Aviation and the environment

Clean, green and smart technologies for the future

Reducing the impact of aviation on the environment is a key challenge facing developed societies

Aviation has been of great benefit to society over the past century, facilitating economic growth and an understanding of cultures around the world. This growth has been built on outstanding developments in aircraft and engine design, design of the passenger experience, infrastructure in and around the airport and flight operations. However, the broader aviation and aeronautics community now faces two existential challenges:

The Covid-19 pandemic has had a serious economic impact on the aviation sector, but recovery is underway. The importance of resilience was highlighted by the pandemic – but it is not just about recovery, it is about forseeing and anticipating major disruptions. Events such as the war in Ukraine and its effect on the global supply chain, political instability and extreme weather are just some of the aviation challenges. The impact can be felt across the entire aviation sector, from ground transportation, airport power supplies, logistics and supply lines through to biosafety for passenger management in the airport and in the aircraft, as well as varying border requirements on flight routes and schedules.

The need to reduce the environmental impact of aviation, and especially on climate change, is becoming ever more urgent. Aviation has made its first global step to limiting its CO_2 emissions by agreeing the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA). While welcome, it is widely recognised that CORSIA is an interim measure and will not be enough to meet aviation's societal obligations. New low carbon technologies will be required, as well as an understanding of the future patterns and growth in aviation as attitudes evolve and as organisations reduce their air travel as part of plans to reduce their carbon footprint. Again, the full aviation ecosystem needs to be evaluated to make it more resilient and sustainable.

Cranfield, which in 2020 became a member university of the National Centre for Atmospheric Science (NCAS) and has hosted its FAAM Airborne Laboratory since 2007, has major expertise and capabilities relevant to tackling the challenges of aviation and the environment, spanning decarbonising travel, the green airport, environmental technologies ie the green airport, sustainable fuels, environmental technologies and sustainable materials and manufacture. Demonstrated by the appointment of two academics, working jointly across the aviation and the environment sectors, and as the only University in Europe with its own fully-operational airport, aircraft and air navigation service provider on campus, Cranfield offers a unique combination of infrastructure for research. The University site is a living laboratory, with the newly launched Urban Observatory a key component. This new approach is capable of supporting enhanced social, economic and environmental outcomes in urban, transport and infrastructure systems.

Professor Dame Helen Atkinson DBE
FREng
Pro-Vice-Chancellor,
Aerospace, Transport Systems and Manufacturing

Professor Christopher Fogwill
FRGS
Pro-Vice-Chancellor,
Water, Energy and Environment

Cranfield's capabilities in aviation and the environment

For more information, please contact:

Dr Chikage Miyoshi,
Reader in Environmental Systems for Aerospace
E: c.miyoshi@cranfield.ac.uk

Professor Keith Mason,
Professor of Air Transport Management
E: k.mason@cranfield.ac.uk

Dr Thomas Budd,
Lecturer in Airport Planning and Management
E: t.m.budd@cranfield.ac.uk

Decarbonising travel

Covid-19 has significantly and rapidly affected and changed practices in the aviation industry, and in our lifestyles. The way this, and possible future pandemics and other shocks, will impact travel behaviour and how airlines and other transport modes respond, will be one of the key challenges for the sector in the foreseeable future.

Cranfield is developing interconnected approaches to address these challenges - from digital aviation, through manufacturing, fuels, flight operations to environmental monitoring and mitigation.

Travel behaviour and airline fleet and network planning

Emissions produced by air transport activity are based on the traffic volume. This results from users' decisions which are based on their perceptions of the flight attributes, including fares, travel duration, schedules and comfort. Our comprehensive analysis considers the entire air transport system, from user selection, through transport to and from the airport to operations and fleet management.

Carbon transport calculator

Cranfield has developed a tool to understand travellers and emissions produced. This internationally-recognised resource has been developed to help the industry to mitigate the climate change impact.

The calculator covers 76 types of aircraft, all civil aviation airports around the world with their International Air Transport Association (IATA) codes, together with location data. It enables accurate estimation of the total amount of fuel consumption and carbon dioxide emission. This calculator has already been used extensively for academic and industry consulting to aid in the understanding of travellers to improve airline and airport management. Outputs include demand forecasting, network and fleet planning, passenger experience studies and airport planning and operation.

Reducing the impact on the environment

Airports need to be increasingly self-sustainable across their entire operation - by reducing emissions, generating cleaner energy, recycling water and waste, minimising air pollution, controlling hazardous materials, reducing noise around the airport, capturing and storing carbon dioxide emissions.

Aspects such as human-centred air transport systems, the evaluation of airline networks and connectivity, fleet optimisation, travel behaviour, mode choice, willingness to pay, and airport surface access and logistics including air freight are all areas in which Cranfield has extensive expertise.

With our own airport, solar power farm and range of large-scale innovation facilities, Cranfield University is a living laboratory which offers transformative technologies and new approaches to delivering enhanced social, economic and environmental outcomes in urban, transport and infrastructure systems.

The Cranfield Urban Observatory

The Cranfield Urban Observatory is a sensor network tracking the environment and infrastructure use such as movement, air and noise pollution, and water flows across the campus. Our semi-rural, peri-urban location at the centre of the Oxford-Milton Keynes-Cambridge Arc provides an unparalleled research and learning opportunity.

An example of current work is an investigation into how air quality throughout the Arc changes as the Covid-19 lockdown measures are eased. The Arc is a priority area of economic development for the UK Government, and one of its ambitions is for growth in the region to have a neutral or even positive gain on the environment. This study, funded by the Natural Environment Research Council (NERC) and the UK Collaboratorium for Research on Infrastructure and Cities (UKCRIC), will be key in understanding infrastructure requirements for better living. The Cranfield Urban Observatory is the cornerstone for these measurements.

Reducing the impact of de-icing on the environment

Cranfield is working on smart materials for the manufacture of aircraft to reduce the requirements for the de-icing sprays used by commercial airports to ensure the safe operation of aircraft during cold weather.

While this technology is progressing, tons of de-icing chemicals are used during the winter months, and despite controls on their discharge, undesirable biofilms are commonly found in waterbodies around airports. Cranfield has worked on a project with Heathrow and the results were used to inform de-icer management and pollution mitigation strategies.

