SARC Meeting – 8/9 June 2023

UK-ARC update

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UK-ARC forward plans

Aerospace technology Institute developments

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UK AEROSPACE RESEARCH CONSORTIUM

UKRI Engineering and Physical Sciences Research Council

Advancing UK Aerospace Research through University Collaboration

The 11 founding member universities:

University of Bristol · University of Cambridge · Cranfield University · Imperial College London · Manchester 1824 The University of Manchester · University of Nottingham UK | China | Malaysia · Queen's University Belfast · The University Of Sheffield. · University of Southampton · University of Strathclyde Glasgow · Prifysgol Abertawe Swansea University

AIMS

Supported by the UK's Engineering and Physical Sciences Research Council (EPSRC) with the aim to provide:

1. A simplified **point of contact** into aerospace and aviation research, continually growing the community.
2. Development and **delivery of excellent research**, aligned with the sector.
3. Strengthened **international collaborative research** relationships.
4. Coordination for development of **world-class university strategic facilities**.
5. Nurture the **future aerospace technology skills**.

A growing network of experts working across aviation and aerospace

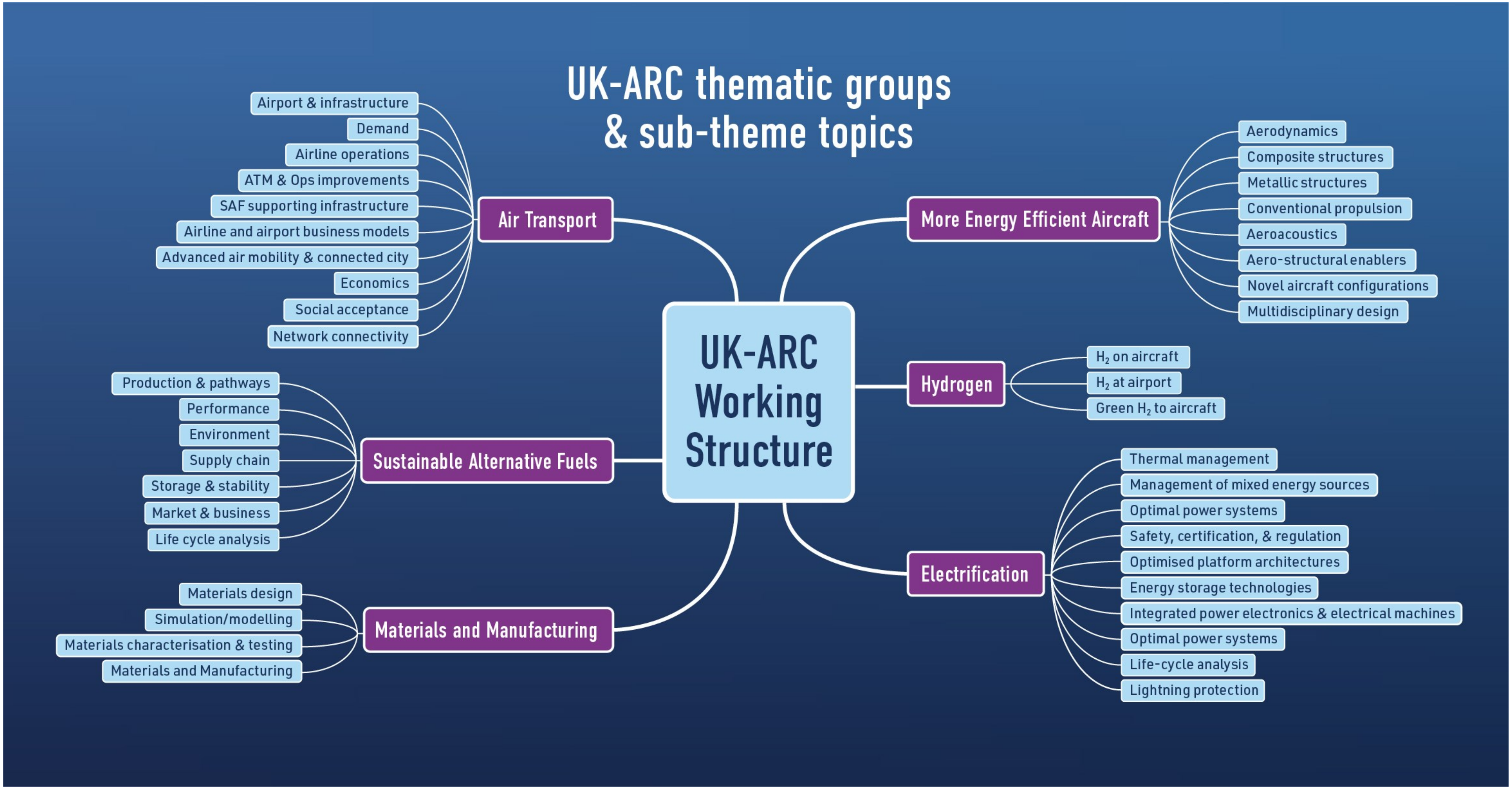
Purpose

- Deliver connectivity and intel - Expand community engagement within and beyond academia and its value to the sector
- Prime research that supports aerospace - Foster aligned research that feeds up to industry and to the aviation community
- Assist national growth agendas - Respond to UK HMG strategies to nudge university research
- Best payback for public investment - Leverage lower TRL research investment to bolster sector innovation
- Provide a window into academia - Build greater awareness and visibility of academic research
- Exploit common interests across national borders - Promote our participation internationally linked to sector plans

Connectivity

- Linking to:
- UK
  - Other research networks – National Wind Tunnel Facility, Acoustics, Vertical Lift, Fluids, Hydrogen
  - ATI strategy
  - UK and multi-national manufacturers
  - Jet Zero Council and aviation system interests
  - Catapults, HVMCs, Connected Places Catapult (aviation)
  - Future Flight Challenge on UAM and drones
- International
  - GARTEUR, EREA, ACARE, EASN, ICAS
  - Bilaterals -

A strong net zero focus, linking with industry



More Energy Efficient Aircraft

- Growing aerodynamics interest
- Digital twins
- Model and data access
- Connecting with the other themes

MORE ENERGY EFFICIENT AIRCRAFT

Leads
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Lighter Metallic Structures

- Improved manufacturing processes
- Improved materials

Lighter Composite Structures

- Improved manufacturing processes
- Improved materials

Multi-Disciplinary Optimisation

- Exploit different topics synergistically
- Pathways to certification

Conventional Powerplant

- Higher BPR
- Improved propellers
- Use of SAF

Aeroacoustics Modelling and testing

- Improved modelling and prediction
- Improved test capabilities

Aerodynamics Modelling and Testing

- Flow control
- More accurate ROMs
- Better edge of the flight envelope modelling
- High speed
- Optimised geometry
- Improved test facilities

