Eliminating Climate Impact From Aviation

Potential pathways that are currently explored in DLR's EXACT project

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ZAL Discourse

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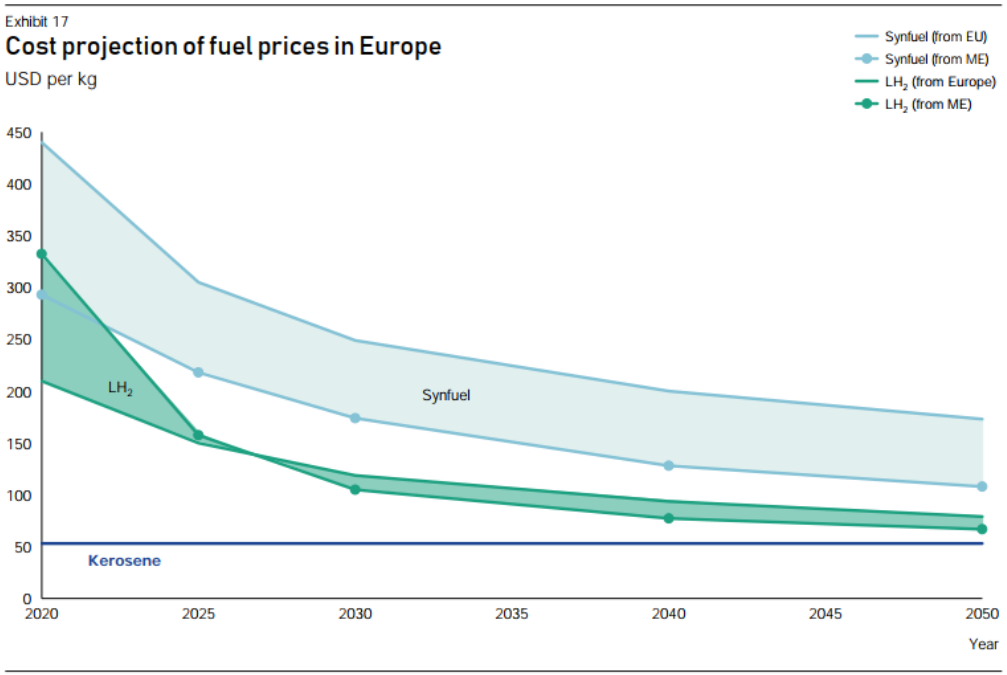
Aircraft as complex system of energy systems