For more information, please contact:

Dr Chikage Miyoshi,
Reader in Environmental Systems for Aerospace
E: c.miyoshi@cranfield.ac.uk

Professor Neil Harris,
Professor of Atmospheric Informatics
E: neil.harris@cranfield.ac.uk

Dr Robert Grabowski,
Senior Lecturer in Catchment Science
E: r.c.grabowski@cranfield.ac.uk

The impact of climate change on aircraft operations

Climate change is creating substantial changes in aviation's operating environment. More severe weather, increasing localised rainfall, increasing surface temperatures, changing average winds, shifting bird populations are all having an impact on aviation. Remote and island communities that depend upon air transport for social and economic activities, and often have limited airport capability, will be particularly affected.

Cranfield-led research shows that these issues have become more significant over the past decades. Future climate change may accelerate these consequences. Air traffic management, monitoring weather patterns and contingency planning can all improve infrastructure resilience.

This research showed that for several critical airports in Greece, climate change has already either increased take-off distances, or reduced the average payload significantly. In the most significant instance, at Chios with an Airbus A320, this was equivalent to an average of 38 fewer passengers with their luggage, or fuel for 1300km, per departure since the A320 entered service in 1988.

For more information, please contact:

Dr Guy Gratton,
Associate Professor of Aviation and the Environment
E: guy.gratton@cranfield.ac.uk

Professor Neil Harris,
Professor of Atmospheric Informatics
E: neil.harris@cranfield.ac.uk

Reduced emissions air traffic management

Digital aviation has often been cited as being the next significant business transformation in the sector and one which can support the aerospace industry towards delivering greater customer satisfaction, while addressing efficiency, cost and capacity issues.

As post-pandemic recovery continues to accelerate, and with UK passenger numbers expected to increase by more than 50% by 2050, greener solutions other than expansion of airport capacity and ground infrastructure need to be found.

It offers a holistic approach in which aircraft, air transportation and air traffic management are integrated in our unique state-of-the-art ecosystem for transformational research towards the net-zero carbon aviation goal. The Digital Aviation Research and Technology Centre (DARTeC) opened in 2021 to spearhead the UK's research activities.

Cranfield's airport is the first in the UK to have an operational digital air traffic control centre. Supplied by Saab Digital Air Traffic Solutions, the innovative technology replicates and enhances what can be seen through the windows of a traditional air traffic control tower. It enables smarter approaches to air traffic control by digitising and integrating airport functions and improves a controller's situational awareness, enabling quick and informed decisions.

As well as serving Cranfield Airport, the digital control tower further enhances our research capabilities, ensuring our place as the home of the leading aerospace research facilities in Europe. The air traffic management laboratory in DARTeC allows us to develop innovative solutions to minimise air traffic delays whilst maintaining safe operations.

For more information, please contact:

Professor Graham Braithwaite,
Director of Transport Systems
E: g.r.braithwaite@cranfield.ac.uk

Dr Yan Xu,
Lecturer in Air Traffic Management and Communication Navigation and Surveillance
E: yanxu@cranfield.ac.uk

Aviation ecosystems and the production and distribution of electrical power

Our work in this area focuses on infrastructure and redesigning our airport network to allow for a range of electric vehicle re-charging while managing the electricity grid.

Our expertise in transport systems and the energy and power sector allows an approach to aircraft electrification that considers the wider aviation ecosystem and net environmental gain. Our living laboratory is a testbed for transformative technologies. With our own airport, solar power farm and range of large-scale facilities, the Cranfield campus is a microcosm of a modern city. We can experiment with innovation at scale, including the use of our Urban Observatory with a campus-wide sensor network.

Other expertise includes:
- airline economics and route development,
- integration of electric aircraft into legacy systems and supply chains,
- passenger experience and acceptance,
- international and UK regulation,
- advanced vehicle engineering.

The production and distribution of electrical power is key to the successful integration of aircraft electrification into the aviation ecosystem. Both renewable and traditional power sources will be required along with reliable large-scale power storage systems.

We offer support in infrastructure-based disciplines including:
- renewable energy production and control systems,
- electrical distribution and grid systems,
- energy harvesting systems,
- power charging systems,
- electrical engineering – machines, motors and drives,
- monitoring and control systems,
- power storage – battery, thermal and chemical systems.

Supplying future aircraft energy

The Aircraft to Grid (A2G) project is a conceptual design of a hybrid, self-generating and super-fast charging system for electric aircraft to improve airports' use of clean energy. The research outcomes will have wider benefits to society, such as reduced carbon emissions to help mitigate global warming, and increased public awareness of green air travel.