Aero-Structure Enablers

- Aeroelastic Tailoring
- Morphing
- Loads alleviation
- Flutter Suppression

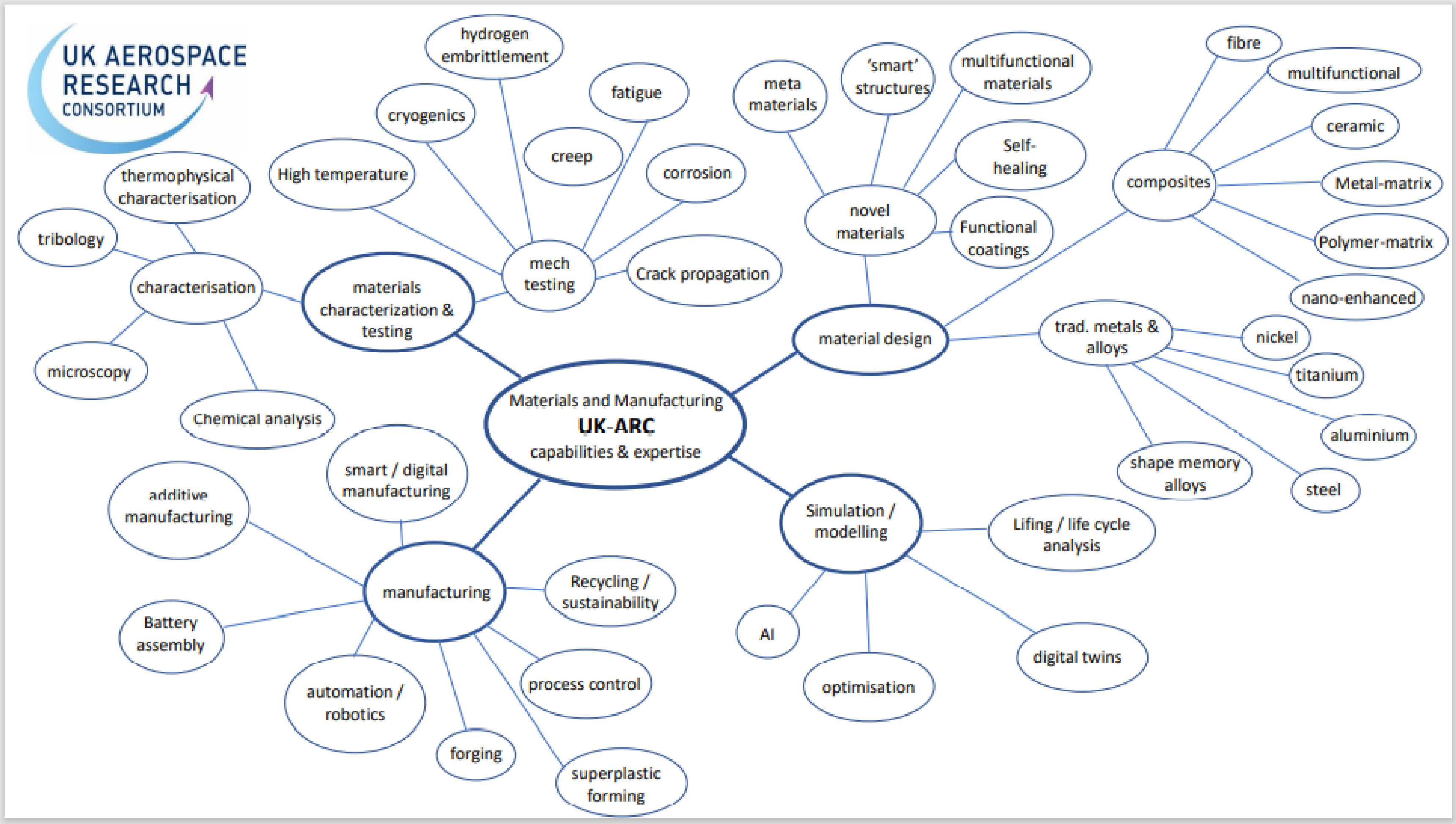
Non-traditional Configurations

- HARW
- BWB
- Strut braced wings
- Joined wings
- Distributed propulsion
- H2 and electric designs

Material and Manufacturing

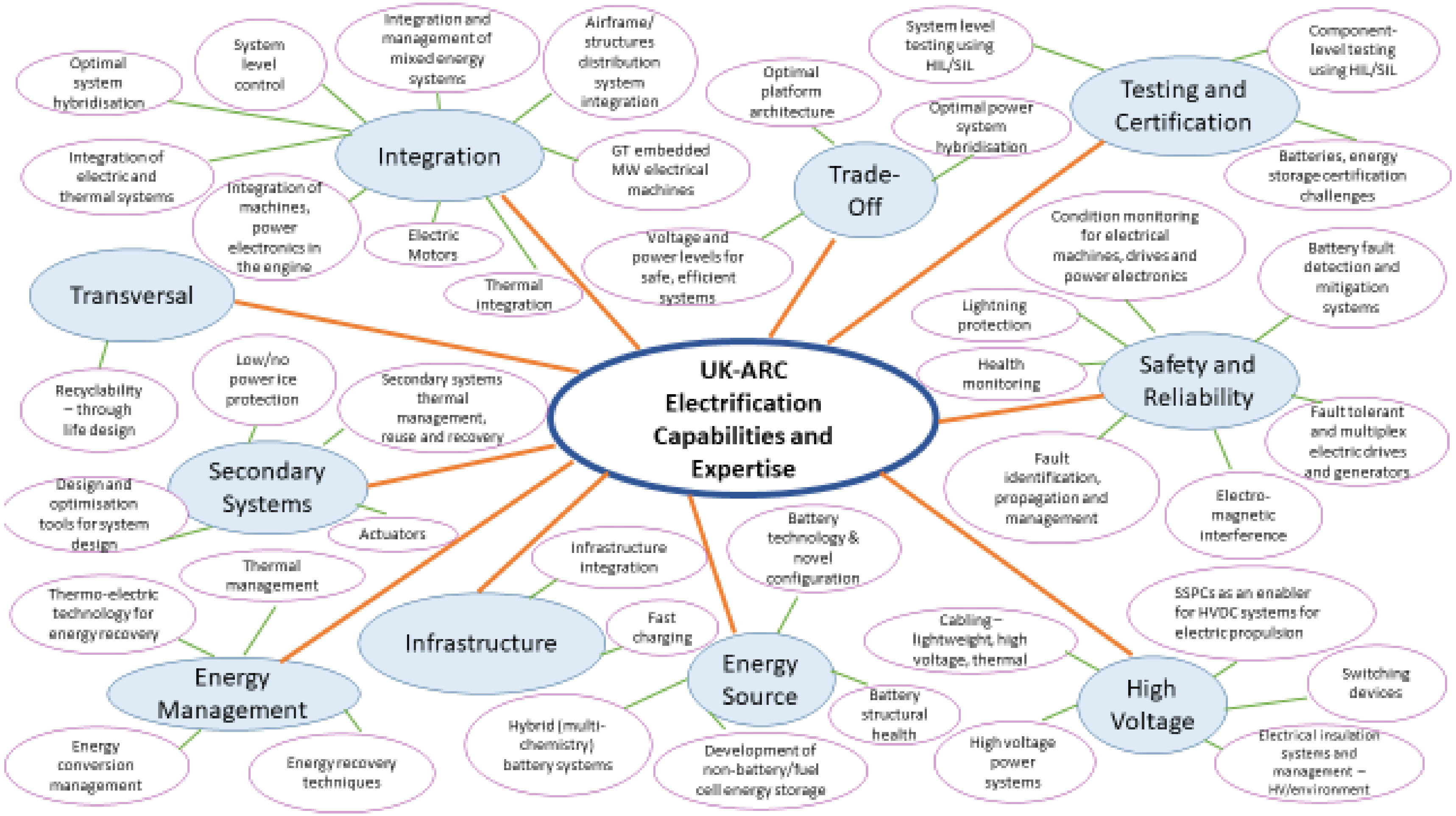
Considering the challenges, e.g. :

