



Zero Emission Flight Infrastructure

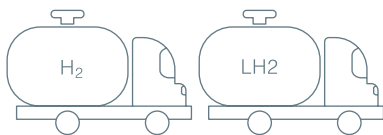
White Paper

CATAPULT
Connected Places

Funded by



Department
for Transport



ZERO EMISSION AVIATION: A CALL TO ACTION

Airport infrastructure must rapidly evolve to enable net-zero aviation by 2050 and ensure the UK leads in zero emission aviation systems.

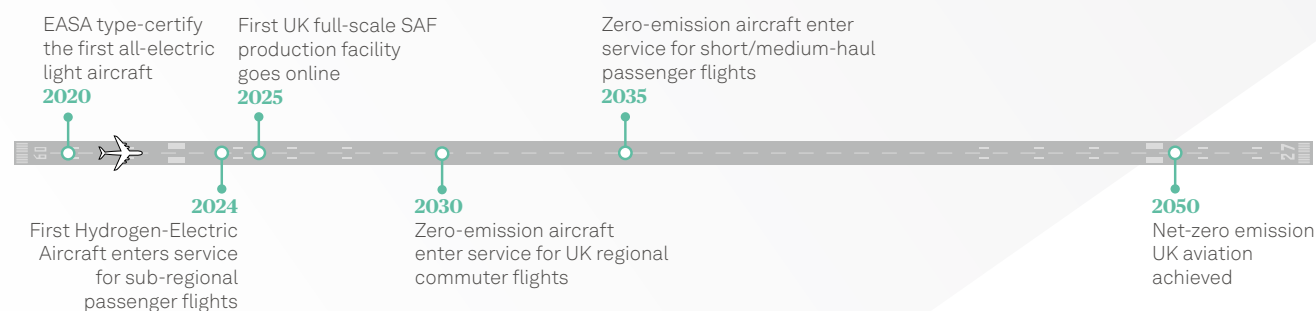
Widespread adoption of Sustainable Aviation Fuel (SAF), hydrogen-powered and electric aircraft is critical to achieving the UK's goals for reaching net-zero in aviation by 2050. Additional infrastructure, supporting systems and operations will be required at airports to realise the full potential of the opportunity.

“As the first major economy in the world to commit to net-zero by 2050, we are leading the charge to cut aviation emissions through the Jet Zero Council.”

Secretary of State for Transport Grant Shapps MP

The aircraft technology to enable net-zero aviation is being developed and tested now, with recent UK test flights of [hydrogen fuel cell](#) and [all-electric](#) aircraft. Electric light aircraft are available now, with zero emission short-haul commercial services predicted by the 2030s in the [consultation](#) being carried out by the [Jet Zero Council](#).

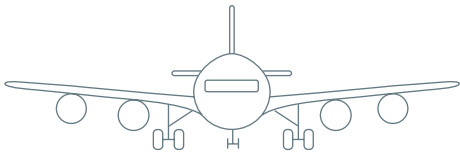
Figure 1 – UK Zero Emission Aviation Target Dates (Data: Sustainable Aviation)



Airport operators must start planning the infrastructure now to support the aircraft of the near future, and to remain competitive in a changing aviation landscape. In the Zero Emission Flight Infrastructure (ZEFI) programme, and summarised here, Connected Places Catapult has identified the critical infrastructure changes operators must deliver and the challenges to be addressed.

ZEFI has explored the infrastructure requirements for hydrogen (both gaseous and liquid) and electric (battery swapping and charging). Integration of these new systems will have significant planning, construction, installation, and operational implications. The situation is further complicated as new technologies will need to operate alongside existing fuelling systems. This is likely to require new ways of working, including innovative business models and logistical approaches.

As the aviation industry continues to be impacted by the COVID-19 pandemic, key strategic insights and stakeholder engagement are vital to ensuring the airports and airfields of the UK are prepared for the future of aviation. Action is needed now to ensure that the infrastructure is in place to meet the ambitious targets (Figure 1) for net-zero aviation in the UK.