The electrification of airports

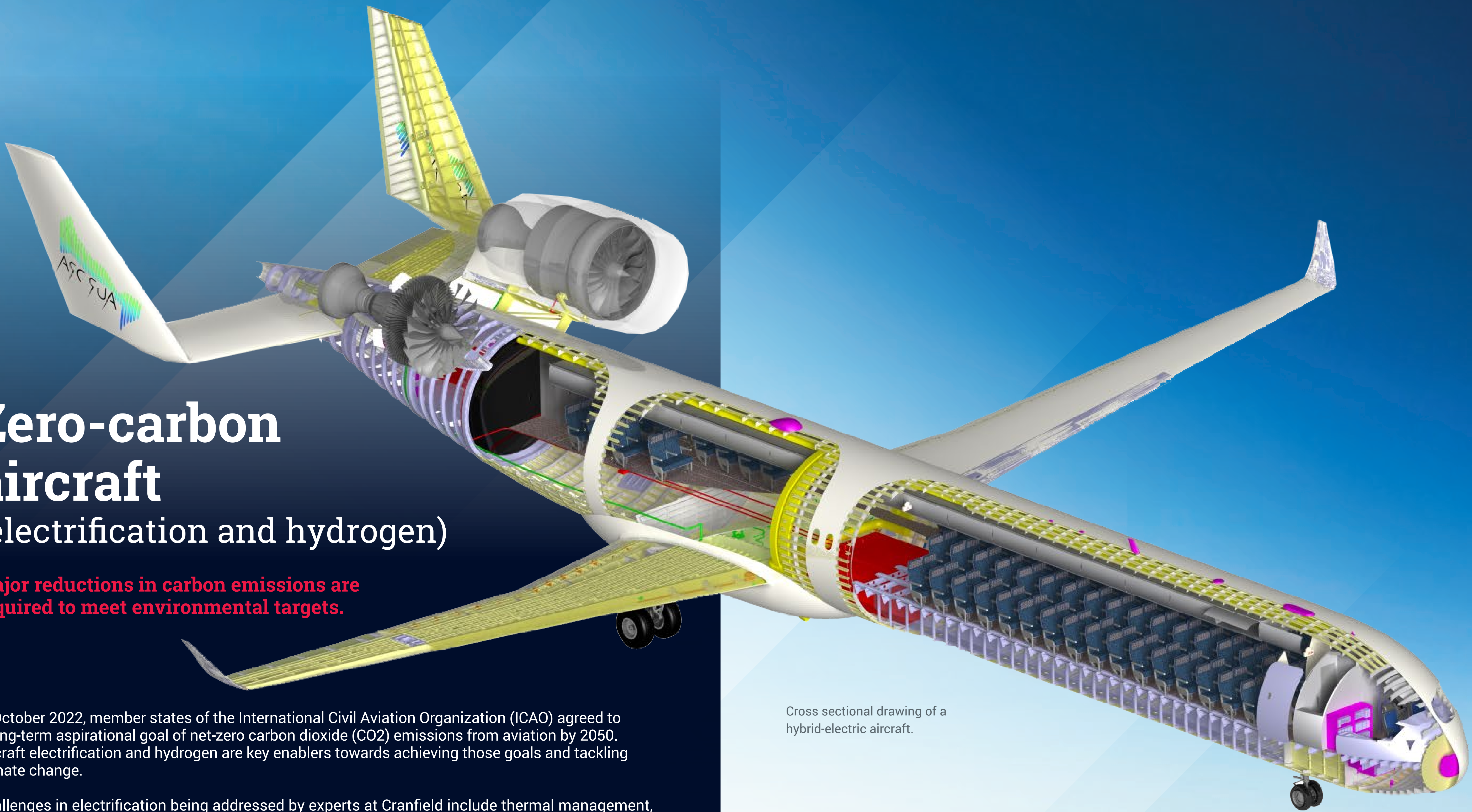
Cranfield is working on The GRid flexibility by Electrifying Energy Networks (GREEN) for Airports project to improve the electricity network infrastructure for electric aircraft (EA) and electric vehicles (EVs) at airports.

For more information, please contact:

Professor Nazmiye Ozkan,
Senior Lecturer in Energy Economics and Head of Centre for Energy Systems and Strategy
E: n.ozkan@cranfield.ac.uk

Professor David MacManus,
Professor of Propulsion Aerodynamics and Installations
E: d.g.macmanus@cranfield.ac.uk

Dr Craig Lawson,
Senior Lecturer in Airframe Systems Design
E: c.p.lawson@cranfield.ac.uk



Zero-carbon aircraft
(electrification and hydrogen)

Major reductions in carbon emissions are required to meet environmental targets.

Cross sectional drawing of a hybrid-electric aircraft.

In October 2022, member states of the International Civil Aviation Organization (ICAO) agreed to a long-term aspirational goal of net-zero carbon dioxide (CO2) emissions from aviation by 2050. Aircraft electrification and hydrogen are key enablers towards achieving those goals and tackling climate change.

Challenges in electrification being addressed by experts at Cranfield include thermal management, systems design for integration into the airframe, battery management, power-to-weight ratios, testing, reliability and certification of new aircraft technology.

Cranfield has world leading expertise and facilities relevant to hydrogen propulsion for aircraft and is able to draw upon its strengths in aircraft structures, systems, avionics and propulsion systems to design revolutionary aircraft. With the support of specialists in battery management and electric motors, materials technology, integrated vehicle health management, rotorcraft, airworthiness, safety and air transport management, hydrogen production, storage and utilisation we offer a capability that is second to none.

The £35 million Aerospace Integration Research Centre (AIRC) is one of Cranfield's newest world-class facilities, working with industry to re-imagine aircraft and airspace concepts and shape the future of aerospace globally. The AIRC provides the capability to take aerospace concepts from theory to flight demonstration at technology readiness levels TRL 6/7.

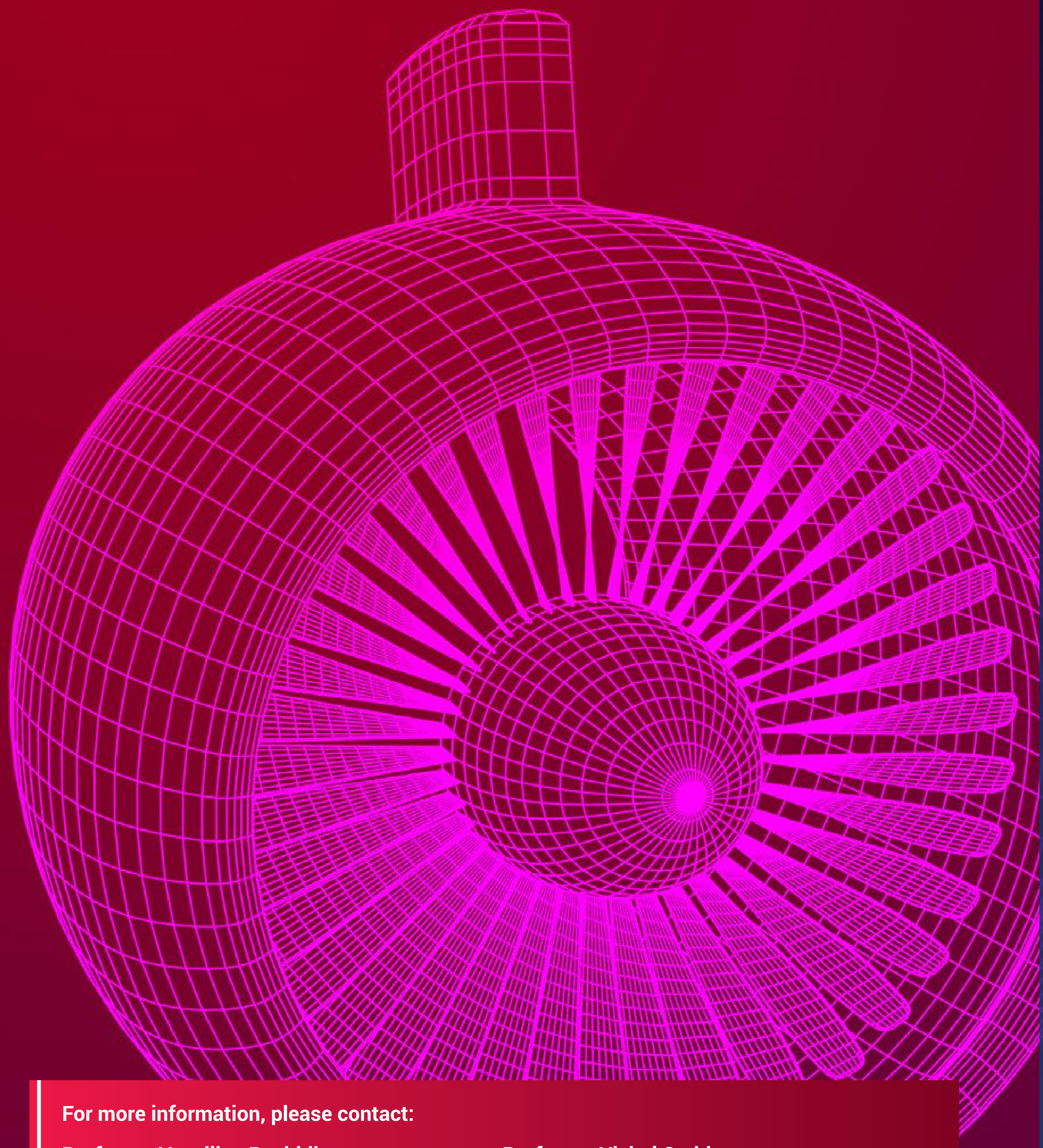
For more information, please contact:

Dr Guy Gratton,
Associate Professor of Aviation and the Environment
E: guy.gratton@cranfield.ac.uk

Professor Mark Westwood,
Professor of Aeronautics, Centre for Aeronautics
E: mark.westwood@cranfield.ac.uk

Jenny Kavanagh,
Chief Strategy Officer and Head of Airborne Systems Group, Cranfield Aerospace Solutions
E: j.kavanagh@cranfieldaerospace.com

Dr Tim Mackley,
Head of the Aerospace Integration Research Centre
E: t.c.mackley@cranfield.ac.uk



For more information, please contact:

Professor Vassilios Pachidis,
Head of the Centre for Propulsion and Thermal Power Engineering
E: v.pachidis@cranfield.ac.uk

Professor Panos Laskaridis,
Head of Hybrid Electric Propulsion Group
p.laskaridis@cranfield.ac.uk

Professor Vishal Sethi,
Head of Low Emissions Technologies and Combustion Group and Associate Professor in Gas Turbine Combustion and Environmental Impact
v.sethi@cranfield.ac.uk

Aircraft propulsion

Our capabilities range from conventional gas turbines through hydrogen, hybrid electric and all-electric propulsion. We deliver performance evaluation, design space assessment and optimisation, component and prototype R&D, mission assessment and power plant integration and diagnostics. This unique set of capabilities has been developed through sustained collaboration with industry including the Cranfield Rolls-Royce University Technology Centre (UTC), Siemens, Hitachi, Samsung, easyJet, NASA, Dstl, Ministry of Defence (MOD), Clean Sky (EU), Engineering and Physical Sciences Research Council (EPSRC), the Aerospace Technology Institute (ATI) and Innovate UK.

Specific capabilities

- Fundamental research on key technologies: hybrid gas turbine design and performance including variable cycles, gas turbine re-sizing and the aerodynamic integration of electric propulsors.
- Bespoke multi-fidelity methods, tools and facilities to analyse and test a wide range of propulsion systems (hydrogen, hybrid, electric, VTOL and VSTOL and gas turbine propulsion) including models for propulsion system components, whole power plant, general arrangement and weight estimation, emissions, lifing, economics and integration. The whole capability can be used in an integrated way for a full Technoeconomic Environmental Risk Analysis (TERA). These capabilities, integrated with advanced diagnostic and life cycle analysis methods, can form the basis of digital twins.
- System architecture: modelling, sizing and analysis of fully integrated systems at system, aircraft and mission levels, including the ability to size and match electrical, energy storage, thermal management and propulsion modules.
- Advanced energy management strategies to minimise fuel, energy and maintenance costs, emissions and environmental impact. Schedules are customised for aircraft size and mission as well as technology level.
- Design concepts for cryogenic cooling systems for all-electric or combustion-based gas turbine propulsion systems.

The Centre for Propulsion and Thermal Power Engineering facilities

The Centre for Propulsion and Thermal Power Engineering operates a large suite of facilities occupying a 3,000 square metre site that comprises 12 test houses and ancillary facilities including a workshop. The team can conceive, design, build, commission and operate large-scale, one-off prototype rigs for bespoke research and development requirements up to TRL 6. The Centre has 11 gas turbines (of up to 1 MW) at its disposal to support its education and research activities. Facilities comprise icing tunnels, combustion, thermal management, turbomachinery (including supercritical CO_2), instrumentation and measurement development, inlet and exhaust ducting etc.

Alternative fuel options for aviation

Reducing reliance on fossil fuels is critical and major technological advances are required in a number of areas including biofuels, synthetic fuels, hydrogen and electrification.

Technology development will be central to this initiative, but it will also be important to develop methodologies which can assess the overall system impact, including economic and environmental factors, as well as how quickly such technologies can be introduced. The web of connections between aviation and society is complex and a systems approach is required to ensure a cost- and environment-effective transition to sustainable growth in the aviation sector.

NASA research grant

In 2013, NASA awarded Cranfield a three-year grant for research into future distributed propulsion systems, including turbo-electric. The award to a non-US institution was a first and provided for wide-ranging research to improve both propulsive efficiency and air frame performance, as well as achieving reductions in noise, emissions and energy consumption.

The pebble bed heater. With its 1800K, 15 bar and 4kg/s capability, it is already pushing the boundaries of ultra-low NOx combustion systems within the EU H2020 ENABLEH2 project and is spearheading Cranfield's activities in hydrogen propulsion for civil aircraft.