- Hydrogen – cryogenics/embrittlement
- Composite/multi-materials
- Electrification – thermal management
- Structures – weight saving – bio-based materials
- AM implementation



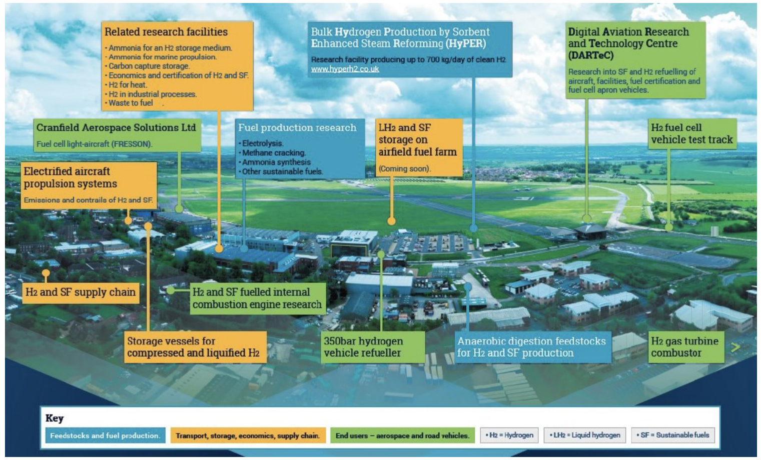
Electrification

- Strongly emerging topics in blue
- GT-embedded machines, H2 and all electric
- Digital twins
- Integration
- Thermal issues
- Batteries



UK AEROSPACE RESEARCH CONSORTIUM

H2



- Building on the thrust of the ATI FlyZero project
- Importance of links with other groups and sector interests
- Theme narrative now developed
- Leverage knowledge from projects such as EU ENABLE H2
- Awareness of certification hurdles
- Importance of international programme context
- Building capability and identifying research facility needs

H2 in the Aircraft
H2 aircraft design and performance analysis
H2 propulsion system design, integration, and performance analysis (gas turbines (including advanced cycles – intercooling, recuperation, pressure rise combustion etc.), fuel cells, hybrid and turboelectric + distributed propulsion).
LH2 tank design, manufacturing, and aircraft integration
LH2 tank fluid movement modelling (sloshing), sensors and gauging
LH2 fuel system thermal management and control (fuel supply system from tanks to “consumer” (either fuel cell or gas turbine))
Aircraft engine and combustion noise
Low NOx H2 Combustion
Contrails modelling and aircraft trajectory optimisation for contrail avoidance (incl. trade-offs with mission fuel burn).
Dual-fuel aircraft (H2 and other (e.g., Jet A-1 or Natural Gas))
Technoeconomic Environmental Risk Assessments (TERA) (Mission level and over the life cycle)
Materials and Manufacturing

H2 in the Airport
H2 aircraft ground operations and airport infrastructure
H2 safety (airport, storage, aircraft, refuelling)

H2 to the Airport
H2, NG and nuclear gas turbines and rotating equipment for land and marine
H2 from renewables
H2 from fossil fuels and CCS
Seawater electrolysis (necessary to protect freshwater supplies)
Automotive and FCs and ICEs for marine

Cranfield University

Low NOx H_2 Combustion Roadmap

as presented during the Advanced Low NOx and H_2 Combustion Workshop 2022 in Florence

	Priorities / Research Gaps	2030 Target(s)
1. Climate Impact – Emissions (NOx)	• Ground-level ozone - Implication on local air quality • Depletion of ozone in stratosphere • Contribution of LTO and cruise NOx on radiative forcing	TBD by atmospheric scientists - subject experts
2. Combustor Design (for Low NOx)	• Technology selection (scalability and extensibility) • For innovation wave 1 (not fully optimised for NOx): emphasis on delivering a working hydrogen combustor (which meets all performance and operability requirements) • For ultra-low NOx: Evaluate benefits/challenges of further enhancing mixing and flame stabilisation, e.g. swirl, increased premixing, auto-ignition/flashback mitigation, fuel staging, control etc. • Engage with the stationary gas turbine low-NOx H2 combustion community to capitalise on lessons learnt	TRL6+ for non-optimised TRL3/4 for ultra-low NOx

3. Numerical Methods	• Improving understanding of flow physics - hydrogen-air mixing, reaction, flashback NOx emissions and thermoacoustics:
	  • Comprehensive experimental datasets are key
	  • Engage with CFD software developers to improve predictive capability of commercial software
	• Use validated and calibrated CFD models for rigorous design space exploration and optimisation of hydrogen combustion systems
	• Perform Technoeconomic Environmental Risk Assessment (TERA) studies (design space exploration and MDO / trade-off studies) to assess implications of engine cycle parameters on mission fuel burn, NOx and Contrails – identify cycles that will deliver minimum environmental impact (using verified lower order models and **system integration tools**)
		1. Numerical models with improved predictive capability relative to current SOA
		2. Demonstration of coupling of SOA methods with AI techniques

Low NOx H_2 Combustion Roadmap

as presented during the Advanced Low NOx and H_2 Combustion Workshop 2022 in Florence

