AEROSPACE TECHNOLOGY INSTITUTE

Hydrogen Capability Network

Global Landscaping Tendering Process

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Executive Summary

The UK has a strong heritage in aerospace technology development, including well-established research capability within its universities, academic institutions and research and technology organisations. The move to liquid hydrogen as a fuel source, as recommended by the ATI's FlyZero project, will be the biggest disruptor to the aerospace technology landscape since the introduction of the gas turbine. The transition to liquid hydrogen will require significant and rapid development of new technologies if the UK is to maintain its market share; the UK already has strengths in many of these areas, underpinned by a strong research base and innovative industrial R&D network. Nonetheless, a hydrogen fuel storage and delivery system will require a greater depth of knowledge of the behaviour of cryogenic hydrogen than is currently present within industry or academia. Thus, the ATI's Hydrogen Capability Network (HCN) has identified a need to bolster research in the UK to support fuel system technology development, with a particular focus on fundamental and pre-normative research to ensure the knowledge can be leveraged throughout the UK aerospace supply chain.

During the first 12 months of the HCN, the following topics were identified as requiring particular focus:

- Cryogenic hydrogen thermofluids behaviour
- Multiphysics understanding of materials at cryogenic temperatures
- Health and safety modelling of failure cases for cryogenic hydrogen systems and validation
- Hydrogen handling protocols.

To assist the identification of priority topics, a mapping of the global capabilities in these topics is required. This report details the tendering process and timescales for each step to enable organisations to indicate their interest in contributing to this landscaping process.

Introduction

The FlyZero project developed roadmaps covering the technologies needed for liquid hydrogen flight to be viable[1]. These cover topics that are both generic (such as automation and digital twins) and specific (such as aerodynamic modifications to manage dry wings, fuel cell development and gas turbine hydrogen combustion). In work carried out by the Hydrogen Capability Network (HCN), involving engagement with key stakeholders, it has been demonstrated that the UK has strong existing knowledge and research capability in many of the topics required to deliver an aircraft capable of liquid-hydrogen-powered flight. There is, however, a clear exception with on-aircraft cryogenic hydrogen fuel storage and delivery systems. Thus, intervening to accelerate the development of fundamental knowledge and capability in this area within the UK will enhance the UK's ability to contribute to the development of zero carbon aircraft. This aligns directly with both Government's Net-Zero policy objectives and the objectives of the HCN.

The challenge relates specifically to the storage and movement of hydrogen fuel between the fuel tanks and power source across a large range of fluid temperatures and pressures. Key research areas include the management of the transition from liquid to gaseous states in a controlled manner to ensure component function and life; the impact of hydrogen on the component integrity; and how to sense and manage hydrogen leaks safely, particularly in flight. While the requirements have initially been driven by aerospace, there is relevance to other sectors that have plans for the use of liquid hydrogen in the future, and a link to these requirements is being maintained through the Hydrogen Innovation Initiative (HII)[2].

During phase 1 of the HCN the key challenges and knowledge gaps in the UK will be identified, and to support this there is a need to complete an assessment of global capabilities, both to identify critical gaps and potential partners for future collaboration. This report details the tendering process for organisations to bid to carry out a desk-based assessment of the state of the art globally, with the objective of delivering reports for publication by the end of December 2024

Timeline

The timeline is illustrated in Figure 1; the deadlines are very tight due to the deadline for report delivery of the end of December 2024 to allow for the conclusions to influence the topic prioritisation process and input to the final report outlining research requirements.

[1] FlyZero Reports Archive - Aerospace Technology Institute (ati.org.uk)
[2] Home - Hydrogen Innovation Initiative

Figure 1 Global Capability Mapping Timeline

Themes

Bids are requested for establishing the global state of the art in the themes given below; these are not exhaustive and are likely to evolve during the project as a part of the monitoring process. Work packages can comprise some or all the themes, but this should be explicit in the quotation. The focus should be for low TRL fundamental capabilities, including expertise, modelling and experimental. The exception to this is for sensing technology, which will aim to establish what technology can be used within the other themes.

Materials

- Fundamental science behind low temperature and hydrogen effects on materials. Including thermal, mechanical, chemical effects - gradients and cycling, considering experimental and modelling.
    - Structural materials –
        - Metallics focus
    - Sealing materials (polymeric, elastomeric, metallic)
    - Effects of joints and points of integration (welding, bonding, etc.)
    - Multiscale, multi-physics.

H&S

- Fundamental science behind cryogenic hydrogen Health and safety
    - Causes (materials & Sealing) – preventative – focus of materials work
    - Loss of containment event (leakage & dispersion) - (link to thermofluids?)
    - Consequences (Low temperature / Ignition and flammability hazards) – Mitigative focus of H&S work
    - State of standards, guidance and regulations
        - Applicability in aerospace case
        - Human factors (training, skills competencies?)

