunities across the political and economic landscape, and scenarios in which repurposing does and does not go ahead. These discussions have subsequently fed into this report.

[1] This work, whilst supporting EPSRC's work with HI-ACT, is funded by Newcastle University.

Professor Sara Walker, Newcastle University

Professor Walker is the Director of HI-ACT. She is the Work Package 4 lead and champion for academic engagement. Professor Walker is also Co-Director of the EPSRC Energy Demand Research Centre, and Deputy Director of the EPSRC Supergen Energy Networks Hub. Previously, she was Director for the EPSRC National Centre for Energy Systems Integration and Deputy Director of the Active Building Centre. Her work is on systems integration, and the role of built environment in particular.

Professor Paul Dodds, University College London

Professor Dodds is a Co-Investigator for HI-ACT on Work Package 2, Whole Systems Understanding. He is a Professor of Energy Systems, as well as being a member of the Hydrogen and Fuel Cell Supergen Hub, the UK Energy Research Centre (UKERC) and the UK CCS Research Centre. His principal research interests lie in the interactions between society and the environment, with a particular focus on energy and resources.

Introduction to HI-ACT

The Hub for Hydrogen Integration for Accelerated Energy Transitions (HI-ACT) is a £12.5m EPSRC-funded research hub led by Newcastle University, aimed at driving forward the design of a hydrogen integration plan for the UK's energy system to help progress the UK's transition to net-zero. HI-ACT's aim is to ensure that hydrogen is appropriately integrated into the UK's future energy system by exploring the technical, environmental, social, economic, regulatory and political challenges facing the industry and policy makers.

This will be achieved by analysing the role of hydrogen and alternative liquid fuels (HALF) in the context of the overall energy landscape and to understand the requirements of all those stakeholders who can help accelerate this transition.

What HI-ACT does

Through academic research, HI-ACT aims to develop a better understanding of the potential pathways for integrating hydrogen into future energy use. Currently, there are a number of gaps in our understanding of how to integrate hydrogen into the UK's energy system, particularly around issues such as infrastructure for storage, delivery and transportation as well as demand and supply chain availability. HI-ACT intends to address these challenges by convening key industry and policy stakeholders to identify key gaps in research and knowledge to help drive forward the Government's ambitions.

By helping to develop models and demonstrators of real-world whole systems infrastructure that answers where, in what form and at what scale hydrogen integration should occur, we can drive forward a future energy market that is greener, more efficient and more secure, with less reliance on imported energy supplies.

Where are we now with hydrogen policy development?

Government ambitions

In August 2021, the Government published its Hydrogen Strategy, committing to a 'twin track' approach, capitalising on the UK's potential capacity to produce large quantities of both electrolytic 'green' and CCUS-enabled 'blue' hydrogen. The strategy also emphasised a strong focus on a "whole-system" approach to developing UK hydrogen capabilities - setting out how government and industry need to coordinate and deliver activity across the value chain and how this will evolve over time.

The government has since published several Strategy updates, the latest of which was released in August 2023. This latest update recaps the hydrogen announcements and forward look, particularly in the Powering Up Britain plan, the new Department for Energy Security and Net Zero's manifesto for the future. It reiterates an increased focus on driving significant private sector investment in the hydrogen sector to deliver economic opportunities and support UK energy independence, including a doubling of the government's low carbon hydrogen production capacity ambition to up to 10GW by 2030. It also states that government continues to place significant value on the advice and information sharing from stakeholders across the sector. This engagement will help to inform government's decision on hydrogen blending, expected later this year, as well as their decision due in 2026 on the role of hydrogen in decarbonising heat.

The Energy Bill, hailed as the longest and most significant piece of energy legislation to ever come before Parliament, is currently making its way through the final stages of the legislative process, and will aim to address a number of current unknowns, such as the role of the Future System Operator, Ofgem's Net Zero duty, the hydrogen levy, as well as specifics surrounding wider production and transport.

Key barriers and challenges to reaching ambitions

Despite these ambitions, the government continues to be in consultation-mode when it comes to the future of UK hydrogen, and there remains a lack of clarity on timelines, funding, and direction of travel. As such this has led to a certain level of uncertainty within industry, putting at risk identified private investment which could be directed elsewhere.

There is mounting pressure on government to provide a greater level of certainty on the regulatory framework that could dictate the direction of hydrogen integration in the UK.