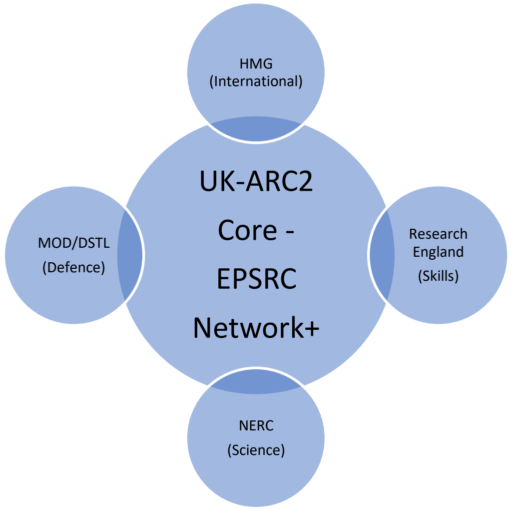
	Priorities / Research Gaps	2030 Target(s)
4. Experimental Methods	• Low and High TRL rigs for H_2 combustion research (including high T and P and altitude relight) as well as for the integrated fuel system • Instrumentation and laser diagnostics for flame visualisation, thermoacoustics and emissions measurements etc.	Comprehensive datasets for various low NOx H_2 combustion systems

5. Mechanical Design & Manufacturing	• Improved manufacturing techniques for intricate H_2 fuel injection system designs (small changes in design variables will have a significant implication on performance and emissions):
	  • Address limitations of SOA AM techniques (tolerances, repeatability etc.)
	  • Explore advanced cost effective (hybrid) techniques e.g. micro-wire laser drilling + AM (qualify the performance and emissions in low and high TRL rigs)
	• Assess integration of the combustion system in the engine (fuel supply, control system, installation (including accessibility/ease of maintenance etc.) and a/c system integration
	• Investigate material performance characteristics for H_2 fuel system (e.g. deterioration, embrittlement, leakage etc.) as well as injector surface cooling ("short" H_2 flames)
		SOA manufacturing techniques may be sufficient for Innovation Wave 1.
		
		Advanced (cost effective) techniques needed for ultra-low NOx

6. Certification & Regulations	• Engage with certification and regulatory bodies to establish realistic emissions legislation and targets both in the short to medium term and longer term. (Accepting that Innovation Wave 1 will not be fully optimised). • Parallel development of low-NOx H_2 combustor technology and certification rules • Evaluate LTO and Mission NOx legislation (and how mission NOx may be evaluated / certified / legislated). • Consider outcomes of TERA evaluations (see above) when defining emissions legislation (i.e. may need to accept trade-offs between mission fuel burn, NOx and Contrails for H_2-fuelled engines)	Flying test-bed demonstrator e.g. HERCULES? (two engines H_2 and two engines Jet A-1)) Close dialogue between certification bodies, industry and academia is necessary. Certification for LH_2-fuelled aircraft will be a major task and certification bodies should be involved in as many research / development programs as possible.

Now >>>>>>>>>>>>>>>>> Looking forward

- UK-ARC1 – EPSRC network funding has one year to run
- Theme focus has built communities
- Many additional universities linked
- Created structures to link to industry
- Alignment with the ATI strategy covering lower TRLs
- Direct bilaterals growing
- Projects now being submitted
- Better connection with climate science and socio-economic
- UK - International linkages - representation, secondments, alliances, workshops, consortia/project building
- Exploring young engineer connectivity and opportunity

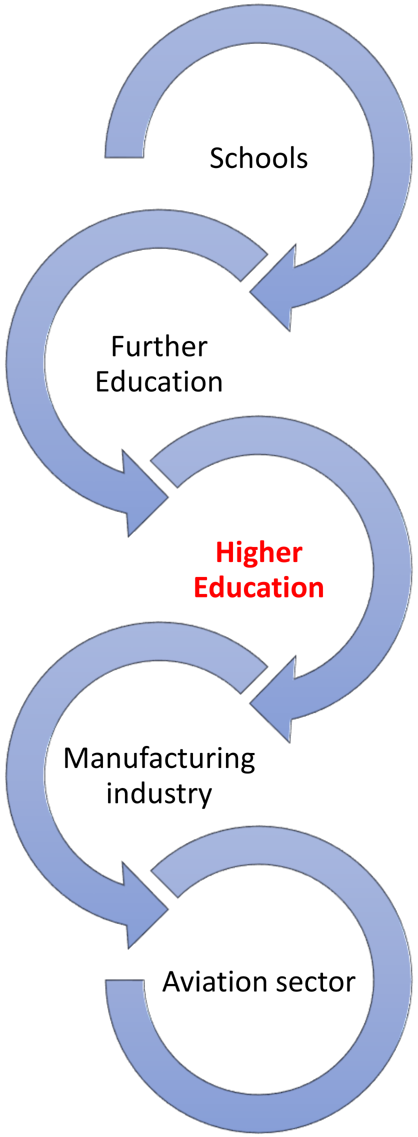


Key changes:

- Internal to external – move out more into sector
- Expand consortium and collaborations
- Simplified agenda setting and resource exploitation
- Project co-creation
- Build internationally
- Potential additional areas: UAM, AI/digital, climate science,
- Support skills development

Skills

- Use capabilities to support & build future skills fitting future technology
- Mechanisms to steer skill development are diverse and uncoordinated
- Building connections, e.g. ADS Skills Initiative, Enginuity, HVMC Skill Group – align agendas
- Can prime but need separate funding
- Initiating ECR activity to test possibilities
- Regional pilots to connect the hierarchy?



Our March 2023 workshop

- Thank you for visiting!
- Some key themes
  - Hydrogen
  - Electrification
  - Materials and manufacturing
  - Sensors and measurement
- Desire to explore facility access
- ECR/PhD search tools – Phinder
- Secondments & exchanges
- Reciprocal dataset access

Collaborative project ideas/discussions

Robert Hewson, Imperial	Chalmers	Design rules for manufacturing
Robert Hewson, Imperial	Uppsala	Possible EU MSCA ITN proposal
Ben Evans, Swansea	Raffaello Mariani, KTH	Experimental aerodynamics – visits planned
Dirk Engleberg, Manchester	Svjetlana Stekovic, Linköping	Plans to follow up
Spencer Jeffs, Swansea	Linköping	Potential collaborations in high temperature materials and materials characterisation
Vilius Portapas, Nottingham	Lund	Interest in aircraft testing facility
Fabrizio Scarpa, Bristol	Saab	Links to Defence and Security Accelerator EoI
Spencer Jeffs	Unspecified	Collaboration in mechanical testing and characterisation to complement projects
Bobby Sethi, Cranfield	Tomas Grönstedt, Chalmers	EU hydrogen projects - MINIMAL
Martin Skote, Cranfield	Saab	Prognostics and health management
Martin Skote	Ardeshir Hanifi, KTH	Computational modelling and simulations

Potential opportunities for UK-ARC – SARC collaboration

- Landing Systems Engineering
  - Cranfield University: Martin Skote, Nico Avdelidis
  - Industry Interest, Sweden: SAAB
  - Industry Interest, UK: Héroux-Devtek
  - Topics: Prognostic and Health Management (Potential use of the SAAB 340 at Cranfield University as a common platform)
- Fluid mechanics applied on aerodynamics
  - Cranfield University, UK: Martin Skote, Karl Jenkins
  - KTH, Sweden: Ardeshir Hanifi, Dan Henningson, Stefan Wallin
  - Topics: Computational Modelling of Supersonic Flow; Boundary Layer Modelling; Turbulence Modelling; Advanced Numerical Simulations; Computational Fluid Dynamics

H2 Bridge project?

