Accelerating the future of aerospace

Energy Transition Infrastructure (ETI) @ NLR

Paul Arendsen; 26-3-2025

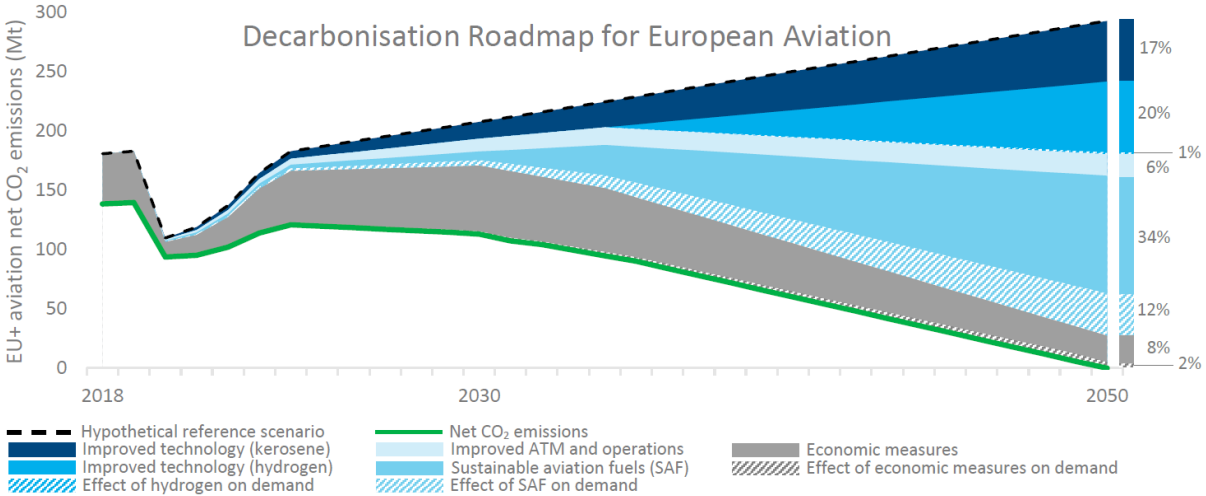
Presentation overview

- ***"Destination 2050"***
  - Some Highlights on NLR's vision on future aerospace
  - NLR is focusing on hydrogen electric propulsion
- **Energy Transition Infrastructure (ETI)**
  - Hydrogen facilities
  - Deep Cryogenic facilities
- **Project Highlights**
  - *"Hypotrade"*, *"COCOLIH2T"*
- **Near Future Developments**

"Destination 2050"

Some highlights of NLR's vision on future aerospace

- www.destination2050.eu (2025 update available)



- All measures hold de-carbonisation potential.

"Destination 2050"
Some highlights of NLR's vision on future aerospace

Industry should

- Continue to substantially invest in decarbonisation
- Develop more fuel-efficient aircraft and bring these into operation through continued fleet renewal
- Develop hydrogen-powered and (hybrid-)electric aircraft and associated supporting (airport) infrastructure and bring these into the market
- Scale up drop-in SAF production and uptake
- Implement the latest innovations in ATM and flight planning
- Compensate remaining CO2 emissions by removing carbon dioxide from the atmosphere

Governments should

- Support industry investments by direct stimuli or by reducing investment risk through a consistent and long-term policy framework
- Stimulate further development and deployment of innovations by funding research programmes and promoting carbon removal technologies
- Work with the energy sector to ensure sufficient availability of renewable energy at affordable cost
- Support the development of the SAF industry
- Contribute to optimising ATM, in particular by fully implementing the Single European Sky

- NLR is focussing on hydrogen electric propulsion

"Destination 2050"