THE EVOLUTION OF AIRPORT INFRASTRUCTURE



Pipistrel Velis Electro with charger

Owned by [NEBOair](#) and showcased at the [SaxonAir](#) 'Clearing The Air' event (17/09/2021)

The first type-certified electric powered aeroplane fully approved for pilot training

The infrastructure required to support Hydrogen and Electric aviation is very different to that for conventional aviation fuels. The focus of ZEFI is the infrastructure within the airport boundary, which can be split into four areas covering arrival to site, storage, distribution, and supply to the aircraft.

Figure 2 (next page) highlights the core elements of the fuelling and energy management systems at a high level. Each airport will have a subset of technologies depending on the aircraft and routes supported. In addition, operators must also consider how supporting systems may change, such as maintenance and fire services.

“The introduction of zero emission aviation into airports brings with it new challenges. Existing airports currently cannot accommodate hydrogen and electrically powered aircraft. New infrastructure, supporting systems, and operational procedures will be required to support the coming green revolution in aviation.”

Henry Tse

Director of New Mobility Technologies, Connected Places Catapult

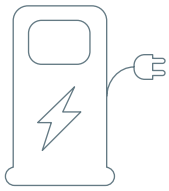
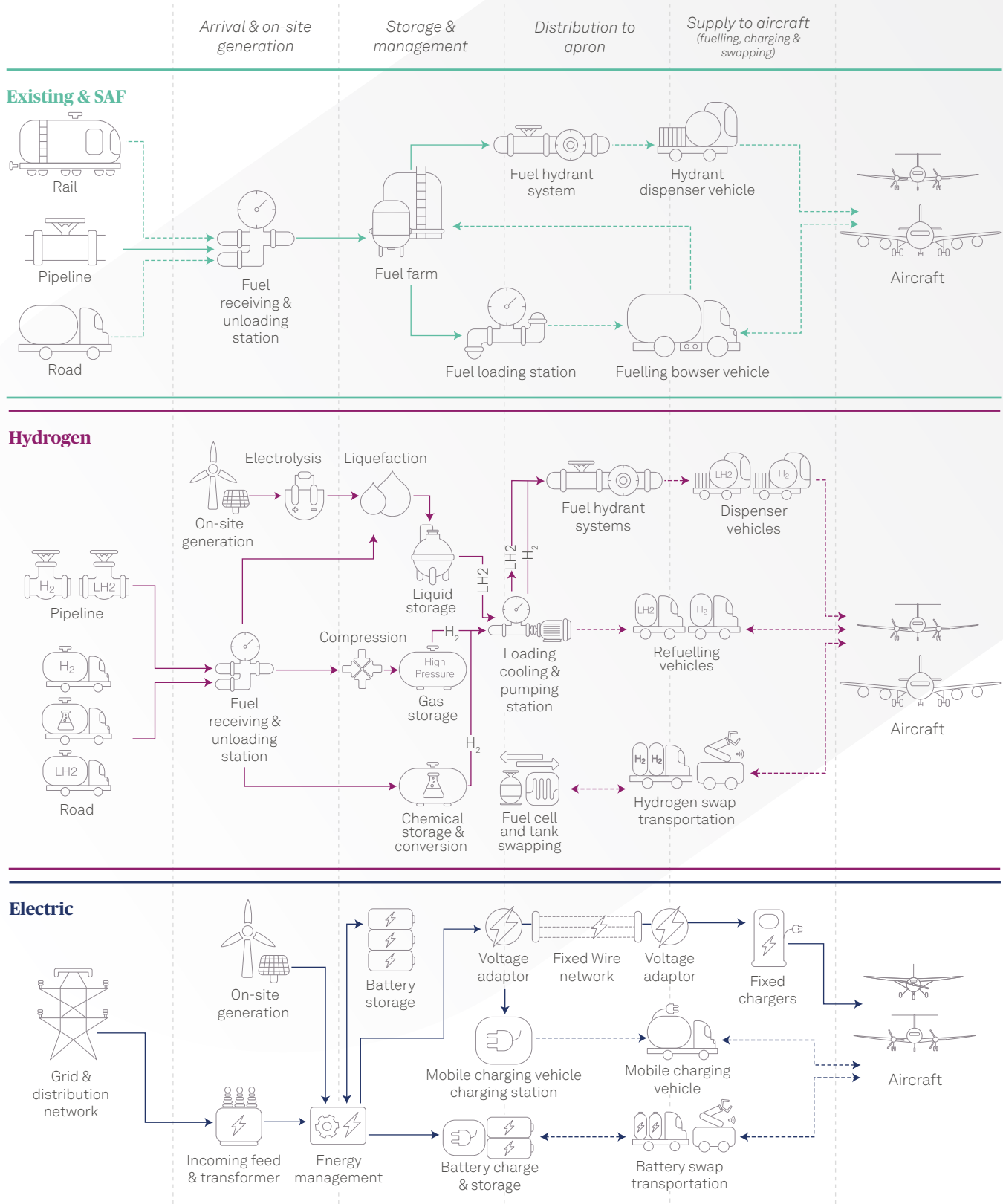
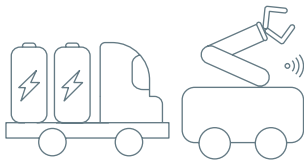