SARC – UK-ARC research collaboration – discussion paper on definition of a potential hydrogen research programme for flights at a domestic UK and then international level

Background

The SARC – UK-ARC research workshop held on 1 March illustrated that there are a number of research areas of common interest. The workshop focused mainly upon hydrogen, electrification and materials and manufacturing. The defence interest was covered as well as civil. Discussion amongst the strategists in the margins of the event suggested that to achieve a bilateral programme and the support of funders, it was probably necessary to identify a key strategic theme and to 'think big' in terms of project activity that served respective national agendas at the governmental level. Net Zero action clearly ticks that box as both states have programmes and goals related to zero carbon aviation, both civil and defence. There is a desire to identify common interest research topics that engage academic and sector research towards.

The drive to exploit hydrogen powered aviation is one such common theme. Both countries have domestic air networks to which such a technology could be well suited and the topic is already attracting both academic and industrial level research attention. Multi-national companies with an interest in hydrogen technology are operational in both countries. There is a wider hydrogen push within Europe and the number of states with a drive towards a hydrogen future makes it clear that there is a good fit with European strategy.

National positions

The UK government's Hydrogen strategy signals intent to exploit the technology. The Aerospace Technology Institute, through the recent FlyZero project, has also identified hydrogen as a priority research area following some significant initial investment. The ATI has now initiated the Hydrogen Capability Network which would be central to enabling significant development of hydrogen use for aviation. Hydrogen aviation features as an important pathway within the government's Jet Zero Council initiative and industry is promoting activity on platforms, infrastructure and enabling a supply of LH2. At the airport level, the UK's Connected Places Catapult has a strand of zero emission flight infrastructure work that is exploring the way to deliver the enablers for hydrogen aviation. In this policy climate, there is a need for projects that promote end-to-end testing of the hydrogen system for aviation. If these projects can be undertaken in tandem with other like-minded states, there is a leverage value for all involved. Sweden, the UK, Germany and France all have a notable interest in the hydrogen topic.

Possible industry/academic programme

Many of the hydrogen projects initiated to date have addressed parts of the challenge, e.g. core technologies, infrastructure or refuelling. As hydrogen becomes more viable as an energy source for aviation, there is a need to address the challenge at a system level and to test the operational and mission issues. This could be addressed in a stepwise manner, expanding out from definition phase towards full flight trials with the support structures, certification needs/approvals and logistics tested at the same time. Such a programme could embrace the following elements:

- Concept definition phase drawing upon project learning from existing publicly funded or industry projects;
- UK flight trials deploying smaller platforms already being developed for commercial use and probably deploying fuel cell technology;
- International flight trials with larger test platforms probably deploying LH2 technology;

In each case, research phases could consider technology development, H2 supply side issues, airport/infrastructure/ramp aspects and operational issues linked to missions. Socio-economic, public acceptance and environmental aspects of hydrogen adoption also require examination. Whilst the prime motivation may be from a civil commercial market opportunity perspective, there is scope to test viability of hydrogen use for military applications.

The idea is to initiate a research programme that ticks the 'grand challenge' box for the UK, addressing a key objective, namely, to advance the adoption of hydrogen for a key part of the UK economy. That first major domestic research phase would then step up to an international phase where like-minded states would be able to support a 'bridge' project connecting the research communities in each nation. In light of the SARC-UK-ARC workshop interests, Sweden and UK seem well placed to develop such a programme, not least as the research interest extends beyond foundation level research within academia to industry enthusiasm for hydrogen in aviation. Research experience and commercial development activity exists in companies operational in both countries. Subject to how such a programme might develop, it is possible that Germany or France might also be interested to participate, especially given the impetus behind EU research on hydrogen.

Stage 1 – feasibility

Determining the viability of full system flight trials depends upon careful preparation of the objectives, the elements of the hydrogen ecosystem – from hydrogen supply to airport infrastructure to platform configuration and performance - that should be involved. This could be part of the de-risking of hydrogen operations. Understanding the body of work undertaken in the UK and beyond, especially studies such as FlyZero, would shape the operational trials to follow. Significant research projects such as H2GEAR and Napkin would help to inform the trials stages. Airlines such as LoganAir or easyJet should be involved. This stage would identify how data and information could be acquired to inform system definition and operation to the level that appropriate approvals can be envisaged. A first feasibility stage should anticipate both trials for fuel cell hydrogen and LH2 systems. Activities such as an airfield-based 'fuel chain' lab might be deployed to de-risk before flight. The work of the Connected Places Catapult through the ZEFI study would be a valuable contribution and links with other UK groups and networks addressing hydrogen deployment for other (non-aviation)uses should be exploited in order to maximise the benefits of learning beyond aerospace.

Stage 2 – UK trials (fuel cell)

It is anticipated that this would be a UK domestic phase of the programme that might connect two or more airports with hydrogen infrastructure/programmes (perhaps Bristol, HIAL and Cranfield) as a basis for potential roll-out on Public Service Obligation (PSO) domestic routes. The full gamut of hydrogen production, supply, airport infrastructure, fuelling, flight operations and economic/environmental/lifecycle analysis are considered to be necessary to test the system. Companies developing fuel cell powered aircraft would be appropriate for this phase given the mission range. A platform such as the Cranfield Aerospace hybrid-electric Islander could be deployed. Such technology would necessarily require the strong involvement of researchers (academic and industrial) participating in hybrid-electric power-train development and fuel cell systems. This feasibility stage could also assist with the shaping and acceleration of the pathways towards certification rule development.

Stage 3 – International trials (LH2)

The third stage would step up to international longer-range operation and would require a liquid hydrogen powered test aircraft and the same infrastructure and logistic capabilities. In this case, test flights between two research airports (Cranfield and Lund in Sweden) co-located at universities could facilitate the testing environment. It is considered possible that a C-130 Hercules aircraft currently in the fleet of the RAF might be considered for conversion to allow two of its four engines to be equipped for liquid hydrogen propulsion as this could make it easier to achieve flight safety test requirements. Fuel cell technology could also be tested using the same platform. The involvement of the defence community and a military aircraft both tests the viability of hydrogen technology for the civil sector and the defence sector.