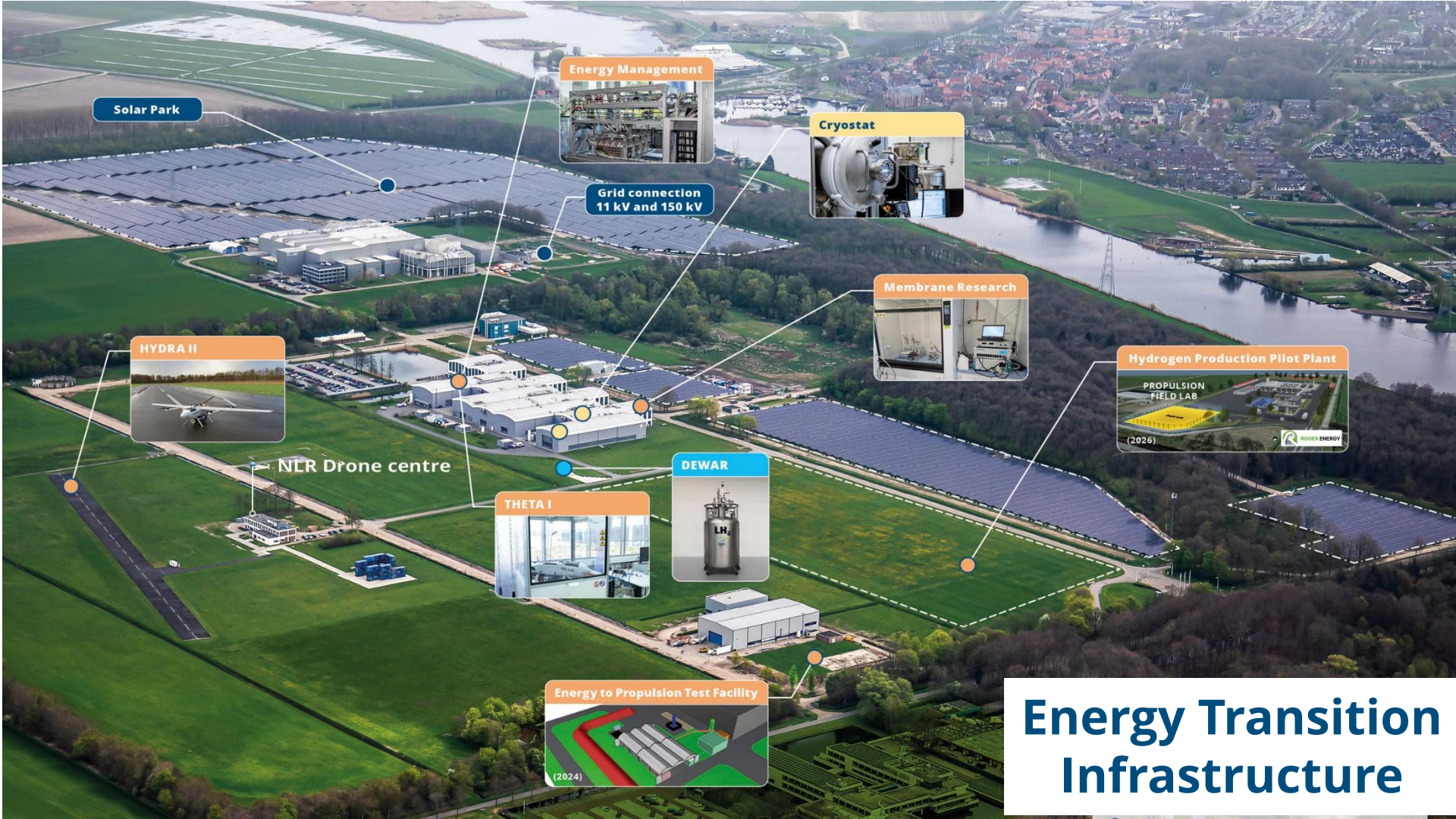
NLR's focus is on hydrogen electric propulsion

Energy management => *System & Equipment development*

- Fuel Cell operation;
  - Electric performance in flight,
  - Air and hydrogen conditioning (incl. warming up LH2)
  - FC health
  - Waste heat during flight

Hydrogen as energy carrier => *Material & Structures development*

- Tank / piping development
  - Gas = too much volume, compressed gas = too heavy container
  - Liquid hydrogen only option for larger AC / distances
    - Deep Cryogenic temperatures (20K = -253°C)
    - Permeability



Energy Transition Infrastructure

Energy Transition Infrastructure (ETI)

Hydrogen facilities: THETA

Experiment Environment for gaseous hydrogen

- Fuel Cells
- Tanks, valves, etc

Energy Transition Infrastructure (ETI)

Hydrogen facilities: OHF

Experiment Environment for liquid hydrogen

- Small amounts
- Dewar 125l
- Re-fuelling (drone) tanks
- Lots of H&S documentation

Energy Transition Infrastructure (ETI)

