



# Hydrogen Capability Network



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SECURING LIQUID HYDROGEN CAPABILITY IN THE UK

May 2024



 FlyZero's LH<sub>2</sub>-powered, zero-carbon emission, midsize aircraft concept

## ABOUT THE

# AEROSPACE TECHNOLOGY INSTITUTE

The **Aerospace Technology Institute** (ATI) is an independent organisation that works alongside government and industry to transform UK aerospace through technology and innovation. The ATI is funded equally by the Department for Business and Trade (DBT) and by industrial recipients of project grants who pay a small levy. ATI projects are chosen and overseen through close collaboration with Innovate UK and DBT.

As well as running this portfolio of R&T projects, the ATI conducts strategic research projects to help define and answer systemic questions of value to the UK aerospace sector. In 2022 the ATI published the findings of the **FlyZero** project, which concluded that liquid hydrogen is the most viable zero-carbon emission fuel with the potential to scale to larger aircraft.

The ATI Programme has made several investments in liquid hydrogen technologies to support the next generation of zero-carbon aircraft. The **Hydrogen Capability Network** was launched in April 2023 with support from the Department for Business and Trade, to progress key recommendations from FlyZero which will enable the aerospace sector to deliver liquid hydrogen research & development (R&D).



**Department for  
Business & Trade**

*Funded by the Department for Business and Trade.*

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# ABOUT THE HYDROGEN CAPABILITY NETWORK

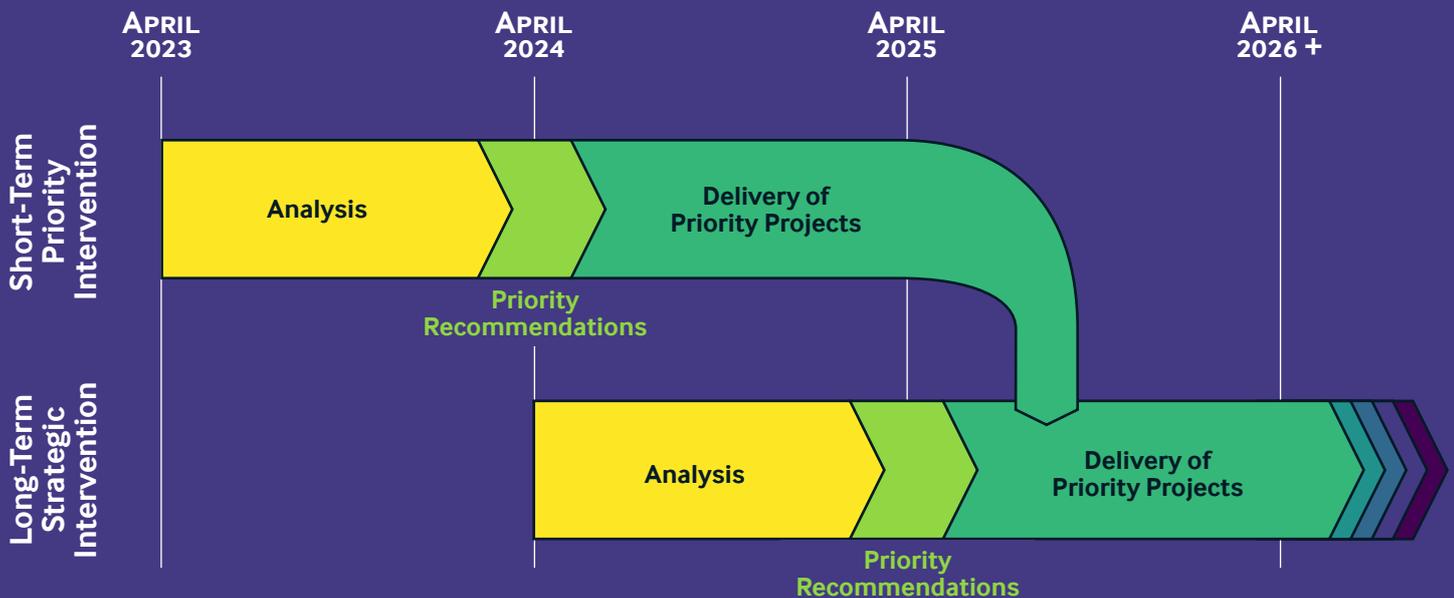
Established in April 2023, the **Hydrogen Capability Network (HCN)** has worked with sector stakeholders to develop the key recommendations from **FlyZero** and determine the **immediate priorities for action**. Recommendations on the **longer-term strategic interventions** required to enable liquid hydrogen (LH<sub>2</sub>) powered flight will be published in mid-2025.