Energy Sector

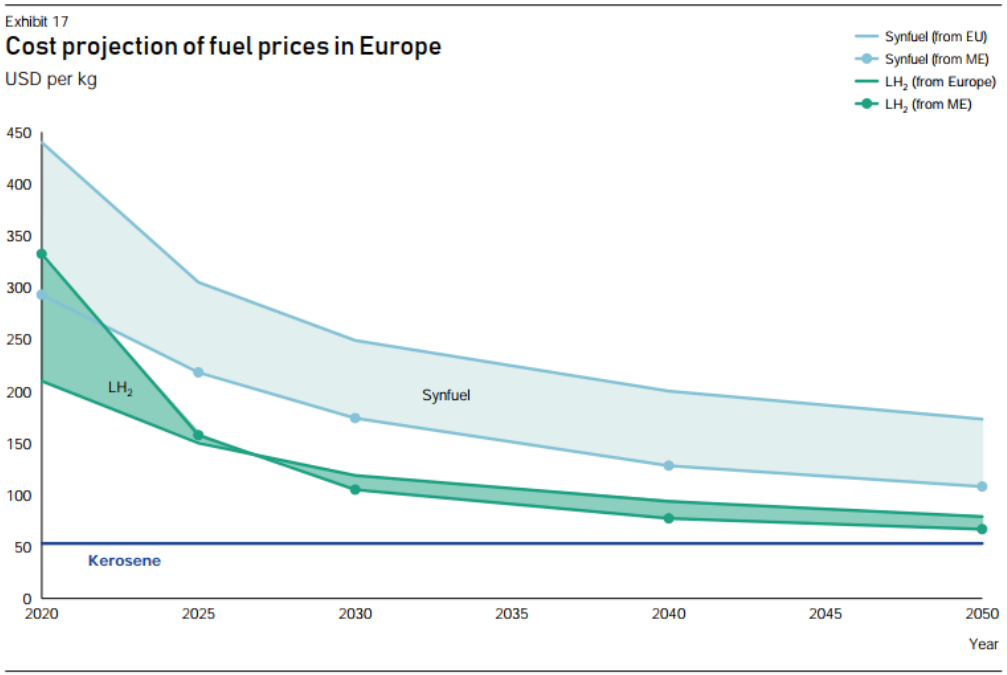


Aviation Sector

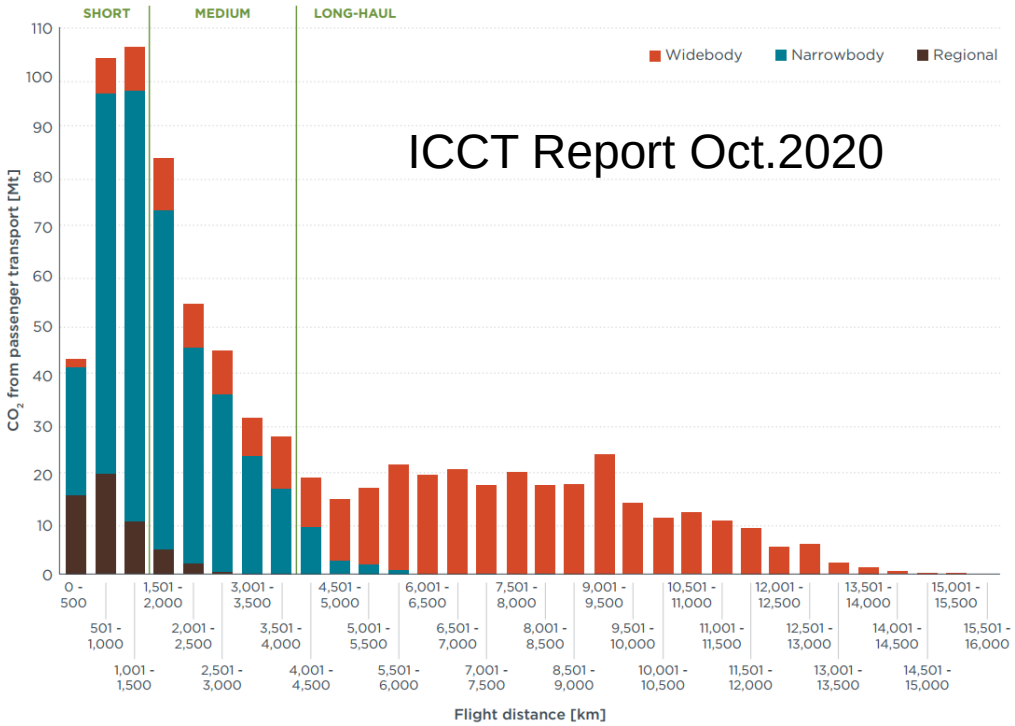
Green energy is the key for climate neutral air mobility. In order to identify sustainable solutions for a green air transportation system, the aviation sector has to go hand in hand with the energy sector. In EXACT, capabilities from 4 DLR divisions (energy, aviation, space, transport) are contributing to EXACT project.

Aircraft as complex system of energy systems

Energy Sector



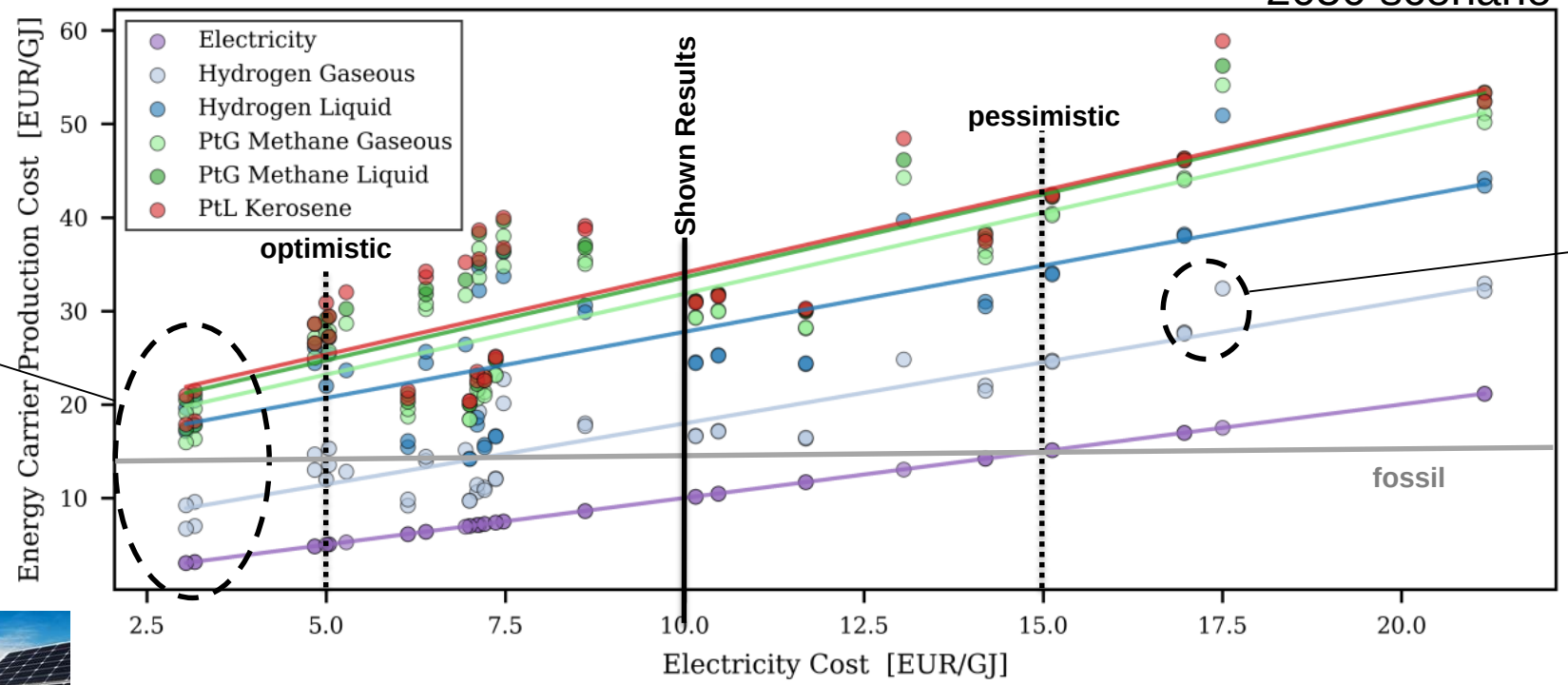
Aviation Sector



Green energy is the key for climate neutral air mobility. In order to identify sustainable solutions for a green air transportation system, the aviation sector has to go hand in hand with the energy sector. In EXACT, capabilities from 4 DLR divisions (energy, aviation, space, transport) are contributing to EXACT project.

