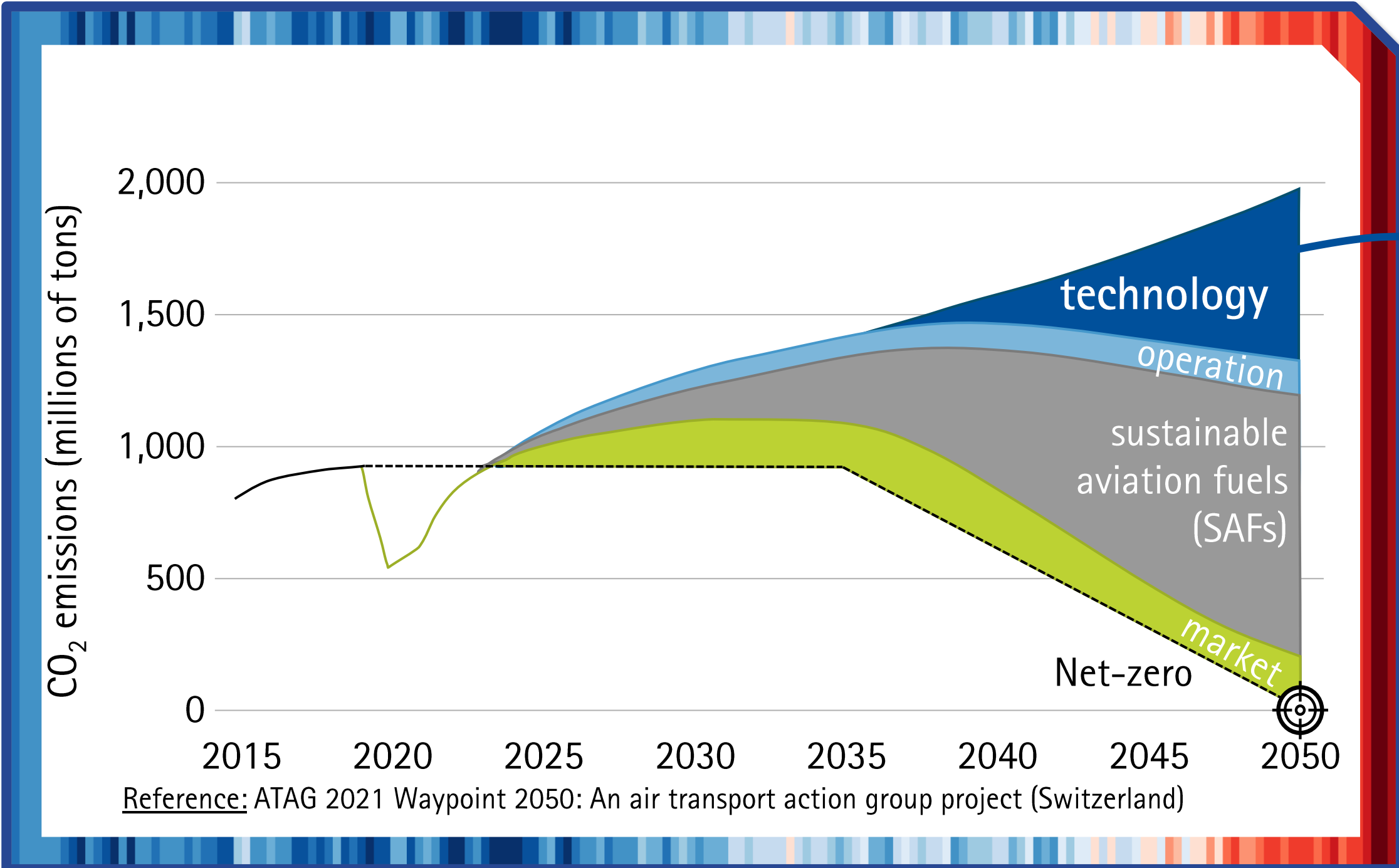


Hydrogen Fueled Solid Oxide Fuel Cell - Gas Turbine Engine

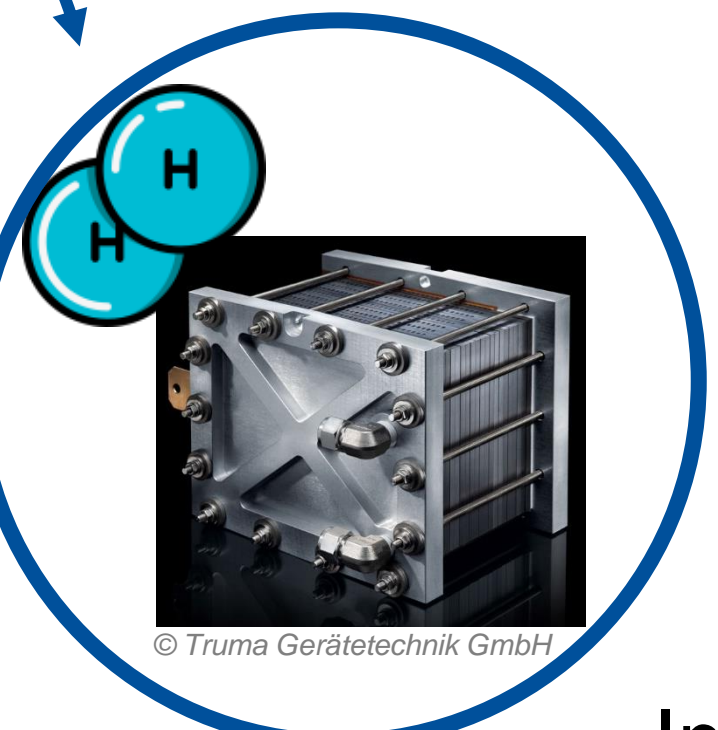
