



ElectRRification

An overview of exciting
projects being pursued by
Rolls-Royce Civil Aerospace

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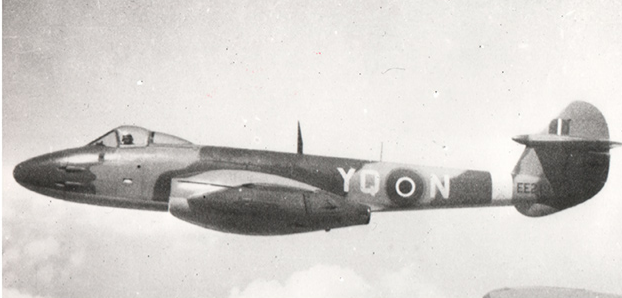
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Vickers Vimy



Meteor



Comet



Concorde



Harrier



Trent XWB-powered Airbus A350 -1000



Bell Boeing V-22 Osprey



Lockheed Martin F35 -B



Trent 1000-powered Boeing 787 -10

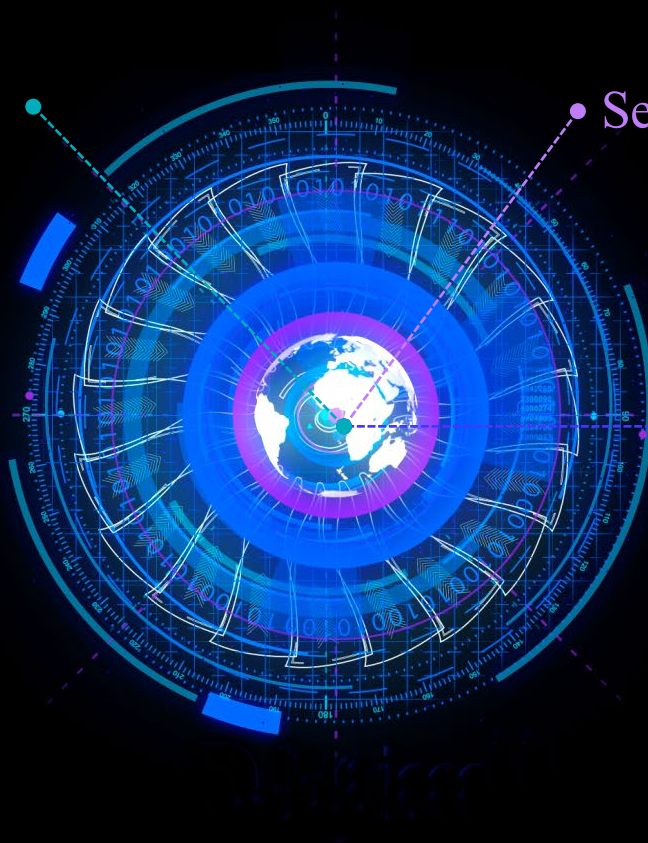


IntelligentEngine

Product

Services

Digital



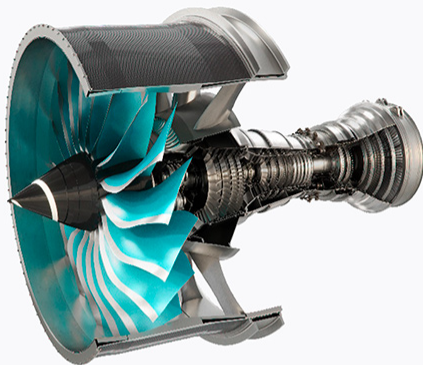


Collaborate on sustainable aviation fuels

Key areas of focus in Rolls-Royce's Civil Aerospace division

All closely inter-connected and being developed in parallel

All have a role to play in the decarbonisation of our industry



Continue to evolve the gas turbine



Increase integration between airframe and engine



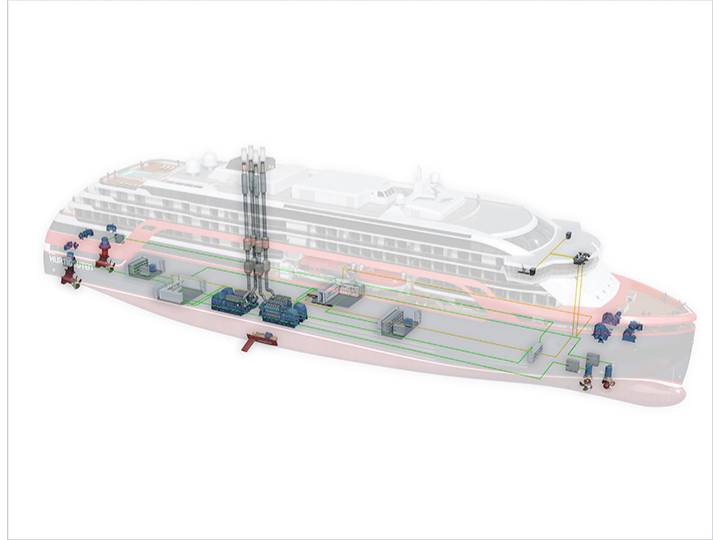
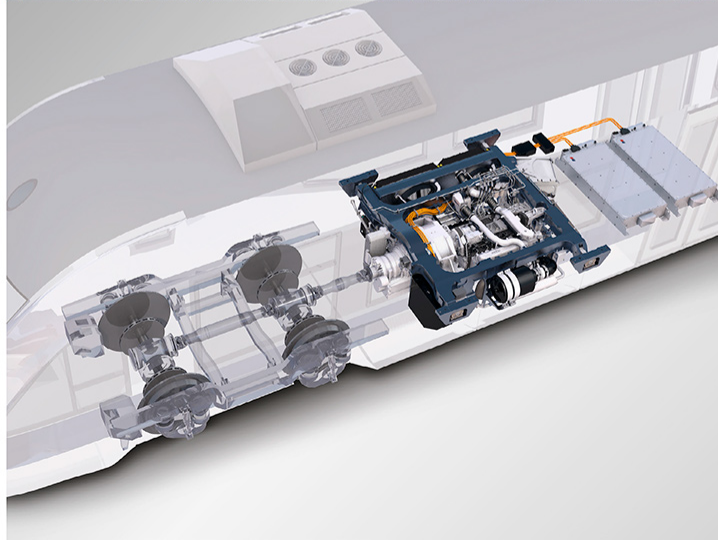
Develop alternatives such as electrification



Electrification is not new to Rolls-Royce

We have a group -wide team with a wealth of experience in electric and hybrid electric applications across different business sectors

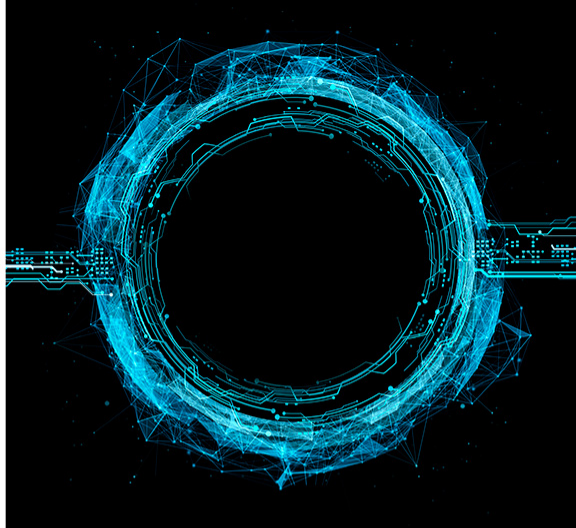
Delivering fuel savings of between 15% and 50%





Why are we championing electrification in civil aerospace?