An independent report from the UK's Hydrogen Champion Jane Toogood, commissioned by the Department for Energy Security and Net Zero (DESNZ) and published in March 2023, highlights the need for greater clarity on upcoming policy decisions for hydrogen users, further available public funding, and urgent overall delivery of the hydrogen roadmap to 2030 and beyond. The recommendations in the report are intended to address these policy and regulatory concerns, highlight project challenges, and identify opportunities for industry to contribute more to solutions.

Specific recommendations for government include:

1. *Create a plan for integrated energy infrastructure to deliver an optimal future energy system incorporating gas, electricity and hydrogen (and CO2), enabling balancing of intermittent renewable power generation. Capturing the significant wider system efficiency benefits has the potential to deliver up to £38bn cost savings. Industry and government should work more closely together to develop this plan.*
2. *Provide an integrated plan for the implementation of the Hydrogen Strategy to 2030, building on the existing roadmap. Collaboration and shared accountability between industry and government will be fostered by a visible, joined-up plan for hydrogen across government departments, coordinated by DESNZ.*

Furthermore, the Climate Change Committee's (CCC) latest progress report (published June 2023) warned that the government's target of up to 10GW of low carbon hydrogen production capacity by 2030 risks being at the lower end of what could be required for the decarbonisation of heating. It stated that the lack of a strategic direction with regards to providing low-carbon heat through hydrogen is creating systemic uncertainty. This is actively hindering the growth of supply chains and limiting progress on power and hydrogen infrastructure.

The CCC has urged government, ahead of the 2026 decision on decarbonising heating, to push forward in areas where there are no-regret and low-regret options and seek to develop and move forward with a strategic approach. Public funding models to enable hydrogen production also need to be finalised, ensuring they limit emissions, while avoiding bias towards hydrogen where electrification is competitive.

Key areas of focus to address these challenges

If we are to meet Government ambitions for hydrogen, then finding ways, through research and innovation, to overcome these barriers will be critical. A discussion on the areas of focus for research and innovation was, therefore, the focus of HI-ACT's recent workshop. The following areas were highlighted by the experts in attendance.

Improved industry and Government collaboration

Currently, there is a lack of a single cohesive narrative that brings together the multitude of stakeholders with their distinct priorities, challenges, and perspectives. This hampers the industry's ability to meet the ambitious goals set by the Government, and makes it difficult for Government to identify reliable sources of information. To bridge this gap, it is essential to foster greater collaboration and knowledge sharing among key stakeholders across the hydrogen sector.

We should look to create a platform that convenes industry experts, researchers, policymakers, and other stakeholders in the exchange of insights, expertise, and data. This collaborative approach will enable a deeper understanding of the conditions necessary for success and scaling-up within the hydrogen industry. By leveraging collective insights, valuable lessons can be learned, and best practices identified and disseminated across the sector.

Additionally, this collaborative effort will help to establish effective feedback mechanisms that provide valuable input to future decision-making processes. By actively involving stakeholders in shaping the industry's trajectory, policymakers can make informed decisions based on real-world experiences, ensuring that strategies and policies are closely aligned with sector needs.

A key outcome of this collective effort will be the development of more robust modelling tools. These tools will help improve our understanding of future scenarios and address uncertainties that may arise during the transition to a low-carbon economy. By integrating diverse perspectives and data into these modelling tools, we can enhance their accuracy and reliability, providing valuable insights to guide strategic planning and investment decisions.

Ultimately, fostering collaboration, knowledge sharing, and data-driven decision-making will help create a cohesive narrative for the hydrogen sector. This collaborative approach will enable stakeholders to work together towards common goals, drive innovation, and accelerate the adoption within a wider, integrated, approach to whole energy systems.

Planning and infrastructure

There are key questions around hydrogen demand, and associated infrastructure, that need to be answered. Demand requirements will play a pivotal role in shaping the future of hydrogen infrastructure development and utilisation, which is vital for effective infrastructure planning decisions.