Undertaking this stage with Sweden may provide a more viable route to international collaboration than a programme with other states. Such a phased project plays to the research interests of both countries and it offers a route to test international collaboration through the mechanisms envisaged through the government's Pioneer report on supported research funding route outside of Horizon Europe. There is a limited window of opportunity for the UK to exploit its capabilities in hydrogen aviation for international leadership and commercial advantage.

The hydrogen aircraft research trials envisaged here would require the participation of multiple stakeholders from academia and industry to airports and approvals authorities. As such it serves to stress test the viability of a hydrogen aviation system in operation. MRO aspects of hydrogen aircraft use could also be examined. Analysis of green routes potential would also be required.

Non-CO2 is a challenge for sector development so analysis and testing of LH2 NOx (from combustion studies/testing to in-flight measurement) would be appropriate and assessment of the upper atmospheric effects of increased water vapour loading from hydrogen use could be explored beyond laboratory and modelling studies.

Such a programme also helps to identify and shape the future skills needs required to support hydrogen-powered aviation.

RMG 05/23

Hydrogen Capability Network

Vision & Objectives

AEROSPACE TECHNOLOGY INSTITUTE | Hydrogen Capability Network

Vision: Securing competitive advantage for UK aerospace through a world leading collaborative network. Delivering a coherent approach to skills development, infrastructure and hydrogen supply to secure long-term UK capability.

Why?

The strategic need & case for the UK

HCN acts on key recommendations from FlyZero to become an essential enabler of UK technology development. With other nations acting quickly and other sectors competing for hydrogen, the UK must act to consolidate the aerospace sector's approach to hydrogen and ensure that testing and development remains in the UK.

What?

Our core activities

Coordinating a secure LH2 supply for the UK aerospace sector's test & development needs

Coordinating the approach to skills & research to increase LH2 talent in the UK

Coordinating the approach to test infrastructure & demonstration through an open access network and greater collaboration

How?

Our approach

Collaborative – A network of stakeholders with a common aims, aligning aerospace with cross-sector initiatives

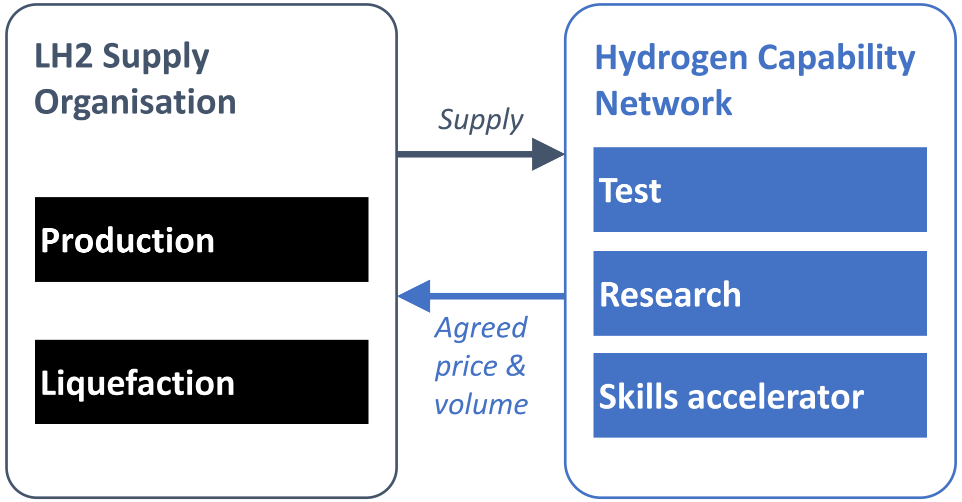
Agile business model – Allowing for growth and reacting to market opportunities

Common vision – Securing UK capability, and driving the aerospace industry to it's shared net-zero aims

High-level concept and key principles

AEROSPACE TECHNOLOGY INSTITUTE | Hydrogen Capability Network

The Hydrogen Capability Network will enable open access to test infrastructure, undertake collaborative research and act as a skills accelerator for UK aerospace



The exact operating and financial model is to be defined in phase 0 of the hydrogen capability network

Key principles

LH2 security and economics of supply for UK aerospace sector

- Consolidated demand / supply to give economies of scale

Undertake collaborative research (e.g. materials data and modelling capability)

- Open access to IP for data sharing across the network

Spill-over of skills and knowledge accelerator across UK

- Build knowledge base and actively disseminate practical knowledge across UK network

Maximise utilisation and impact of UK LH2 test infrastructure

- Open access for wide user base
- Minimise duplication of investment / capability → makes a clear case for investment

Creates a strategic UK asset as a nucleus for aerospace collaboration

- Enable and facilitate UK-led, world-leading LH2 technology programmes
- Bring in catapults, universities and other research organisations
- Hub and network framework across multiple sites

About Phase 0

Phase 0 of the Hydrogen Capability Network is an initial 12-month project backed by a government investment of £1.29m. This will see the ATI develop the concept of a Hydrogen Capability Network through to the point of launch

Aim

Coordinated approach to aligning the aerospace sector requirements for the Hydrogen future. Detailed planning & preparation for launch of an entity to deliver the future Hydrogen Capability Network and vision

The deliverables of Phase 0 include:

- Defined test infrastructure requirements for the UK aerospace sector
- Agreed supply of liquid hydrogen for UK aerospace test & research activities
- An LH2 academy to accelerate skills development and research
- Financial commitment to establish initial operating capability for the Hydrogen Capability Network

AEROSPACE TECHNOLOGY INSTITUTE

International

International Collaboration

ATI, along with partners aims to:

- Actively bring together UK and internationally communities across the ecosystem to develop innovative solutions and bring new capabilities and technologies into aerospace.
- Work collaboratively with other organisations whose focus is on the broader aviation landscape, providing advice and guidance on future aircraft technology developments.
- Develop, with international partners, a route to flying test of the UK strategic zero-carbon systems ahead of 2030.

International Delivery Models

Establish formalised partnerships: Actively seeking formal partnerships with international aerospace organisations, research institutions and universities. Collaborative agreements can be established to facilitate joint research projects, technology development and knowledge exchange.

Wider Thought-Leadership: Defining key thought-leadership development and sharing exercises on critical challenges that will outline how best to tackle.

Network and collaboration: Acting as a key conduit to connect aerospace organisations in networking, knowledge sharing and the formation of collaborative partnerships.