The energy infrastructure

2050 scenario

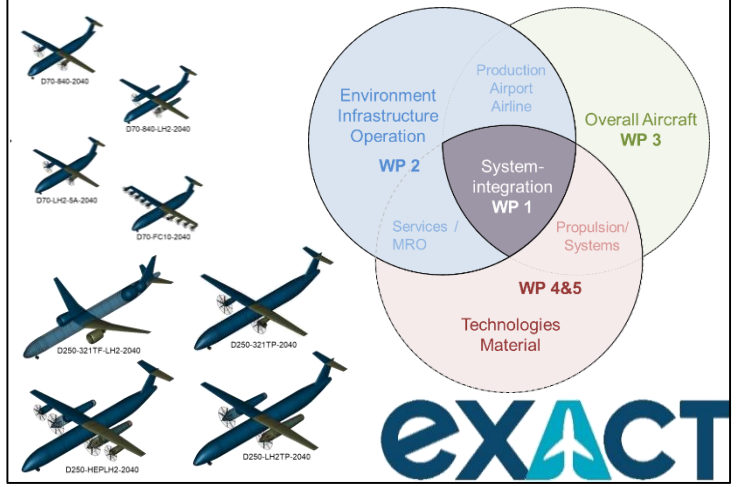


Fixed cost based on production infrastructure effort

Efficiency of production processes

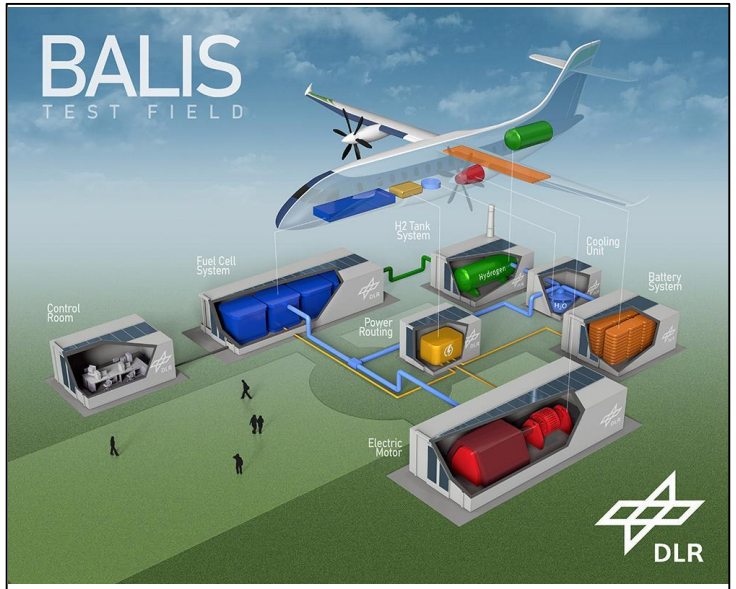
Different point of views

Market Pull



(In-Flight) Demonstration

Technology Push



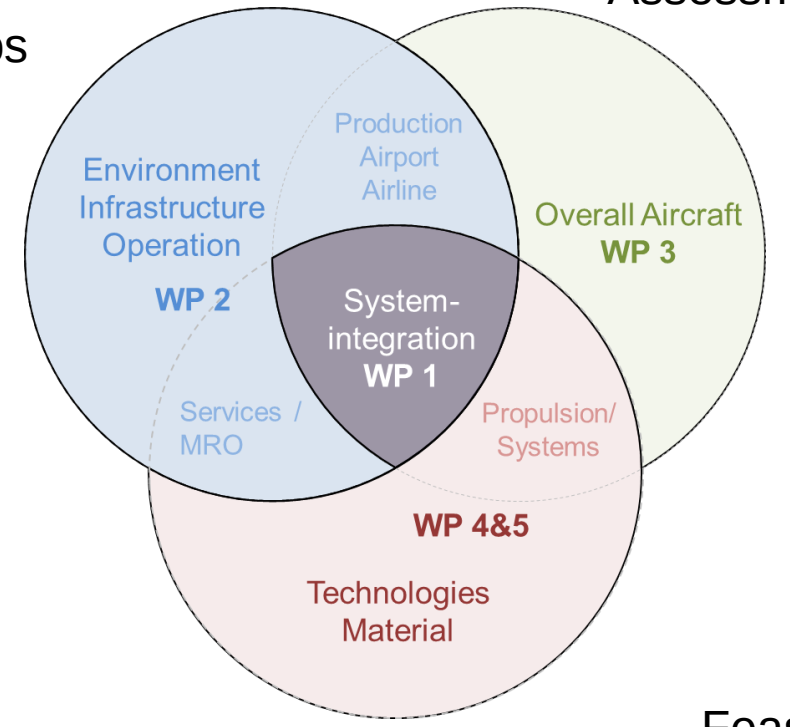
EXACT project approach

Future Demand Scenarios

Top Level System Requirements
- Climate Neutral
- Economically Viable
- Operational Feasible

CONOPS

Energy Carrier



Enabling Technologies

Assessment (Operation, LCC, LCA)
- Aircraft Level
- Fleet Level
- Global Air Transportation System Level
- Global Energy System Level