1. There is a pressing need to determine **where** hydrogen infrastructure will be required. Identifying the specific locations that would benefit from hydrogen infrastructure is crucial to ensure targeted and efficient deployment. By understanding the geographical areas that hold the greatest potential for hydrogen adoption, stakeholders can allocate resources strategically and prioritise infrastructure development accordingly. This includes considering factors such as existing industrial clusters, transportation hubs, and energy-intensive sectors that could significantly benefit from hydrogen integration.
2. The timing of hydrogen infrastructure deployment is critical, in order to understand **when** hydrogen infrastructure is needed. It involves assessing the pace at which demand for hydrogen will emerge and intensify in different sectors of the economy. By understanding the projected timelines for hydrogen adoption in sectors such as metals and ceramics manufacture, transport, and power generation, stakeholders can plan infrastructure development in a phased and synchronised manner. This proactive approach enables the optimisation of resources and avoids potential bottlenecks or delays in meeting growing demand.
3. The third area is that of **how** to deliver the infrastructure which is needed. One method is to adapt and repurpose current infrastructure originally designed for other energy sources, such as natural gas. Assessing the suitability of current infrastructure for hydrogen injection, storage, transportation, and end-use, can potentially accelerate the deployment of hydrogen systems, reduce costs, and leverage existing assets.

Gaining clarity on hydrogen demand with regards to **where**, **when** and **how**, is vital for effective long-term planning and investment. In identifying the locations where infrastructure is needed and understanding the timing of demand growth, stakeholders can strategically allocate resources and ensure the timely development of infrastructure. Additionally, exploring opportunities to repurpose existing infrastructure presents a cost-effective and efficient approach to accelerate the deployment of hydrogen systems. Through robust analysis and collaboration, addressing these key questions will contribute to the successful integration of hydrogen as a clean and sustainable energy solution.

Developing well-defined business models to secure investment

There is a pressing need for the government and the regulator to provide clearer guidance and direction on the business models for hydrogen projects, and to support innovation in this space. Without a well-defined and transparent framework, it becomes challenging to gauge the effectiveness of these models and identify areas where improvements can be made.

To address this, comprehensive information must be gathered to establish a solid foundation for developing business models. This includes case studies from other successfully implemented technologies, understanding the specific needs and requirements of different stakeholders, and identifying the key factors that contribute to the success of hydrogen projects.

By analysing and sharing best practice, stakeholders can gain valuable insights into what works and what doesn't in the context of hydrogen initiatives. This knowledge exchange can help shape the design and implementation of effective business models that align with the goals of the government, industry, and other key stakeholders.

Furthermore, by fostering an open dialogue and creating platforms for information exchange, stakeholders can collectively contribute to the development of robust business models that drive the growth and adoption of hydrogen technologies. This can inform and support the role of the Future System Operator, in considering a whole energy systems approach within which hydrogen is embedded.

Additionally, it is important to recognise that the UK market for hydrogen is likely to be relatively small, and that business models may be more robust for companies who are able to develop investment models which are appropriate to multiple international markets beyond the UK.

Ultimately there is a role for research to play in gathering data, sharing best practices, and understanding stakeholder needs to help the developing business models that enable the successful deployment of hydrogen technologies.

Next steps for HI-ACT

HI-ACT is committed to facilitating a collaborative and coordinated network which will bring together government, industry and academia to ensure the effective implementation of hydrogen into the energy system. Having reviewed the initial engagement with stakeholders, the next stage of our work will look to ensure the following:

1. **Aligning HI-ACT's research priorities and timelines to support and inform key government decisions**, through conducting comprehensive research into the technical, financial and social barriers and enablers of repurposing existing energy infrastructure for hydrogen. HI-ACT will seek to engage regularly with key policymakers to ensure they are supported with the necessary information to put in place robust business models that are focussed on achieving government ambitions.

2. **Working to ensure maximum efficiency within the hydrogen knowledge-sharing space**, whilst recognising the complexity of the regulatory landscape for different parts of the energy system. HI-ACT will work to find ways of shifting the narrative on from the current binary approach of assessing the different energy components (for example, siloing hydrogen for X, electricity for Y), and take a more nuanced approach, by looking at the system as whole. A key component of this will be to take greater consideration of the actions and attitudes of the end-user, distinguishing them as an instrumental part of the journey to net zero, and consulting with them as such.

3. **Continuing to facilitate wider knowledge sharing** to enable a greater level of evidence-informed policy decision making, leading to improved modelling tools. HI-ACT will work to develop an entrenched and collaborative framework to continue to engage stakeholders across academia, industry, government in order to both address the challenges and take the opportunities relating to the implementation of hydrogen and alternative liquid fuels into the energy system. Our academics will work with representatives across the industry to explore the most effective mechanisms for knowledge sharing, including further facilitated events, the development of consortia, and creation of informative and accessible knowledge-share platforms.