For more information, please contact:

Professor Vassilios Pachidis,
Head of the Centre for Propulsion and Thermal Power Engineering
E: v.pachidis@cranfield.ac.uk

Professor Christopher Fogwill,
Pro-Vice-Chancellor, School of Water, Energy and Environment
E: chris.fogwill@cranfield.ac.uk

Dr Tosin Adedipe, Technical Project Manager of the £8 million Department for Business, Energy and Industrial Strategy's Energy Innovation Programme-funded project HyPER was recognised as one of the Top 50 Women in Engineering awards 2022.

For further information, please contact:

Dr Peter Clough,
Senior Lecturer in Energy Engineering
E: **p.t.clough@cranfield.ac.uk**

Professor Upul Wijayantha,
Head of Centre for Renewable and Low Carbon Energy
E: upul.wijayantha@cranfield.ac.uk

Professor Vishal Sethi,
Head of Low Emissions Technologies and Combustion Group and Associate Professor in Gas Turbine Combustion and Environmental Impact
v.sethi@cranfield.ac.uk

Hydrogen – revolutionary clean energy for aviation

At Cranfield we believe that hydrogen is a viable clean aviation fuel that will help the world meet its net zero emissions targets and limit the effects of climate breakdown. Our expert engineers are investigating hydrogen in terms of production, storage, utilisation and transport.

Flying is not the problem, carbon's the problem. The aviation industry has come a long way since the Wright brothers. Cranfield University brings all the facilities and capabilities together to test and validate new technologies and provide new ways of looking at the aviation ecosystem. The diagram on the next page shows some of the related facilities at Cranfield.

CASE STUDY

The HyPER project

An international collaboration between Cranfield University, GTI Energy and Doosan Babcock, funded through the Department of Business, Energy and Industrial Strategy's (BEIS) Energy Innovation Programme will examine the potential for low-carbon hydrogen (H_2) to be the clean fuel of the future. The HyPER project (bulk H_2 production by sorbent enhanced steam reforming) will construct a state-of-the-art 1.5-megawatt H_2 production pilot plant at Cranfield University to test an innovative H_2 production technology that substantially reduces greenhouse gas emissions.

www.cranfield.ac.uk/research-projects/hyper

CASE STUDY

The ENABLE H_2 project

The ENABLE H_2 Horizon 2020 project funded by the European Commission aims to revitalise enthusiasm in liquid hydrogen (LH_2) research for civil aviation by maturing key-enabling technologies. This includes hydrogen (H_2) micromix combustion and fuel system heat management to use the formidable heatsink potential of H_2 to facilitate advanced propulsion technologies.

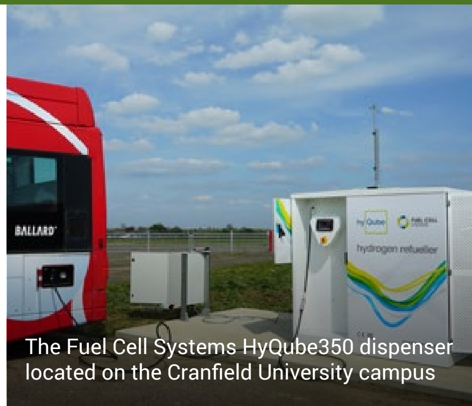
The project is key in the initiative to decarbonise civil aviation through the adoption of LH_2 and contributes to the goals of Flightpath 2050, in that it will demonstrate that LH_2 combined with advanced airframes, propulsion systems and air transport operations can meet sustainability targets for civil aviation.