The HCN’s aim is to ensure that there is collaboration, coherence and efficiency for the aerospace sector to enable hydrogen research and development. It is focussing on test and demonstration infrastructure, fundamental and enabling research, and hydrogen skills. The HCN works on behalf of the sector through a network of stakeholders and delivery partners.

The initial phase of the HCN project concluded in April 2024 and the ATI, with the Department for Business and Trade, has launched a new phase of work to take forward the immediate priorities into delivery and develop proposals and recommendations for the longer-term strategic needs of aerospace R&D.

This document outlines the immediate priority action areas and next steps. Action in these areas will make the UK a world-leading destination for hydrogen research and development and secure competitive advantage.

Hydrogen Capability Network timelines



The **immediate priorities for action** are:



### Test Infrastructure

Establish UK medium-scale hydrogen test hubs to provide the required testing infrastructure, LH<sub>2</sub> supply and expertise to satisfy UK aerospace priority test needs.



### Research

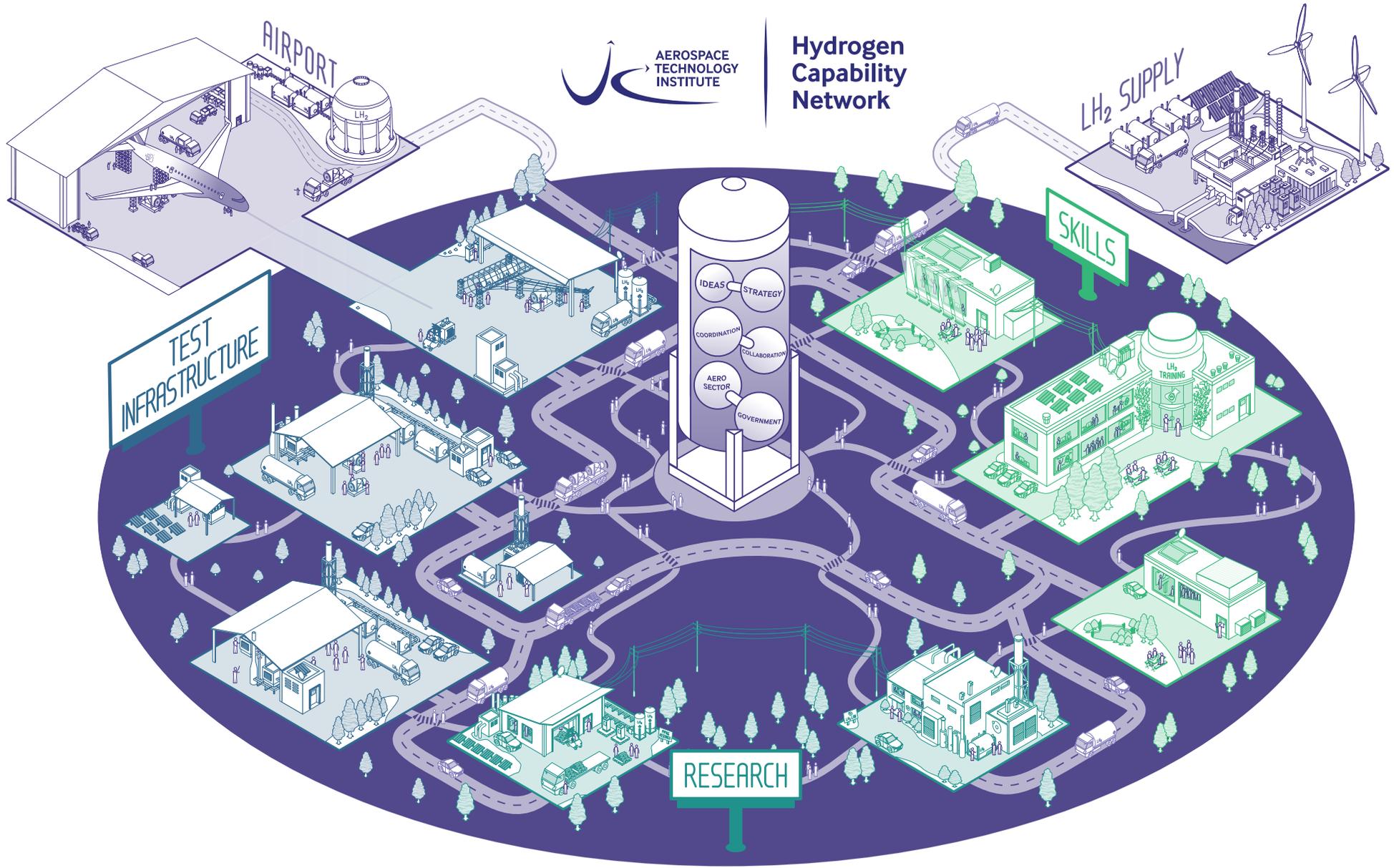
Implement a collaborative strategic research programme on Cryogenic Hydrogen Materials Testing Standards (CHyMES) to enable product design and certification.