APPENDICES

Appendix A | **HI-ACT Workshop** | Attendees May 2023

Sulekha Abdi, Senior Policy Advisor for Hydrogen Systems, Department for Energy Security & Net Zero (Hydrogen Strategy and Systems)

Jeremy Brutus, Head of Hydrogen Networks and Markets, Department for Energy Security & Net Zero (Hydrogen and Industrial Carbon Capture)

Simone Cooper-Searle, Head of Hydrogen Strategy, Department for Energy Security & Net Zero (Clean Heat)

Cameron Davies, Senior Strategy Adviser Department for Energy Security & Net Zero (Hydrogen Strategy and Portfolio)

Richard Halsey, Director of Capabilities / Hydrogen Advisory Council member Energy Systems Catapult

Philip Hamilton, Innovation Strategist National Gas

Mohamed Khalif, Head of Hydrogen Transport Business Model, Department for Energy Security & Net Zero (Hydrogen and Industrial Carbon Capture)

Dave Mason, Lead Energy Research Advisor Department for Energy Security & Net Zero (Science & Innovation for Climate and Energy)

Tom Mowle, Head of Hydrogen Demand Department for Energy Security & Net Zero (Hydrogen and Industrial Carbon Capture)

Kerry Mullen, Business Development Manager, Hydrogen, Hynamics, EDF Energy

Ruqaiyah Patel, Joint Head of Energy and Decarbonisation, EPSRC (Engineering & Physical Sciences Research Council)

Josh Peacock, Hydrogen Technical Adviser Department for Energy Security & Net Zero

Barnaby Powell, Head of Offshore Energy Integration, Engineering & Physical Sciences Research Council (Net Zero Strategy)

Chris Quarton, Hydrogen Technical Adviser Department for Energy Security & Net Zero

Jon Saltmarsh, Chief Technology Officer Energy Systems Catapult

Henry Tse, Director of New Mobility Technologies, Connected Places Catapult

James Walker, Interim Head of Hydrogen Strategy, Ofgem

David Watson, Head of Energy Transitions Cadent Gas

The workshop in May 2023 was facilitated by Professor Sara Walker and Professor Paul Dodds.

Appendix B | **HI-ACT research programme**

The Programme will be delivered through four interconnecting Work Packages brought together to collaborate on Hydrogen and Alternative Liquid Fuels (HALF) Use Cases.

The Way Forward

There are significant gaps between current levels of hydrogen production, transportation, storage, conversion, and usage, and the estimated requirement for achieving net-zero by 2050. HI-ACT will develop forward-thinking HALF technology roadmaps; assess the supply chain availability and security; identify and quantify the opportunities, risks and dependencies of selected representative HALF use cases, which will provide building blocks to the whole-system analysis; and develop an overarching roadmap for HALF system integration in order to inform technology advancement, industry and business development, as well as policy making and social interventions.

Whole System Understanding

This work package will push the boundaries of whole systems methodologies, improving HALF characterisation and exploring urgent new perspectives on the energy transition, including those related to ensuring resilience and security while also achieving net-zero, and contrasting the energy transition delivered by real incentives/behaviour versus those projected by widely-used optimisation models. It provides the whole systems modelling engine of the HI-ACT Hub, with a diverse array of state-of-the-art tools to explore HALF integration.

Cyber Physical Architecture

Our academics will explore the vital coupling of data and information relating to whole system planning and operational decision support through the creation of a cyber physical architecture (CPA). The CPA will synchronise digital assets with physical networks, within a digital modelling environment. This will generate new learning on current and future opportunities as well as risks leading towards a whole system ontology for accelerated integration of hydrogen technologies.

Social and Political Perspectives

This work programme will consider solutions or options for a future Whole Energy System (WES) which incorporates HALF from a number of perspectives, as represented by the stakeholder groups in the diagram below. The first is to consider expert views on HALF energy futures, and the public perceptions of those views. The second is a perspective which considers place-based options for social benefit in WES+HALF transitions. The third is to consider regulatory and policy options which would better enable the WES+HALF futures which the other WPs are investigating.