Figure 2 – The main airport infrastructure systems for existing fuel, hydrogen, and electric powered aviation.





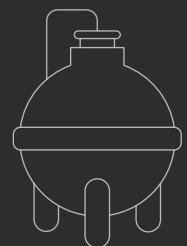
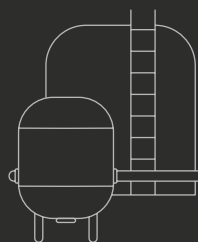
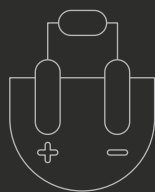
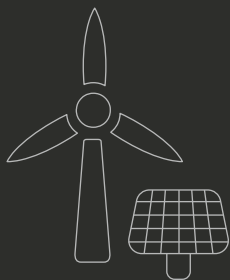
KEY CHALLENGES

The challenges of zero emission aviation bring new opportunities for innovation and collaboration.

There are four core challenge areas which the aviation industry needs to work together to address:

Table 1 – Core zero emission flight infrastructure challenge areas

1. Technology Readiness	2. Operations
New zero emission aircraft and supporting infrastructure are being developed concurrently and have not reached a technology readiness suitable for large scale transformations or infrastructure investment. We recommend a phased approach to infrastructure delivery within airports to support innovation and allow for agility as the technology matures. Smaller airports are well placed to host demonstrators and initial regional services.	Airports and airlines will need to analyse their operations and future aspirations when selecting appropriate technology. There is no ‘one size fits all’ approach, and different technologies will be chosen depending on passenger volumes, airport sizes, aircraft types and routes serviced. Larger airports should start early and small by mirroring the approaches of smaller airports to deliver a flexible transition to full-scale operations.
3. Standardisation	4. Parallel Demands
Standardisation efforts are in their early stages, for instance, the specification of charging and fuelling connectors. Flexibility in engineering and modular designs are encouraged to permit changes as the systems evolve. Organisations should engage and partner to define the required standards.	New fuel and electric technologies will run in parallel with conventional aviation fuels. Parallel operation requires additional physical space, trained personnel, and operations to manage. Supporting systems such as safety, quality, management, and billing will also need to evolve. A holistic approach to planning is required.



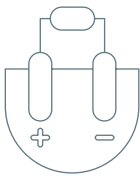
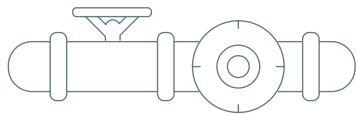