### Skills

Launch pilot initiatives to accelerate action on skills and coordinate the sector's skills needs in cryogenics and LH<sub>2</sub> systems.

Implementing these immediate priorities for action will ensure that the UK becomes the most attractive destination for hydrogen testing and will build a world-leading ecosystem of technology development, academic research, and a first-class skills base.



# Hydrogen Capability Network

# CONTEXT

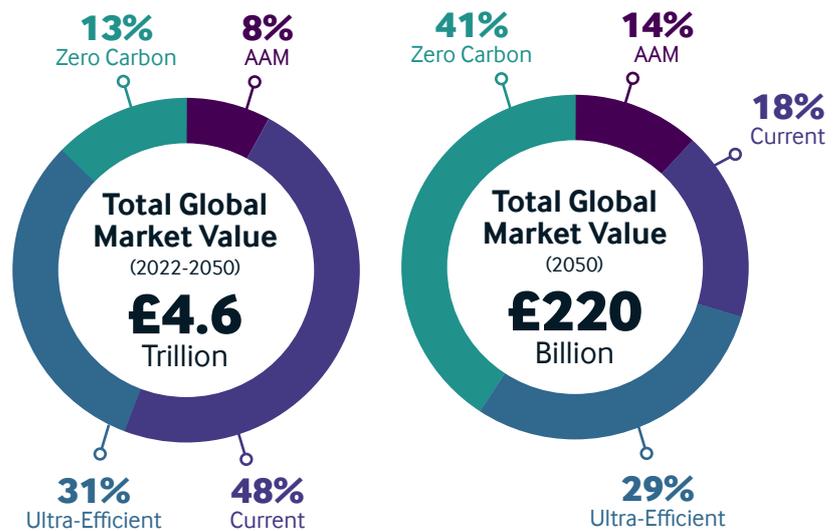
The **FlyZero**<sup>i</sup> project concluded that liquid hydrogen is the most viable zero-carbon emission fuel with the potential to scale to larger aircraft. Amongst the many reports published, FlyZero identified a UK gap in liquid hydrogen capability. At the same time, the ATI published the UK aerospace technology strategy, **Destination Zero**<sup>ii</sup>, which identified that the UK could grow its market share from 13% to nearly 18% by 2050, as aircraft fleets transition towards zero-carbon emission technologies.

**£91 Bn**

2050 forecasted annual global market for zero-carbon aircraft

**£16.4 Bn**

Potential UK market share in 2050 for the development of zero-carbon aircraft



Achieving this market share is contingent on continued investment in technology development, regulation, and infrastructure. Hydrogen aircraft deliveries are forecast to create a **global market opportunity of £34bn by 2050**. Having identified that other countries are already planning, or have commissioned, facilities and initiatives to support their domestic supply chain, in 2023 the ATI set up the Hydrogen Capability Network.

The HCN project aims to make strategic interventions and investments to maximise UK industry competitiveness in the emerging liquid hydrogen-powered flight market. Over the past 12 months, the HCN team has connected with over **260 stakeholders** from across the UK. This has included **90+ face-to-face discussions and site visits**; and **over 100 attendees from 44 unique organisations** to our testing, research, and skills workshops.

<sup>i</sup>The ATI's **FlyZero project** material.