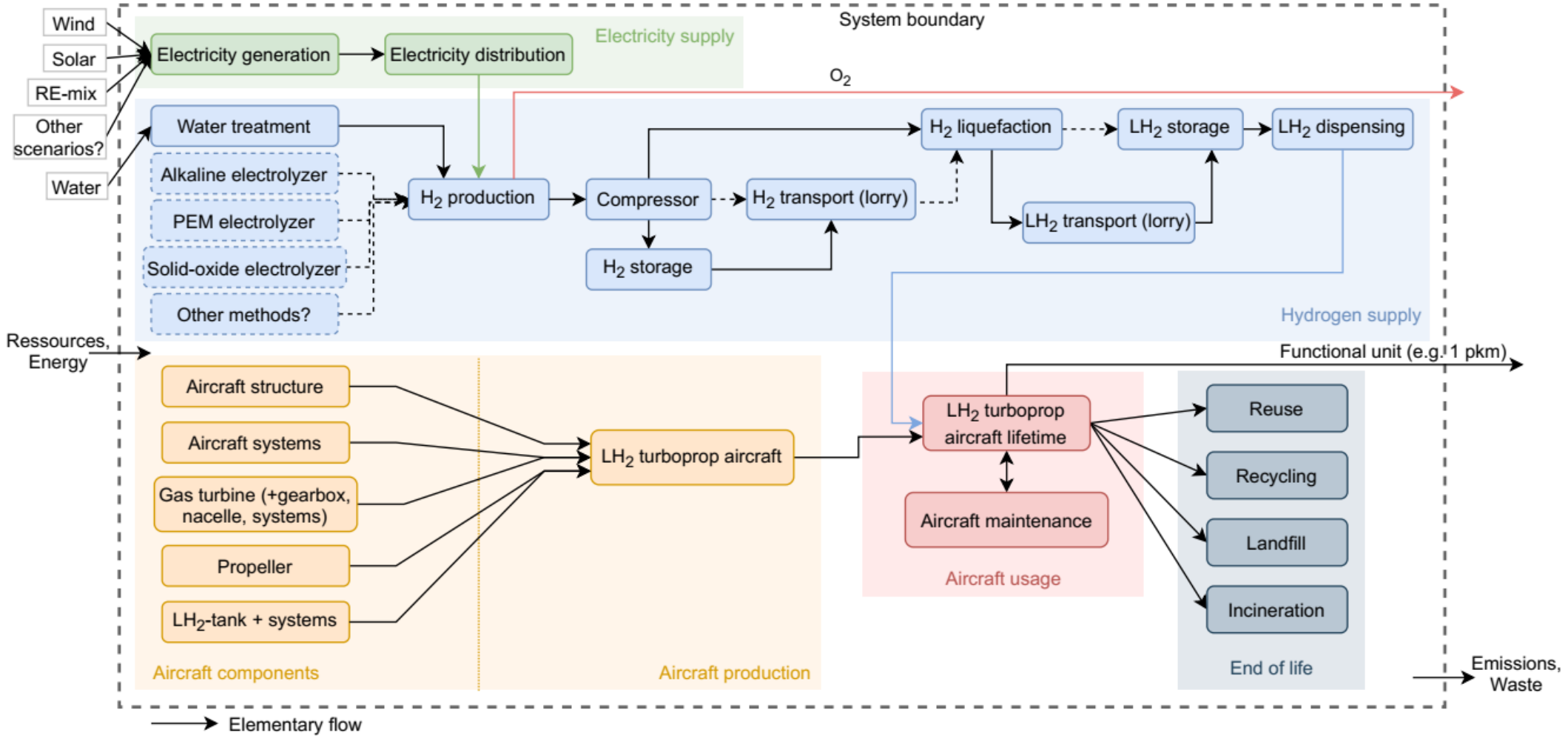
Overall Aircraft Design

Integrated Technology Bricks

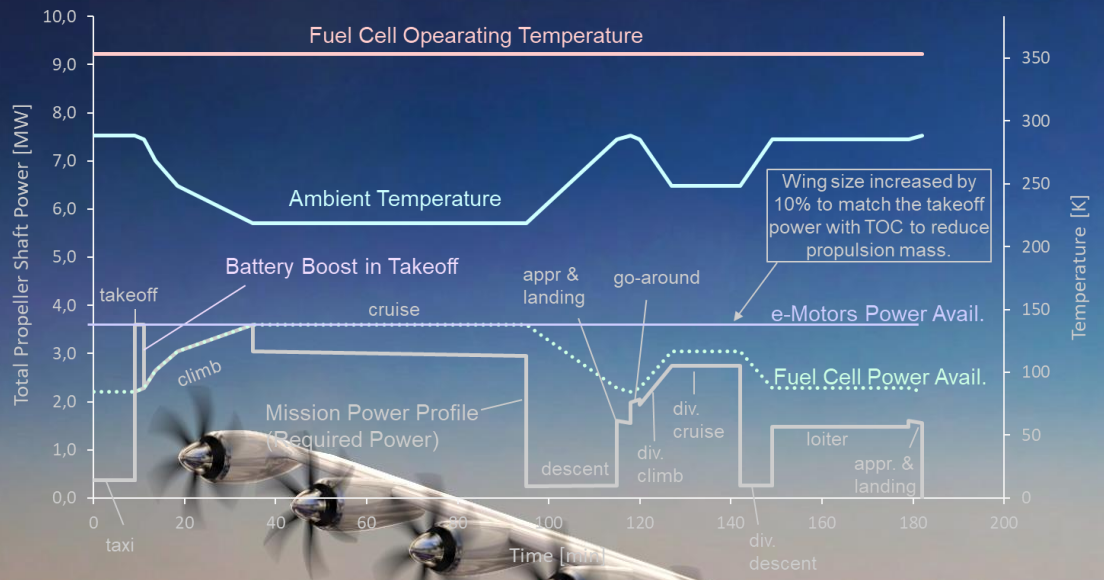
Feasible Solution

Fully digital model based backbone

EXACT project approach



(Fuel Cell) Electric Regional Aircraft



Comparison against ATR72-like aircraft

Energy demand	-20%
CO2 reduction	100%
Climate impact reduction	80-90%
Seat Mile Cost	-11%
Entry into service	2040
MTOW	+16%
Fleet size change for same departure count	-3%

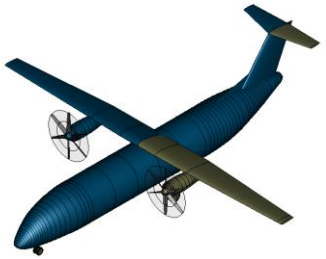
Design Mission

- 70PAX, in single class layout
- Mach 0.55; 1000nm range

Features

- Distributed propulsion with 10 self-sufficient nacelle modules (FC, Inv, eMot, HX)
- Central tank architecture with 2 LH2 tank @ rear end in 5-abreast fuselage

Comparison of Aircraft Concepts



Design Mission Block Energy

-10%

D70-LH2-5A-2040

Cruise Efficiency

-12%