(*liquid*) Hydrogen facilities: EPTF

Energy to **P**ropulsion **T**est **F**acility

- Goals
  - Power trains (MW)
  - Slosh tests LH2 tanks
  - Attitude test power trains
  - Super conductivity tests
- Specs
  - 40m^3 LH2, 8m^3 LN2
  - 400kVA bidirectional E-power
  - Permits, H&S documents

Energy Transition Infrastructure (ETI)

Deep Cryogenic facilities: S-Cryostat

Goals

- Material characterisation @20K
- Commercially available

Specs

- Most common ASTM tests
- Static for now

Development

- Dynamic Q4 2025
- In-situ H2 2026
- Superconductivity tests 2027

Project Highlights

Hypotrade

Site Acceptance Test, Q4 2024

- 110kW Fuel Cell

Bi-directional power supplies

Fuel Cell

Operator room

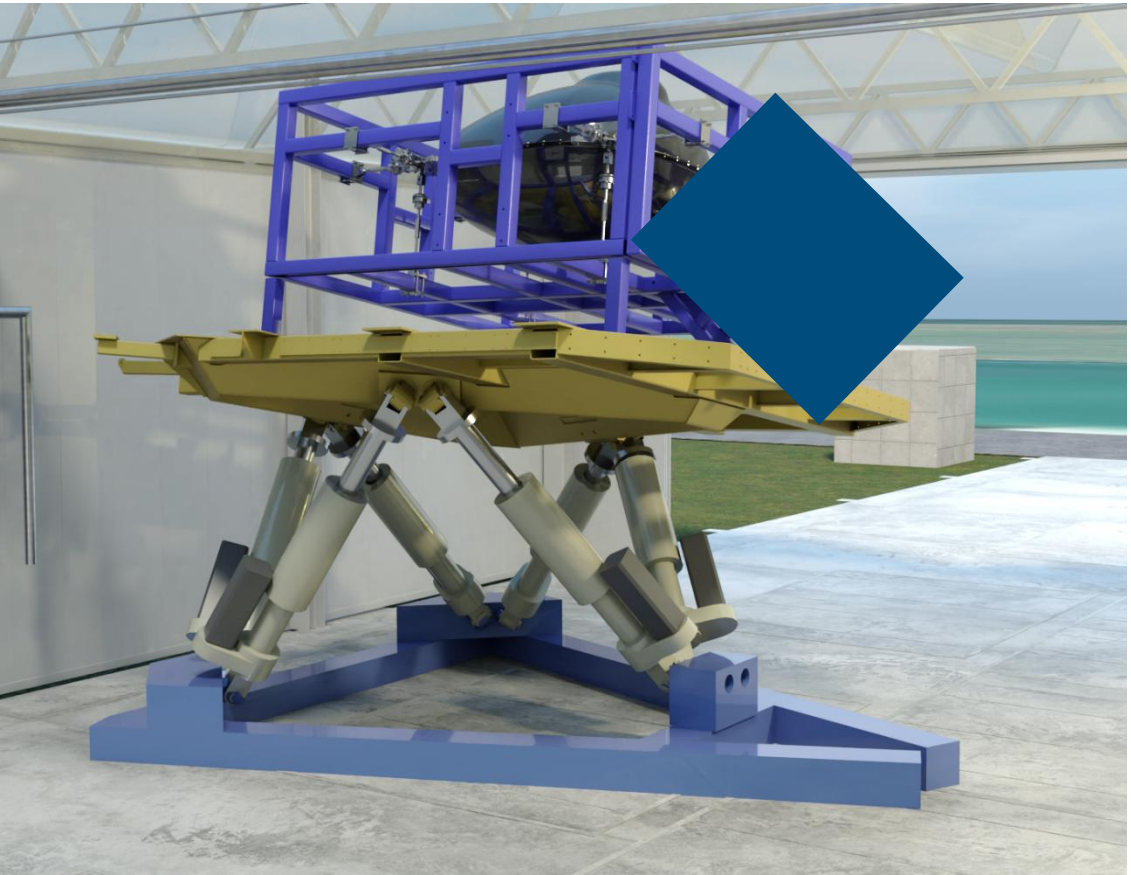
hydrogen bundles

Project Highlights

COCOLIH2T

COnformal **CO**mposite **LH2 T**ank

- Non cylindrical LH2 tank
- Slosh test on 1m^3 LH2 tank



Status March 2025;
Fully operational Hexapod

Near Future Developments: Hydrogen Production Pilot Plant ROGER & NLR

Thank you for your attention!

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