<sup>ii</sup>The ATI's 2022 technology strategy document - **Destination Zero - The Technology Journey to 2050**

# TEST INFRASTRUCTURE

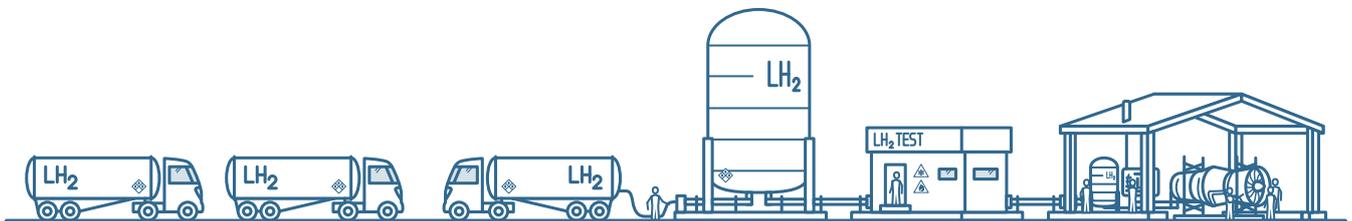
## IMMEDIATE PRIORITIES



### Recommendation:

Establish UK medium-scale hydrogen test hubs to provide the required testing infrastructure, LH<sub>2</sub> supply and expertise to satisfy UK aerospace priority test needs.

The HCN collated the demand signal for liquid hydrogen testing in the UK and how this will change over time. This was informed by industry testing plans and included the technical and strategic requirements for UK based infrastructure. As part of this analysis, the HCN looked at the immediate needs for testing at large volumes and with high flow rates as well as consolidating the demand from 19 UK based aerospace organisations. Fluctuation in this demand prediction can be expected as LH<sub>2</sub> test programmes become more mature in the coming years, however forecasted demand currently shows a quarterly average usage of 11 – 22 tonnes of LH<sub>2</sub> until around 2030. This is the equivalent of approximately 3 tankers delivering LH<sub>2</sub> into the UK each month.



 **2 to 3 tankers of LH<sub>2</sub> will be required each month to satisfy UK aerospace testing demands until 2030.**

Given the size of the demand and the geography of the requirement, the HCN has concluded that creating bespoke test hubs will be the most effective way to create economies of scale and ease of access for industry. These proposed hydrogen hubs will operate an open-access model, allowing research and testing to be undertaken by UK entities in a representative LH<sub>2</sub> environment. They will also play a crucial role in meeting the technical and strategic requirements for UK-based infrastructure identified during the analysis phase of the project.

The HCN's analysis suggests that at least two bespoke hydrogen test hubs will be required in the UK to meet future testing demand. The HCN examined several UK-based site options and has concluded that the sites with the highest potential to develop medium scale test capability now are the **Health and Safety Executive's** (HSE) site in Buxton, and **Airbus'** site in Filton.

# TEST INFRASTRUCTURE

## NEXT STEPS

The HCN will now secure the building and commissioning of the two hubs and develop a strategy for supporting hydrogen testing requirements over the next decade. This will identify the long-term requirements for larger-scale hydrogen testing, certification, and demonstration in a representative airport environment. It will consider the UK's supply of LH<sub>2</sub> and explore price incentive mechanisms with government.

The UK is at a turning point when it comes to hydrogen research and the HCN will continue to work with others in the community who are developing their hydrogen infrastructure. Testing at various scales has different requirements, and the HCN aims to create a network of UK test infrastructure which is complementary and provides the sector with sufficient capacity and capability to satisfy test demands.



# RESEARCH

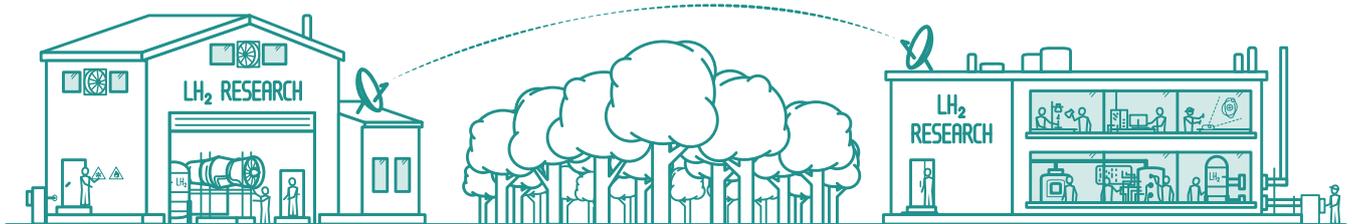
## IMMEDIATE PRIORITIES



### Recommendation:

Implement a collaborative strategic research programme on Cryogenic Hydrogen Materials Testing Standards (CHyMES) to enable product design and certification.