Design Mission Block Energy

-16%

+6% Energy
Due to increased fuselage & vtp mass.

+6% Energy
Due aero penalties

-2% Energy
Better sfc (bigger engines)

-21% Energy
Increased efficiency of power generation.

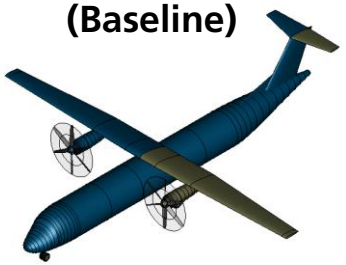
-4% Energy
Improved descent and allowances efficiency.

+9% Energy
Due to increased mass.

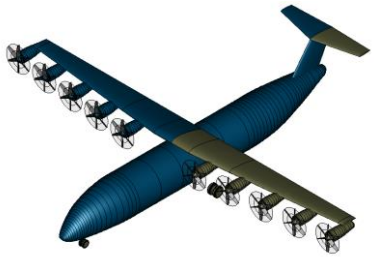
-5% Energy
Improved aero-propulsive eff. due to distributed propellers & VTP redesign.

+5% Energy
Due to fuel cell cooling losses.

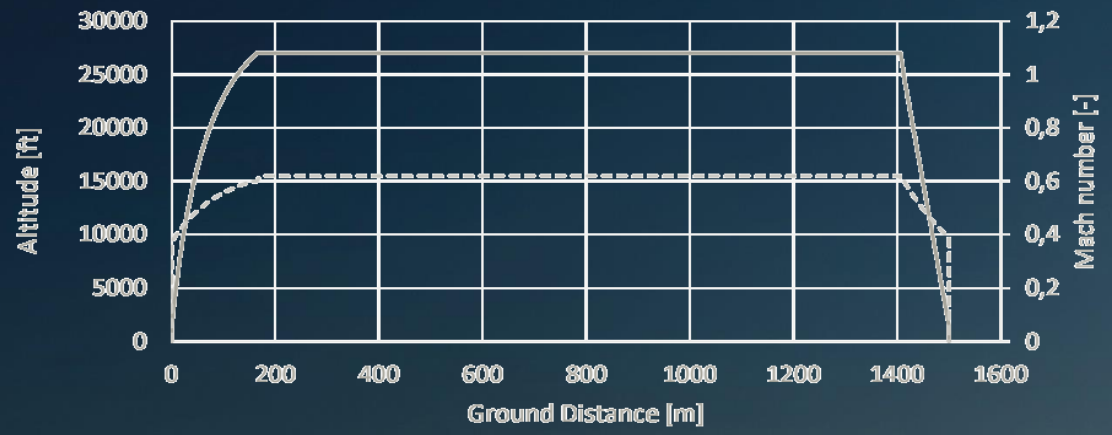
D70-840-2040 (Baseline)



D70-FC10-2040



LH2 Short Range Aircraft



Comparison against A320NEO-like aircraft

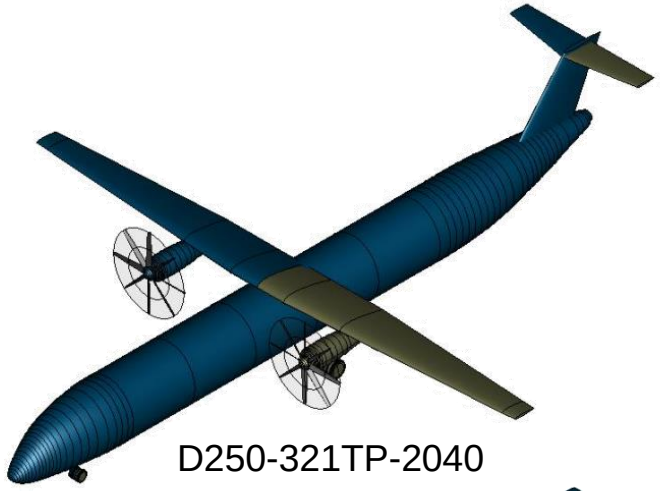
Energy demand	-40%
CO2 reduction	100%
Climate impact reduction	70-85%
Seat Mile Cost	+4%
Entry into service	2040
MTOW	-11%
Fleet size change for same departure count	+5%