www.enableh2.eu

CASE STUDY

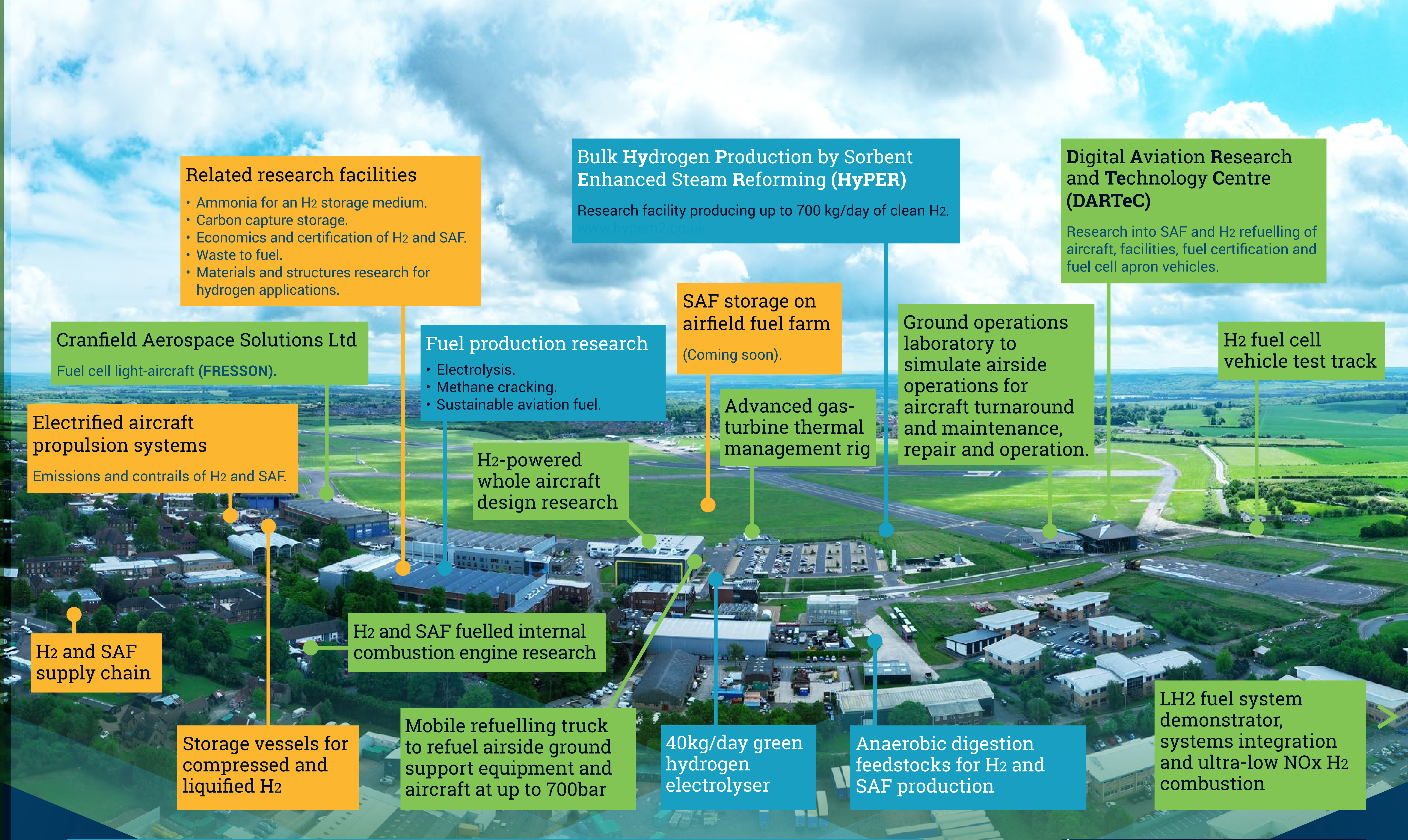
Hydrogen refuelling station

Cranfield has opened a new hydrogen refuelling station on campus to service vehicles with this pioneering fuel. There are only a handful of hydrogen refuelling stations around the UK – with the one at Cranfield ideally placed for researchers working on hydrogen projects. This is the first step towards Cranfield installing its own electrolyser and mobile refuelling facility, supported by Research England's RPIF Net Zero fund, which will enable compressed gaseous hydrogen to be taken airside to refuel fuel-cell aircraft on Cranfield's airport and at our Digital Aviation Research and Technology Centre (DARTeC).



The Fuel Cell Systems HyQube350 dispenser located on the Cranfield University campus

For more information see **www.cranfield.ac.uk/hydrogen**



Key

Feedstocks and fuel production. | **Transport, storage, economics, supply chain.** | **End users – aerospace and road vehicles.**

• **H_2** = Hydrogen • **LH_2** = Liquid hydrogen • **SAF** = Sustainable aviation fuels

For more information, please contact:
Jon Horsley,
Transport Systems Development Manager
E: j.horsley@cranfield.ac.uk

Sustainable fuels

Advances in sustainable aviation fuel production are key to the aviation sector, to reduce emissions and increase carbon offsetting towards net-zero aviation.

Cranfield has expertise in the relevant areas of precision agriculture; applied remote sensing; crop models; food security; informatics and statistics; experimental design; and glasshouse phenotyping.

Optimising mixed food-fuel cropping for sustainable aviation fuel

Cranfield is investigating mixed food-fuel cropping for production of sustainable aviation fuel by applying multi-cropping techniques. When optimised and scaled to large operations for select food-fuel crop combinations, they have the potential to deliver a yield uplift of 30% and reduced impact to the environment by 40%. This allows an increase in biofuel production (needed for sustainable aviation fuel) without impacting or displacing existing food production.

For more information, please contact:

Dr Toby Waine,
Senior Lecturer in Applied Remote Sensing
E: t.w.waine@cranfield.ac.uk

Dr Chikage Miyoshi,
Reader in Environmental Systems for Aerospace
E: c.miyoshi@cranfield.ac.uk

Batteries, energy storage and electric machines

Batteries and energy storage

Our research in this area centres on managing batteries and the characterisation of cells with real application duty cycles. We work with conventional lithium-ion batteries and novel ultralight technolgies such as lithium-sulfur. We have expertise in state-of-the-art estimation techniques and AI.

We focus on the practicalities of using batteries in the real world. This extends from the design of algorithms to estimate the internal state of charge and health of batteries to facilities to subject cells and small modules or packs to realistic electrical and thermal duty cycles. We have led the development of critical battery management algorithms for lithium-sulfur batteries, which combine light weight with strong safety, low production-scale costs and good environmental credentials.