As a leading industrial technology company, we have a key role to play



Potential game -changer for society

- Population growth and more mega-cities
- Opportunity to increase connectivity sustainably
- Different approaches to infrastructure and investment required



Potential game -changer for our industry

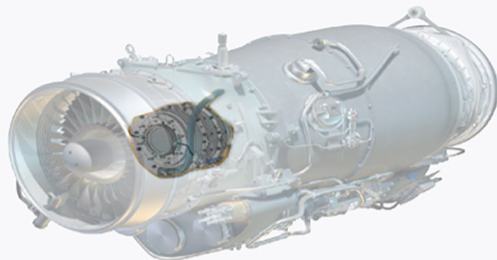
- Radical new aircraft/engine designs
- Gains in efficiency and emissions reduction
- New entrants and new scope of supply



Electrification in Civil Aerospace

We are working on both pathways in parallel

Partnership and collaboration are central to our approach



Evolutionary (incremental)

- More electric aircraft
- Electrical content increases – replacing mechanical and hydraulic systems
- Understanding of electrical technology becomes more important across the industry

Revolutionary (disruptive)

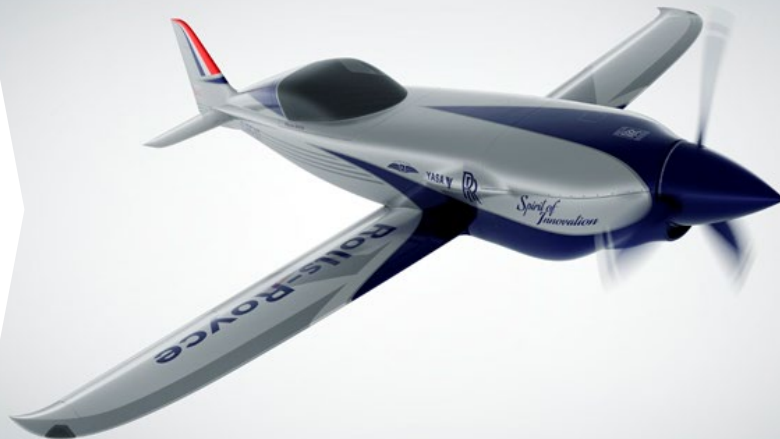
- Electric and hybrid electric aircraft in service
- New airframe and /or transport concepts
- New scope of supply
- New entrants in the market
- Market could structurally change
- Potential new regulatory approach



ACCEL

Aims to stimulate electrical supply chain, provide an independent path to electrical system capability acquisition plus learning how to de-risk electrical concepts.