The consistent message from industry is that there is an urgent need for cryogenic material test standardisation to enable technology development in the UK. The development of standards and test methods is a non-competitive area and building knowledge in this space will benefit the entire UK supply chain, and accelerate further R&D. For cryogenic technologies to achieve TRL 6 by 2030, materials testing and standards need to be developed now. Growing the UK's expertise in this area will provide a strategic advantage and the knowledge to enable testing at larger scales. Therefore, the HCN has recommended the establishment of a 4-year collaborative strategic research programme for materials - the **Cryogenic Hydrogen Materials Testing Standards (CHyMES) project**. The project will develop, validate and standardise materials test methods and to provide the UK supply chain with this data and knowledge.



The HCN has also identified that an overarching strategy is required for research in cryogenics and to align research activity to the sector's industrial requirements<sup>iii</sup>. Through workshops and consultations with industry and academia, the following strategic research topics have been identified as requiring further development:

- ▶ **Cryogenic Hydrogen Thermofluids**
- ▶ **Cryogenic Hydrogen Health and Safety**
- ▶ **Fundamental Materials Behaviour in Cryogenic Hydrogen Environments**

<sup>iii</sup>The [HCN's Research Proposal](#) provides an overview of the case for intervention in this area as well as the HCN's plan of action through Phase 1 and beyond.

# RESEARCH

## NEXT STEPS

The HCN will begin delivery of the CHyMES project, which will be conducted in partnership with the **National Physical Laboratory** (NPL) and other universities and research organisations who will be invited to contribute. It will also publish a report with the NPL to provide an overview of the international landscape in cryogenic material testing<sup>iv</sup>.

In parallel, the HCN will work with subject matter experts to scope and develop the strategic research topics listed above. It will also design a joint funding programme and competition to support research topics which arise in the future. EPSRC, UKRI and other organisations will contribute to shaping this longer-term vision.

<sup>iv</sup> The report will be published later in 2024, but an overview of the recent collaboration can be found [on the NPL website](#)



# SKILLS

## IMMEDIATE PRIORITIES



### Recommendation:

Launch pilot initiatives to accelerate action on skills and coordinate the sector's skills needs in cryogenics and LH<sub>2</sub> systems.

UK industry is struggling to recruit suitably qualified and experienced people to support current technology development, particularly relating to a shortage of cryogenic hydrogen skills\*. This is due to a global shortage of skills and the HCN has identified a need to accelerate the sector's approach to future skills through a set of pilot initiatives.

The HCN examined other burgeoning technology areas that have required similar initiatives to build their UK skills base. Examples from other sectors include the [Nuclear Skills Academy](#), the [Faraday Institution](#) for battery technologies and the [Alan Turing Institute](#) which is supporting the development of skills in artificial intelligence. Using these models, the HCN has recommended adopting their best practices to develop skills for cryogenics in aerospace.



\*The [HCN's Skills Proposal](#) provides an overview of the UK's current skills landscape, case studies from other sectors and the HCN's plan of action through Phase 1 and beyond.

# SKILLS

## NEXT STEPS

The HCN has identified the following key deliverables to pilot in the next phase of the project.

- ▶ **Building a 'hydrogen in aerospace' community** - Trial enrichment activities to connect researchers and academics to industry through site tours and expert seminars. This could be delivered through running hackathons, mini-MBA modules, and a cryogenic hydrogen research conference to grow the community in this space.
- ▶ **Signposting** - Establish a public database of UK and international training opportunities, which will also promote PhD and employment opportunities.
- ▶ **Training support** - Offer bursaries for applicants to join training courses and conferences.
- ▶ **Secondments and learning placements** - Encourage the transfer of skills from adjacent sectors into aerospace and promote international opportunities with world-leading experts.
- ▶ **Explore Continuing Professional Development (CPD) opportunities** - Working with delivery partners to identify routes for CPD.