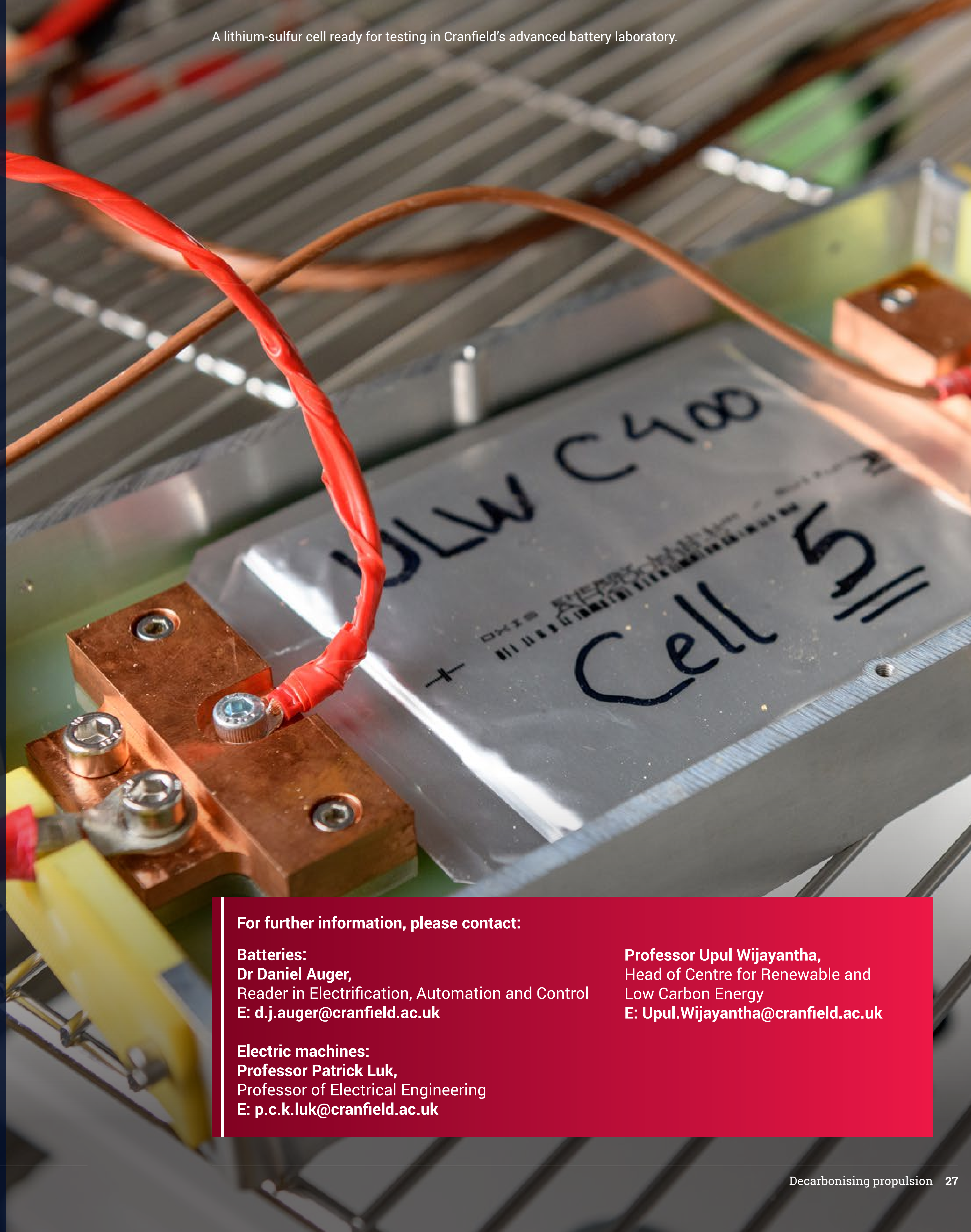
Electric machines

We adopt innovative design methodologies and exploit the latest devices and materials in electric machine technology to achieve more efficient and reliable power conversion and control in applications ranging from renewable energy systems, transportation, and Mobility-as-a-Service (MaaS).

Specific capabilities include:

- Bio-inspired micro electromagnetic actuator for novel conjugate battery cooling.
- Modelling of multi-MW superconducting machines for electric distributed propulsion aircraft.
- High frequency converter for wireless power transfer for static and dynamic charging of electric vehicles, including autonomous aerial vehicles.
- Modular electric vehicle platform as Mobility-as-a-Service for electric-taxiing, zero-emission airport ground transportation, and the like.

Dr Bing Xia testing an electric traction motor that he designed in the electric machine laboratory



A lithium-sulfur cell ready for testing in Cranfield's advanced battery laboratory.

For further information, please contact:

Batteries:
Dr Daniel Auger,
Reader in Electrification, Automation and Control
E: d.j.auger@cranfield.ac.uk

Electric machines:
Professor Patrick Luk,
Professor of Electrical Engineering
E: p.c.k.luk@cranfield.ac.uk

Professor Upul Wijayantha,
Head of Centre for Renewable and Low Carbon Energy
E: Upul.Wijayantha@cranfield.ac.uk

Smart, clean and green manufacturing

Sustainable materials and manufacturing are integral to the aerospace industry. Cranfield has been developing a roadmap for a sustainable manufacturing sector by applying fundamental science and thought leadership for manufacturing solutions across all sectors to support the aspiration of net zero carbon emissions.

National facilities such as our materials characterisation suite and the National High Temperature Surface Engineering Centre in Surface Engineering and Precision, which is now an associate member of the Henry Royce Institute, build on the strong synergies between manufacturing, materials, design and management. We are supporting the transition from product service systems (PSS) to through-life engineering services as a contributor to high value manufacturing; and enhance our commitment to manufacturing technology (composites, welding and laser technology, advanced materials) in the context of sustainable, resource-efficient manufacturing.

To meet these objectives, the main research strategies are:

- Smart: operations efficiency across topics such as business model innovation, resilient supply chains and reverse logistics, cloud manufacturing, sustainability as part of manufacturing company key performance indicators (KPI), circular economy and decentralised manufacturing.
- Clean: process efficiency using sensors and big data for factory management, product service systems, factory modelling and artificial intelligence for eco-efficiency, internet of things for traceability and authenticity, intelligent micro-factories and autonomous manufacturing systems
- Green: resource efficiency such as energy efficient manufacturing, development of materials production with low carbon footprint, closed loop materials and circular economy, real-time life cycle analysis and advanced materials.

For more information, contact:

Professor Mark Jolly,
Director of Manufacturing and Materials
E: m.r.jolly@cranfield.ac.uk

Professor Phil Webb,
Royal Academy of Engineering and Airbus Chair in Aero-Structures Design
E: p.f.webb@cranfield.ac.uk

For more information, please contact:

Dr Chikage Miyoshi,
Reader in Environmental Systems for Aerospace
E: c.miyoshi@cranfield.ac.uk

Professor Kostas Salonitis,
Head of Sustainable Manufacturing Systems Centre
E: k.salonitis@cranfield.ac.uk

Dr Suresh Sampath,
Head of Gas Turbine Systems Engineering and Operations Group
E: s.sampath@cranfield.ac.uk

Professor Upul Wijayantha,
Head of Centre for Renewable and Low Carbon Energy
E: upul.wijayantha@cranfield.ac.uk

Professor Ron Corstanje,
Professor of Environmental Data Science and Head of Cranfield Environment Centre
E: roncorstanje@cranfield.ac.uk

Improving sustainability

Sustainability in the aviation sector will be based upon the principles of the circular economy and it is important to assess the overall impact of technological solutions rigorously. For example, the development of more efficient materials such as lightweight cabling which will reduce the use of energy, water and materials across the entire life cycle.

The enhancement of eco-efficiency straddles the improvement and development of new materials, more efficient manufacturing processes and the reduction of, and better use of, waste materials.

New expectations in component safety, recyclability and zero carbon operations are key factors in future planning and life cycle assessment covers every aspect from the energy usage in the factories in which aircraft and components are built to the length of time they are in use. Advancements such as anti-microbial materials will be key for post-Covid-19 passenger safety.

Cranfield's multidisciplinary expertise tackling industry issues and the impact of the aviation sector enable significant progress. One such area is the creation of new materials to build aircraft so that de-icing can be reduced or eradicated altogether. However, until these clever materials are used on all aircraft, the need for de-icing continues, and Cranfield researchers are helping airport operators reduce the impact on the surrounding environment.

Comparing the environmental impact of different transport modes

This project investigated the potential environmental benefit of mode shift from air and road transportation by the introduction of a high-speed train between London and Manchester, focusing on life cycle carbon dioxide emissions.

The FAAM Airborne Laboratory is a world-leading research facility aircraft dedicated to the advancement of atmospheric science. It is used for a wide range of atmospheric studies including the 2010 eruption of the Eyjafjallajökull volcano which caused great disruption to air travel across Europe.