Design Mission
- 250PAX, in HD single class, flat 6-abreast
- 1500nm range
- Mach 0.62

Features
- Advanced Low NOx H2 Gas Turbine in combination with FC-APU+ (mild hybrid)
- LH2 Storage System in Pods **OR** in fuselage (with aviation specific characteristics)

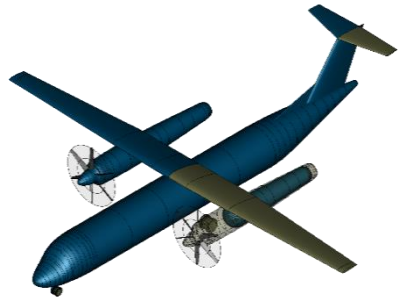
Various Aircraft Architectures for Reduced Climate Impact

D250-321TF-LH2-2040

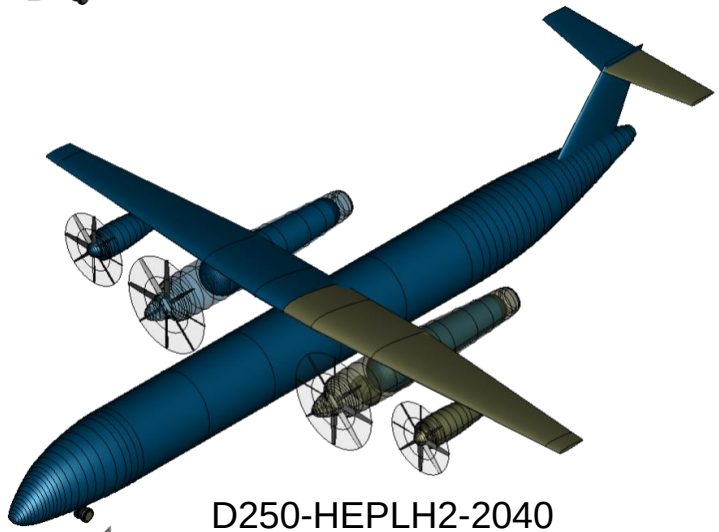


D250-321TP-2040

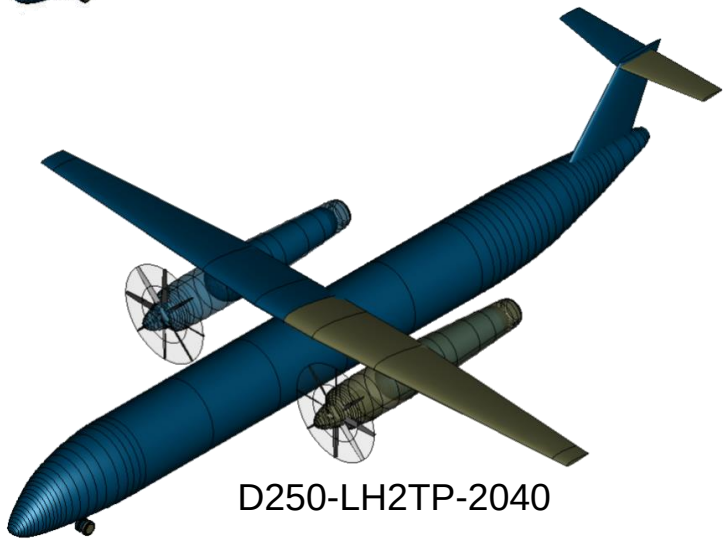
D70-840-2040