Table 2 – Technology comparison and key challenges for industry

Energy/ Fuel	Technology	Aviation Fuel		Hydrogen			Battery Electric	
	Type	Conventional	Sustainable (SAF)	Gas (H ₂) Fuelling	Liquid (LH2) Fuelling	Fuel Cell or Tank Swap	Aircraft Charging	Battery Swap
Route Types Served		All	All	Medium and Long-Haul	Medium and Long-Haul	All	Regional / General Aviation	Regional / General Aviation
Technology Readiness	Fuel	Mature	Medium-High	Low-Medium	Low	Very Low	N/A	N/A
	Aircraft	Mature	Mature	Prototype (flight testing)	Early Concept	Early Concept	Small scale, type certified demo	Early Concept
	Infrastructure	Mature	Mature	Low	Very Low-Low	Very Low	Low-Medium	Very Low
Level of Change	Infrastructure	None	None	High	Very High	Very High	Medium	Medium-High
	Operational	None	Low	High	Very High	Very High	High	Very High
	Safety	None	None	Medium	High-Very High	Very High	High	Very High
Key Challenges for Industry and Operators	Fuel / Technology		<ul style="list-style-type: none"> UK production of SAF 	<ul style="list-style-type: none"> Fuel quality standards UK availability of sustainably produced Hydrogen Onsite production methods 			<ul style="list-style-type: none"> Increased energy density and cycle life of batteries to enable longer routes Develop onsite generation and storage 	
	Infrastructure		<ul style="list-style-type: none"> Potential for additional storage if not a full replacement for conventional fuel 	<ul style="list-style-type: none"> Qualification of storage, transport and handling technologies for the airport environment 	<ul style="list-style-type: none"> Develop safe Liquid Hydrogen storage, distribution and fuelling technology 	<ul style="list-style-type: none"> Adapt automation and handling technologies from other industries 	<ul style="list-style-type: none"> Develop fast-charging technologies to improve turnaround times Standards for universal chargers 	<ul style="list-style-type: none"> Adapt automation and handling technologies from other industries
	Safety		<ul style="list-style-type: none"> Certification and qualification to ensure compatibility 	<ul style="list-style-type: none"> Firefighting Handling changes Increased clearances during fuelling 	<ul style="list-style-type: none"> Hydrogen challenges Cold liquified gas handling 	<ul style="list-style-type: none"> Hydrogen/LH2 challenges Management of handling systems Tank storage, inspection and maintenance 	<ul style="list-style-type: none"> Lithium battery firefighting High voltages 	<ul style="list-style-type: none"> Electric challenges Management of handling systems Charging and storage areas



WHERE NEXT?

Connected Places Catapult is ready to help you spark new ideas, connect with innovative technology, and accelerate your journey towards zero emission aviation.

ZEFI has three streams of work, providing opportunities and insights for the UK aviation community and sharing best practices across transport, energy, and other sectors:

- We are conducting stakeholder engagement and detailed studies to investigate and document the infrastructure requirements to ready airports for zero emission aircraft. Reports will be published in early 2022 as this work is completed.
- We have funded 15 projects under the first ZEFI [Transport Research and Innovation Grant](#) to accelerate technologies towards commercialisation. Projects span a wide range of ZEFI topics, and the selected organisations are being supported to disseminate their research and innovations as they develop.
- We are planning demonstrations to showcase UK technology and innovation and to build understanding in the use of hydrogen and batteries in airside environments.

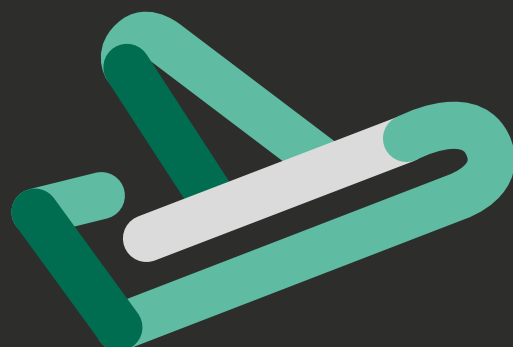
Next steps for zero emission flight infrastructure in the UK

- **For airports and airfields:** engagement with ZEFI will ensure key stakeholders better understand the challenges and needs of airports and airfields. This will also raise awareness of relevant technology development and inform future planning.
- **For aviation, academia and supporting industries:** engagement with ZEFI and our future work will help align your research and technology development with airport needs and masterplans.
- **For government departments:** ZEFI and related work will inform decision-making and ensure support is timely and focussed.

Sign up for updates on our [project](#) website.

We need your ideas and expertise to help shape the future of zero emission flight infrastructure.

Please [get in touch](#) with the **ZEFI team**.



Visit the ZEFI website [here](#)



Follow us on Twitter
[@CPCatapult](#)



Follow us on LinkedIn
[Connected Places Catapult](#)

Email us
zefi@cp.catapult.org.uk