Research aircraft

Cranfield is home to unique research aircraft, either owned by the University or by our partners including UK Research and Innovation (UKRI). These can be used for environmental measurements, science training, equipment testing, prototype development, procedural explorations, and other research uses.

This provides us with the ability to conduct experimental trials and test flights to enable certification with research payloads from grammes to tonnes. Cranfield Airport is experienced in supporting third-party research aircraft.

The National Flying Laboratory Centre's new Saab 340B

For more information, please contact:

Robert Harrison,
Head of the National Flying Laboratory Centre
E: robert.a.harrison@cranfield.ac.uk

Dr Guy Gratton,
Associate Professor of Aviation and the Environment
E: guy.gratton@cranfield.ac.uk

Mr Alan Woolley,
Head of Facility
FAAM Airborne Laboratory
E: alan.woolley@faam.ac.uk

Cranfield's global research airport

A national asset for the UK

Multi-User Environment for Autonomous Vehicle Innovation (MUEAVI)

This instrumented transport corridor runs through the middle of the campus and is used for the development of intelligent and autonomous vehicles, including drones and connected vehicles for smart city infrastructure. Sensors include lidar (laser scanners that can measure distance), radar that can detect pedestrians and cyclists at up to 200 metres, and thermal imaging cameras.

Gas turbine power and propulsion laboratories

Aerospace Integration Research Centre (AIRC)

Major research facility with Airbus and Rolls-Royce dedicated to future aerospace integration challenges.

National Flying Laboratory Centre (NFLC) including the SAAB 340B Flying Test Bed

The NFLC's 'flying laboratory' provides a viable alternative to flight test and research work using simulators, wind tunnels, or more expensive turbine aircraft, often testing new parts and equipment for industry partners. The NFLC also has other light aircraft used for research.

Living laboratory

Sensors around the airport monitor air quality, soil moisture, temperature and noise levels, including sound from wildlife. Other sensors monitor water quality and levels, and runway and ground movements.

Digital air traffic control centre

Housing the UK's first operational remote air traffic control tower, the centre provides air traffic services for the airport.

FAAM Airborne Laboratory

Dedicated to the advancement of atmospheric science, the specially-modified BAe-146 research aircraft is owned and run by the Natural Environment Research Council (NERC). This is used by many UK and overseas universities and by the Met Office.

Drone test and development

Regulatory compliance and safety (including Beyond Visual Line of Sight - BVLOS).

Aviation Innovation and Technology Entrepreneurship cluster (AVIATE+)

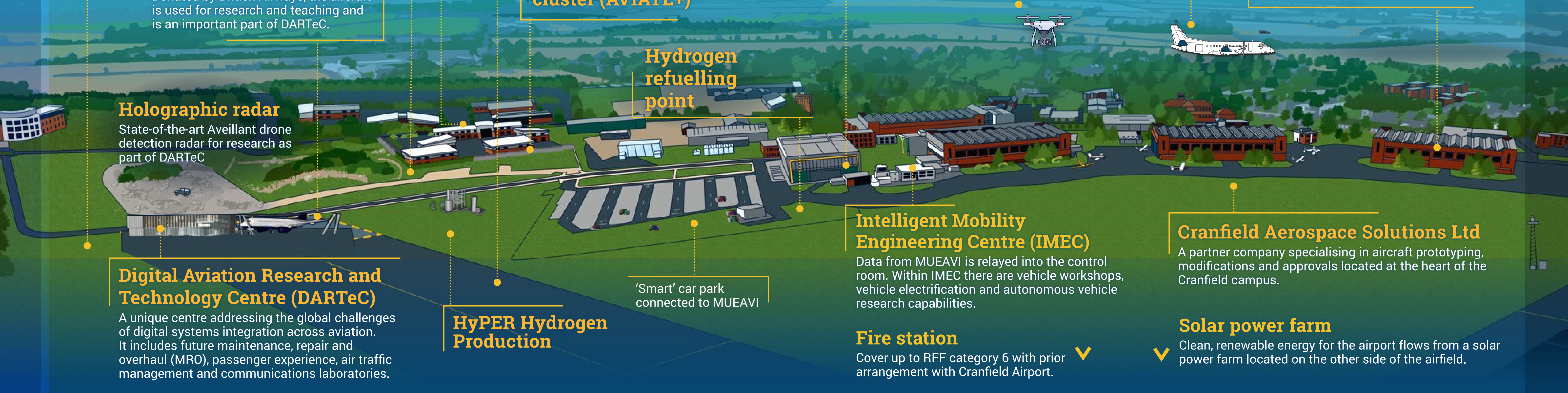
Boeing 737

Donated by British Airways, the aircraft is used for research and teaching and is an important part of DARTeC.

Hydrogen refuelling point

Holographic radar

State-of-the-art Aveillant drone detection radar for research as part of DARTeC



Digital Aviation Research and Technology Centre (DARTeC)

A unique centre addressing the global challenges of digital systems integration across aviation. It includes future maintenance, repair and overhaul (MRO), passenger experience, air traffic management and communications laboratories.

HyPER Hydrogen Production

'Smart' car park connected to MUEAVI

Intelligent Mobility Engineering Centre (IMEC)

Data from MUEAVI is relayed into the control room. Within IMEC there are vehicle workshops, vehicle electrification and autonomous vehicle research capabilities.

Fire station

Cover up to RFF category 6 with prior arrangement with Cranfield Airport.

Cranfield Aerospace Solutions Ltd

A partner company specialising in aircraft prototyping, modifications and approvals located at the heart of the Cranfield campus.

Solar power farm

Clean, renewable energy for the airport flows from a solar power farm located on the other side of the airfield.

@cranfielduni
@cranfielduni
/cranfielduni
Cranfield University
blogs.cranfield.ac.uk

For more information please contact:
aviation.environment@cranfield.ac.uk

Cranfield University
Cranfield
MK43 0AL, UK
www.cranfield.ac.uk

Professor Iain Gray,
Director of Aerospace
E: i.gray@cranfield.ac.uk

Professor Angle Medina Vaya,
Director of Environment
E: a.medinavaya@cranfield.ac.uk

Professor Graham Braithwaite,
Director of Transport Systems
E: g.r.braithwaite@cranfield.ac.uk

June 2023