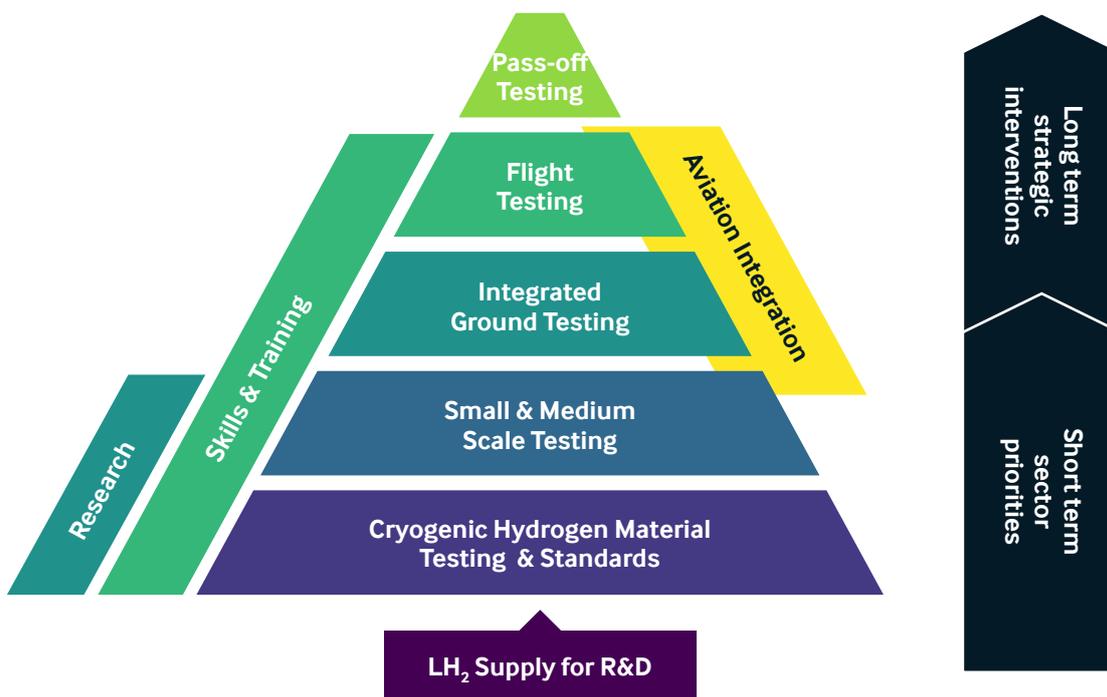
Alongside this, the proposed hydrogen hubs and CHyMES project will provide opportunities for 'learning-by doing', and will increase the sector's knowledge, capability, and familiarity with dealing with cryogenics.

The HCN will also continue to develop a strategy for a UK 'hydrogen in aerospace' skills roadmap working closely with the [Aerospace Growth Partnership](#) and the [Hydrogen Skills Alliance](#) to identify a route for a future cross-sector hydrogen academy.



# CONCLUSIONS

The UK has a unique opportunity to become a leader in hydrogen testing and to build a first-class ecosystem of technology development, research and skills. Over the next 12 months, the HCN will focus on mobilising and delivery of the immediate priorities for action which have been identified in this report. These key priorities will require support from industry, academia and government in order to accelerate and grow the sector’s knowledge, capability and expertise.



**HCN short- and long-term priorities and interventions**

Developing this ecosystem provides the UK with a strong foundation to achieve the longer-term ambitions for the UK sector: larger-scale testing, demonstration in an airport environment and ultimately the design and manufacture of liquid hydrogen aircraft technologies.

The HCN will develop an overarching sector strategy for hydrogen development in aerospace in the UK. This will include what interventions are required in the long term to further develop this ecosystem as understanding and testing becomes more mature. This strategic overview will complement the [ATI’s technology strategy](#) which focusses on priority technology areas and the work of the [Jet Zero council](#) which is investigating sustainable aviation fuels (SAF) and the regulatory framework required to deliver zero emission transatlantic flight within a generation.

## Stay in Touch

To keep up to date on HCN progress through reports, publications and news you can access our website at [ati.org.uk/hydrogen](https://ati.org.uk/hydrogen) where you can also sign up to receive more regular updates.

For specific questions or to participate in HCN activity, get in touch directly with the project team by emailing [hydrogen@ati.org.uk](mailto:hydrogen@ati.org.uk)



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