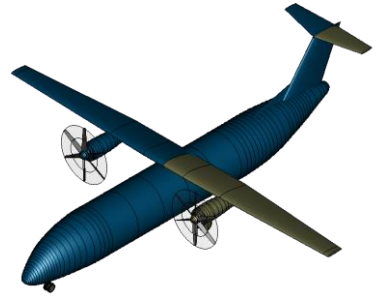
D70-840-LH2-2040



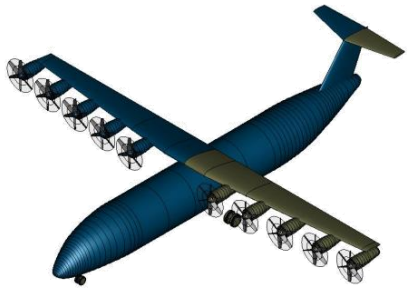
D250-HEPLH2-2040



D250-LH2TP-2040

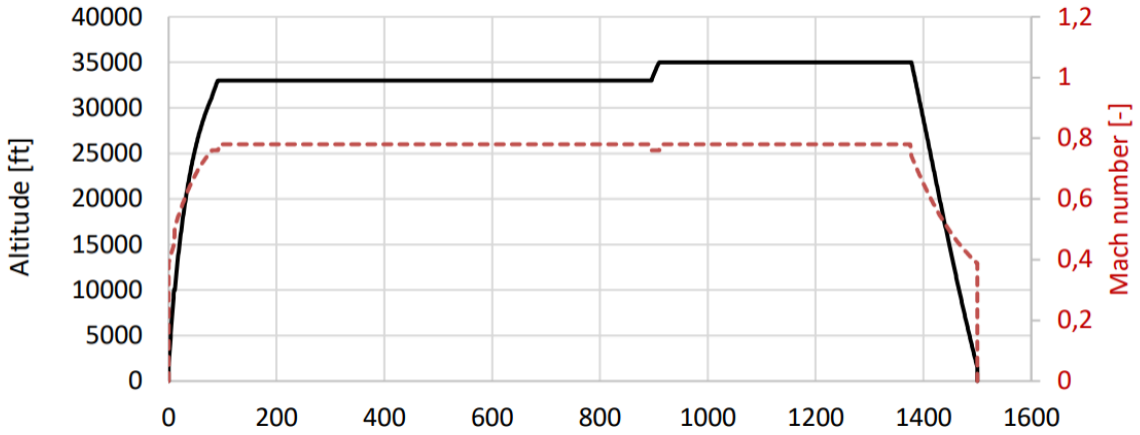


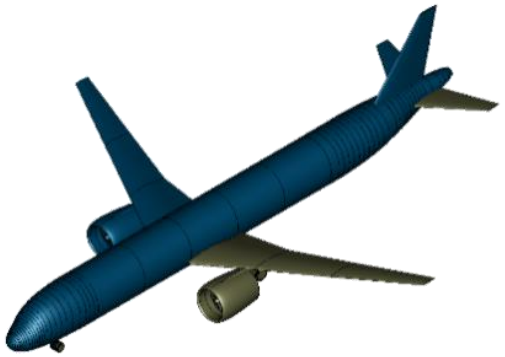
D70-LH2-5A-2040



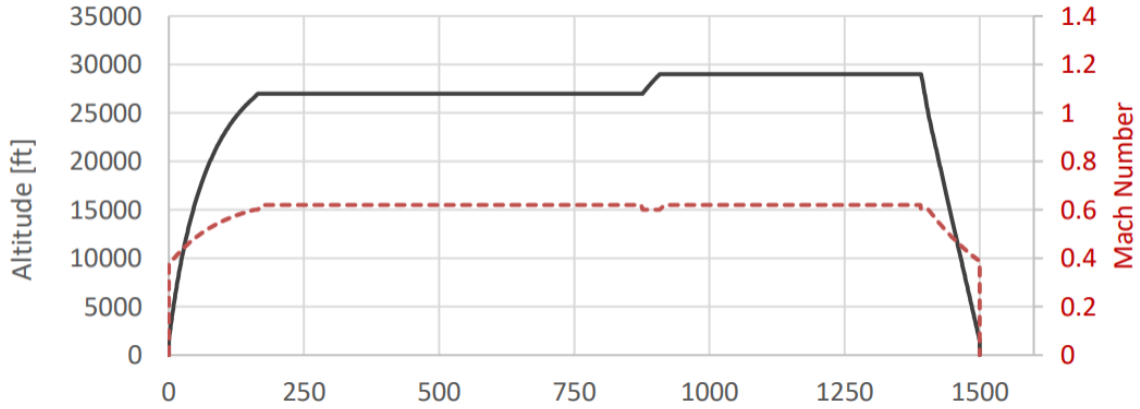
D70-FC10-2040

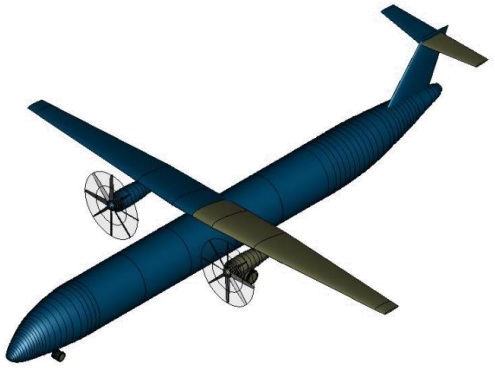
The Baseline Scenario





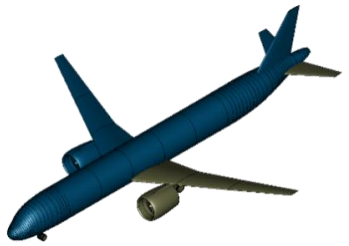
D250-321TF-2040





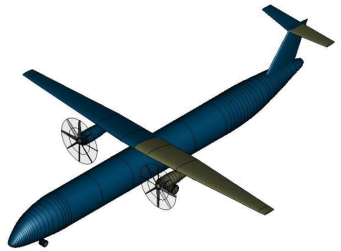
D250-321TP-2040

What makes a solution a good one?