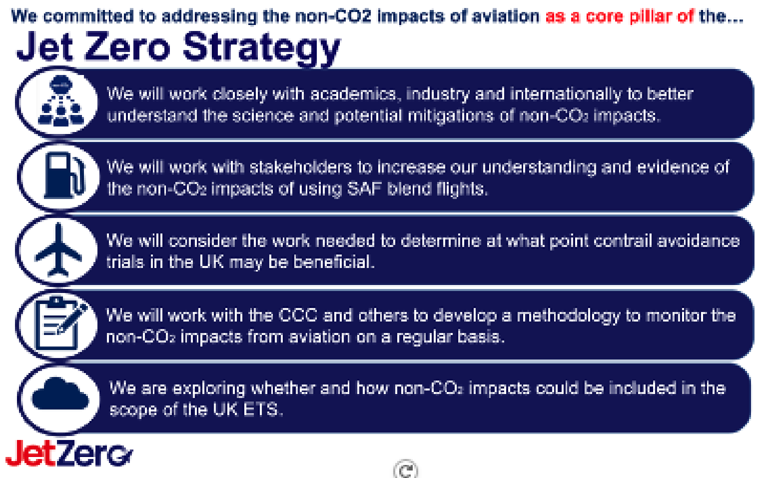
Representation at international conferences and symposiums: Participate, present and organise international conferences and forums, bringing experts, researchers and industry professionals from around the world to share their knowledge, present research findings and foster collaboration.

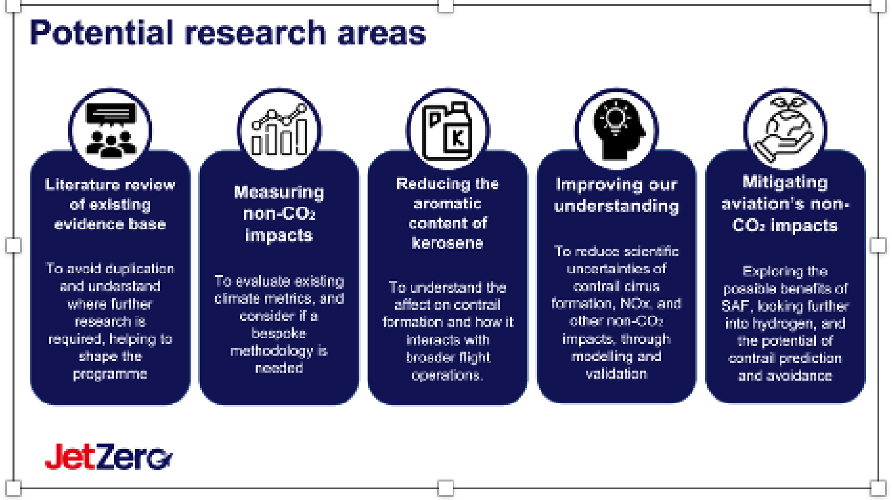
Research and development programs: The ATI can define and create collaborative research and development programs focusing on specific projects. These programmes can be funded jointly by the ATI and international partners, promoting cross-border cooperation and the sharing of resources and expertise.

Funding opportunities: Alongside Government, ATI can develop funding opportunities specifically to stimulate international collaboration. This can include grants, joint funding schemes, and incentives for collaborative projects between UK organisations and partners from overseas countries.