Thermofluids

- Fundamental science behind cryogenic hydrogen thermofluids – experimental and modelling
    - Heat transfer, Mass transfer, Fluid dynamics, considering Multiphysics multiscale, multi-fidelity modelling techniques & experiments
    - Considering these scenarios, storage, pipe flow, pressurisation, heat exchange, loss of containment

Sensing Technologies

- Current landscape and aerospace applicability

The draft reports for the workshops that have helped scoped out these topics is available on request to the HCN mailbox (Hydrogen@.ati.org.uk). These have not been formally released, so must be used only for the purposes of generating a bid and not shared with other parties, both internally and externally.

Deliverables

The primary deliverable will be a report detailing the capability within the relevant topic, including, but not limited to, who is researching in the area, their capabilities (both experimental and modelling), level of maturity (experience and TRL), validation and verification, existing research programs, levels of investment and any gaps identified. Links to relevant websites or other sources of information should be included to facilitate follow up. Final approval of the report will be by the Hydrogen Capability Network and it will be made publicly available on the ATI's website.

The report will be used to inform the prioritisation of the research topic areas required to support the development of hydrogen powered flight and hance make recommendations to the Department of Business and Trade.

Quote Submission and Costings

The format given in Appendix 1 Quotation Format should be used for submitting proposals.

As outlined above, the exercise should be desk-based, so costs are expected to be primarily for personnel. The total budget is of the order of £250k to cover all topics. Bids can be for work in all the topics listed, a single topic or a subset of a topic, but this must be specified clearly in the application.

The proposed time timeline for the work should be stated in the bid; the final deadline for completion of the activity is the 20th December 2024 and all bids must adhere to this, although earlier completion is acceptable.

Queries regarding the tendering process and work scope should be emailed to the Hydrogen Capability Network Mailbox (Hydrogen@.ati.org.uk) and FAQs will be published and updated weekly on the ATI's website.

The deadline for submission is the 12th July 2024.

Project Down Selection

All proposals will be reviewed against the following criteria:

- Recognised expertise in the relevant area
- Cost and value for money
- Resource availability

- Timescales
- Relevance of proposal

Initial reviews will be carried out by the HCN Head of Skills & Research and HCN Technical Lead, with prospective projects being invited for interview during the week commencing the 15th July. Final approval and buy-off will be carried out by the HCN Programme Director.

If particular topics are underrepresented within the bids submitted, specific institutions may be approached to bid.

A more detailed timeline of the bidding process is given in Figure 2.

Figure 2 Timeline for tendering process

Project Terms & Conditions

The project terms and conditions are outlined in the research contract document available on request.

Project Review

There will be a launch meeting of the project at which the experimental research and consultancy team will provide a plan showing all the key activities of the offload. This will be agreed jointly at this meeting to ensure the scope and expectations are in alignment. This will be maintained with all changes and be updated throughout the duration of the offload.

Each work package will be reviewed monthly; draft reports will be reviewed, not presentations, to ensure timely progress. Dependent on the outcome of the work, the HCN and the supplier can agree to pivot the topics and themes being analysed to ensure on-going relevance of the work. This will be recorded, and plans updated accordingly. The content of the report will also be reviewed to ensure

the required level of detail is included and if necessary additional material may be requested and agreed and this too will be recorded.

Project Conclusion

Once the final report has been approved by the HCN, it will be published by on the ATI website and the final invoice can be submitted. The output from the reports delivered will be used to inform recommendations made to the Department for Business and Trade, and the institutions who have contributed to the understanding of research landscapes will be acknowledged.

Appendix 1 Quotation Format

HYDROGEN CAPABILITY NETWORK EXAMPLE OF ACADEMIA PROPOSAL FOR GLOBAL LANDSCAPING

This document provides an example of the proposed structure for a proposal against an Academic Statement of Work. Please follow the guidance given below. Proposals should be submitted using your own letterhead documents.
Any further questions can be addressed to the Hydrogen Capability Network Mailbox (Hydrogen@.ati.org.uk).

INTRODUCTION

(Max 400 words)
Reference Title
Introduction to the proposed research group(s) involved

PROPOSED WORK PLAN

(Max 400 words)
Define the proposed research work plan and how you would address the Statement of Work

RESEARCH CAPABILITY AND EXPERIENCE

(max 400 words)
Detail out relevant experience and potential for making a significant contribution to the Hydrogen Capability Network's objective of identifying low TRL research to support the development of hydrogen powered flight.

RESOURCE AND TIMELINE

(Max 400 words)
Detail the people and facilities resources you would expect to leverage onto this project. Confirm that you can support the timing expectations defined in the statement of work.

PRICE

Broken down costs (people, facilities, materials, overheads, other)
Details of proposed payment plan

Please submit completed proposal to Hydrogen@ati.org.uk