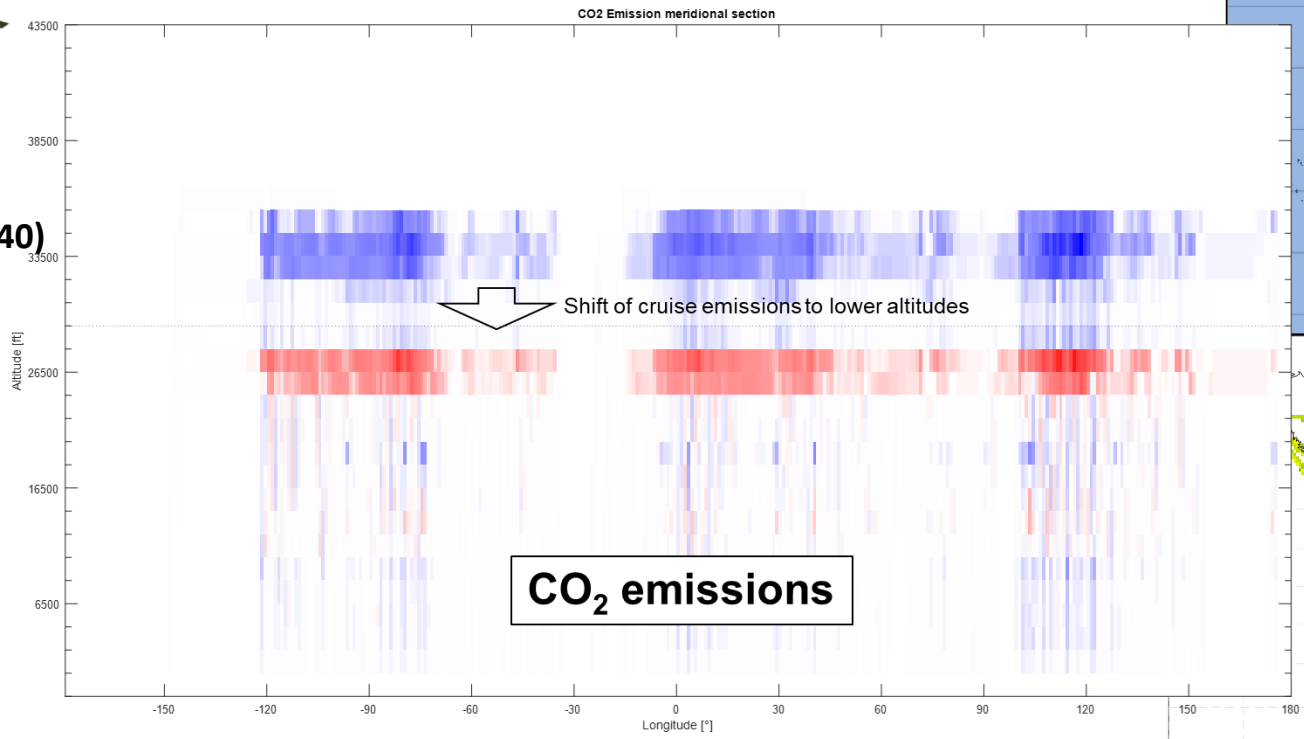
250 PAX TF (baseline 2040)

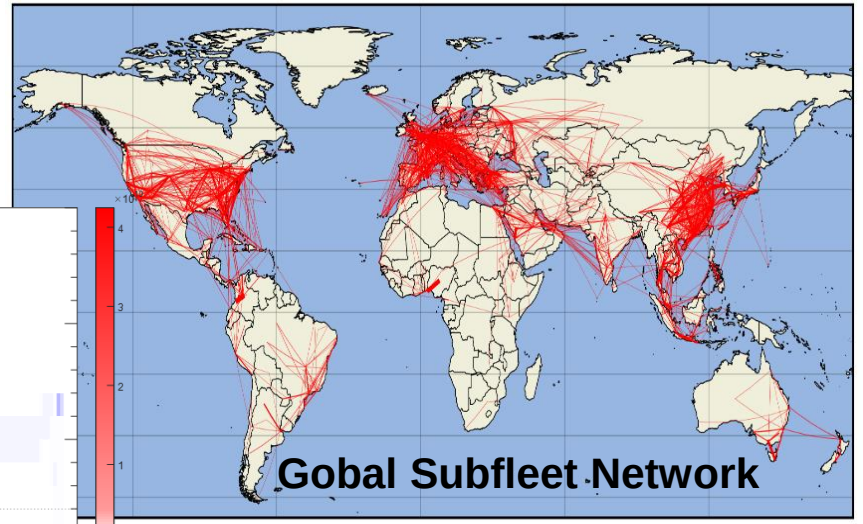
Ma = 0,78; R_{DP} = 1500NM

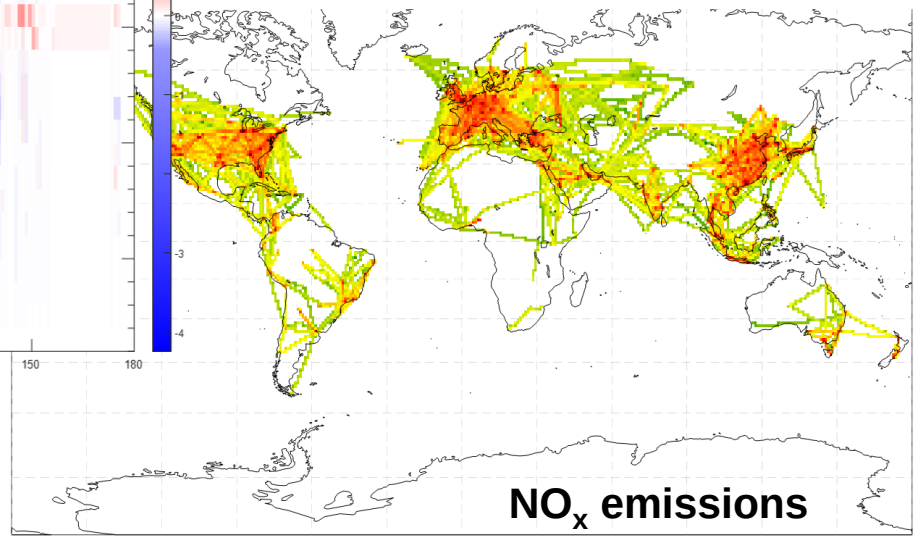


250 PAX TP

Ma = 0,62; R_{DP} = 1500NM







Thank You!

Reach out to: Johannes.hartmann@dlr.de