Jet Zero Council (JZC) and other developments

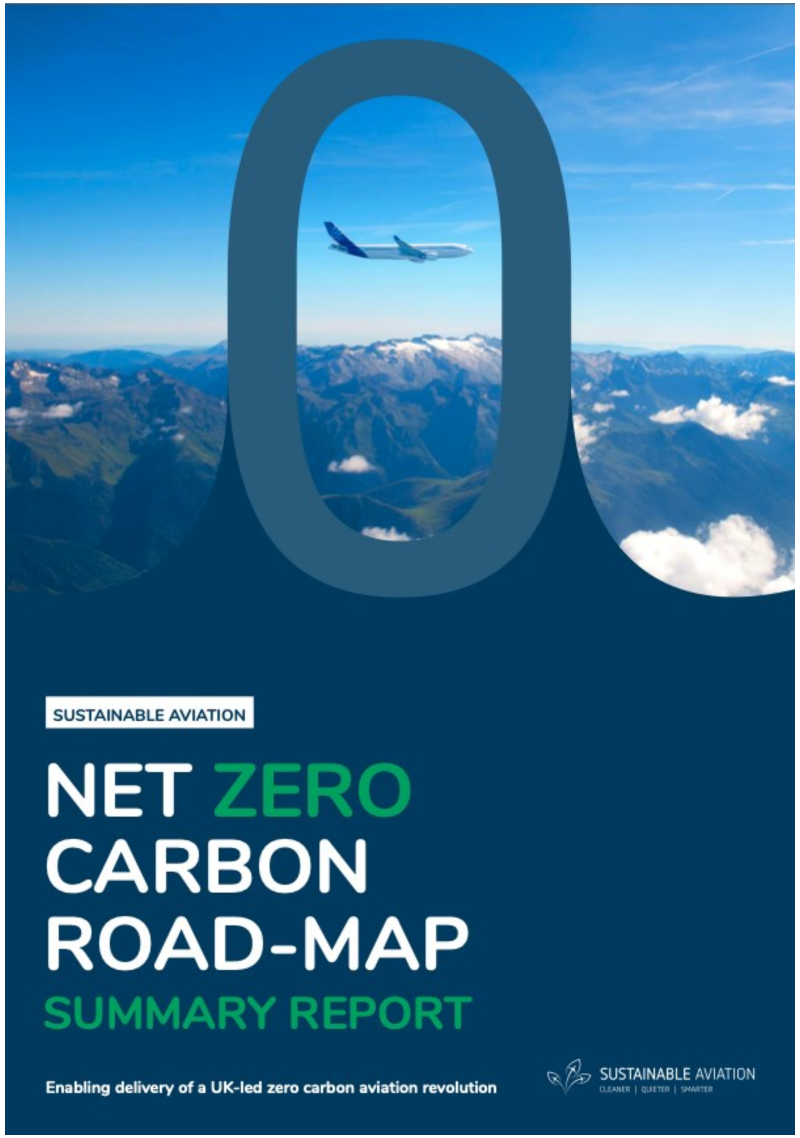
JZC non-CO2 webinar – 11 April 2023



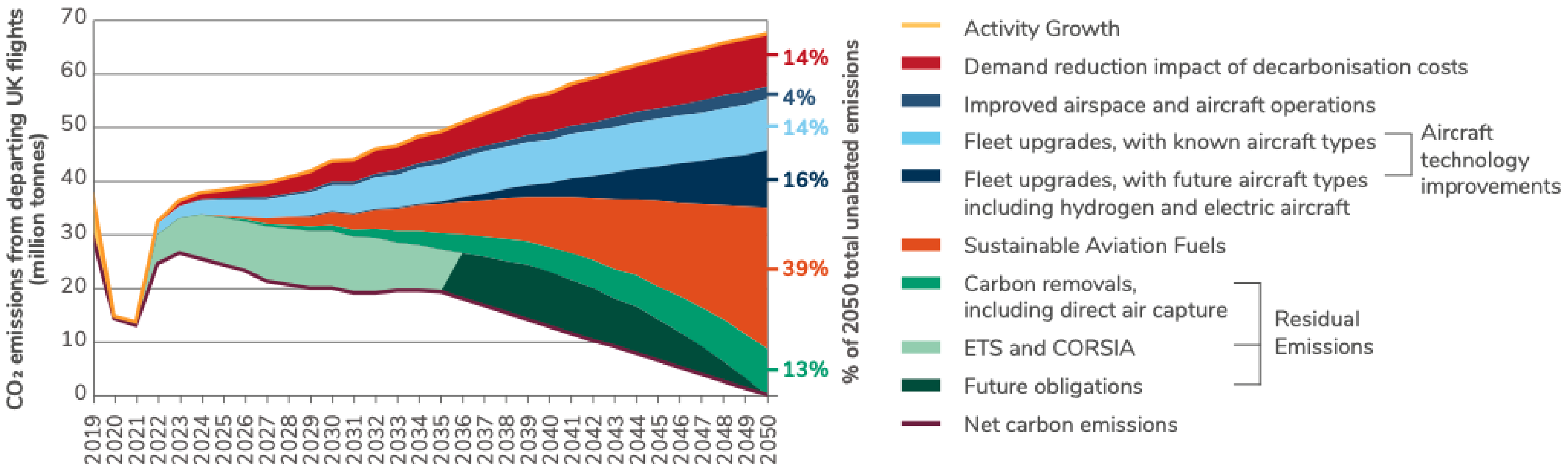


Airport level preparation

- Demonstrations to showcase near to market technologies
- Focus on:
  - Hydrogen Safety
  - Development of new or adapted hydrogen infrastructure.
- Earlier reports on:
- Zero emissions flight infrastructure: Standards
- Zero emissions flight infrastructure: Hydrogen infrastructure options for airports
- Available at [Connected Places Catapult]()



Sustainable Aviation Net Zero Carbon Road-Map

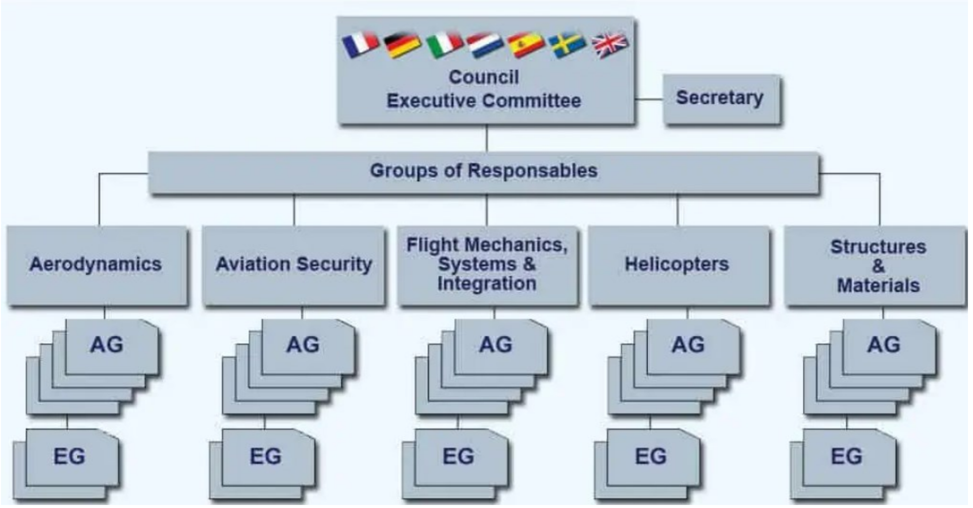


We ask the UK Government to support this road-map in the following ways:

- **Maximising short-term operational efficiencies** by accelerating the UK airspace modernisation programme and completing by the end of the decade.
- **Delivering commercial UK SAF production at scale this decade** by providing a price stability mechanism, alongside a SAF mandate and by prioritising access to UK sustainable feedstocks.
- **Investing in zero-emission flight technology** by uplifting matched funding levels to the Aerospace Technology Institute (ATI) programme through to 2031 - to drive efficiency improvements and the development of zero carbon emission technologies, alongside investing in the UK hydrogen supply and airport infrastructure.
- **Addressing residual aviation emissions** by accelerating the rollout of carbon removals, including them in the UK Emissions Trading Scheme (ETS) and ensuring aviation's fair share.

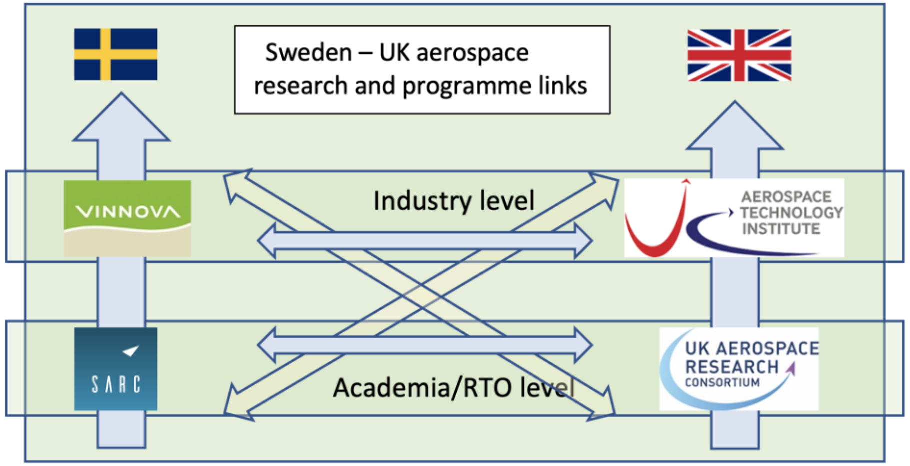
GARTEUR

- Scope to advance topics of mutual interest
- Plan for a UAM activity
- Potential interest in AI
- Conference on 5/6 October, Naples
- Swedish XC rep – Annette Walhlström, FMV



Discussion points – collaboration opportunities

- Push forward university – university connections
- Scope for a large international hydrogen project
- Explore and exploit call opportunities
- Sweden + UK + ? Other country collaborations/projects
- Support Innovair/Vinnova - ATI connection
- Developing secondments and exchanges – probably in UK-ARC2
- Intention to ramp up connection through UK-ARC2



THANK YOU FOR YOUR ATTENTION– ANY QUESTIONS?