Potential for zero carbon electric powered short-range regional and commuter travel.



A small, fast, all-electric single-seater demonstrator aircraft flying ~200nm

Flight testing in
2020

Targeting new air speed records

In partnership with:
Electroflight Ltd UK
YASAUK
UK Government



E-VTOL

Opportunity to collaborate with a range of strategic partners.

Battery provides additional take-off, hover and landing capability
Wings rotate to 90 degrees with option to take off and land vertically or conventionally.

Adaptable to personal & public transport, logistics & military; no re-charging required.

Deploys M250 (helicopter) gas turbine technology to generate electricity to power 6 electric propellers.



A concept series hybrid electric vertical take-off and landing vehicle for up to 5 passengers. Could travel up to 500nm at 250mph.

Could take off in the early

2020s

1/6 scale model wind tunnel testing successfully completed; indoor/outdoor flight testing in H2 2019



E-Fan X

Developing the world's most powerful flying generator
(ground testing starts Q3 2019)

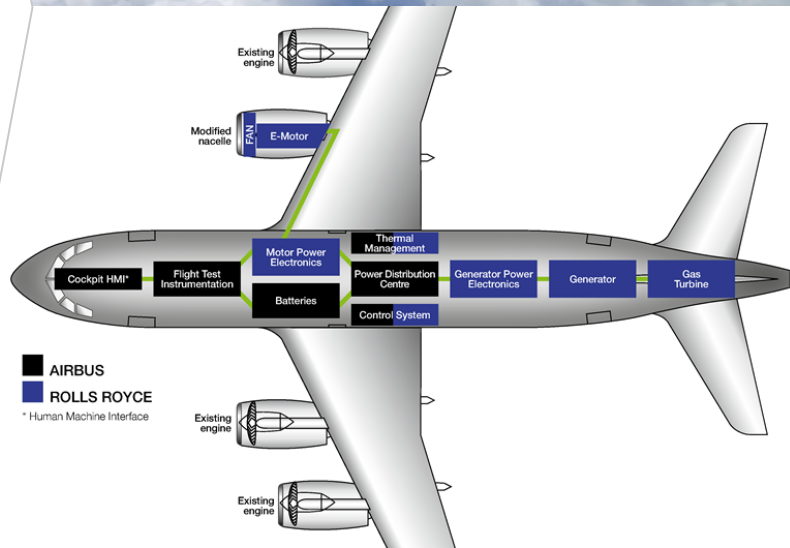
Designed to demonstrate that the fundamental challenges of hybrid -electric propulsion at this scale can be overcome

A building block towards hybrid electric commercial aircraft at the scale of today's single aisle family and beyond



An Avro RJ100 reconfigured to test series hybrid system

Integrating a 2MW Electric Propulsion Unit (EPU), a 2.5MW AE2100-based power generation system and a 2MW battery



Scheduled to fly in
2021

In partnership with:
Airbus
ATI UK
Clean Sky 2

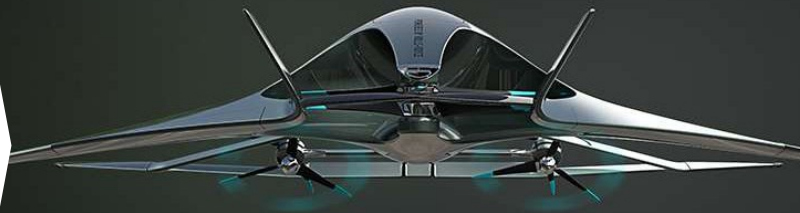


Aston Martin Volante concept

Powered by a Rolls-Royce
hybrid propulsion solution
(based on M250 gas turbine).

Offering fast, efficient urban,
and inter-city congestion-free
air travel for 3 people.

Developing high-performance
battery technology and
integrated motor and power
electronics.



A design study to show
how electric propulsion
technology can be used
to create exciting new
air vehicles.

Could enter into service
mid 2020s

In partnership with:
Cranfield University
Cranfield Aerospace
Solutions





It's about much more than the aircraft

Electrification could enable a shift in transport mode for civil aviation but innovative thinking is required right across our industry:

Transportation policies and subsidies

Physical and cyber security requirements

Digital ticketing

Airport design

Ground infrastructure and air traffic management

Regulatory requirements for certification and airworthiness

Potential single pilot operation

Mobility as a service