Project: Hydrogen Electrical Engine Novel Architecture (HYLENA) – Status: 09/2024

P. Köhler, J. Tillner, Prof. Dr.-Ing. S. Kabelac

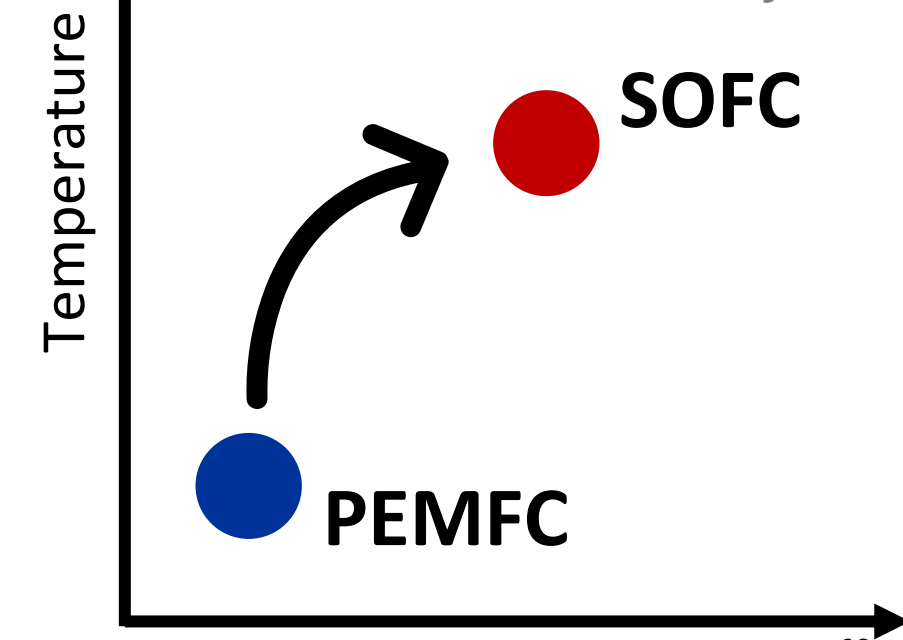
Aim & Background



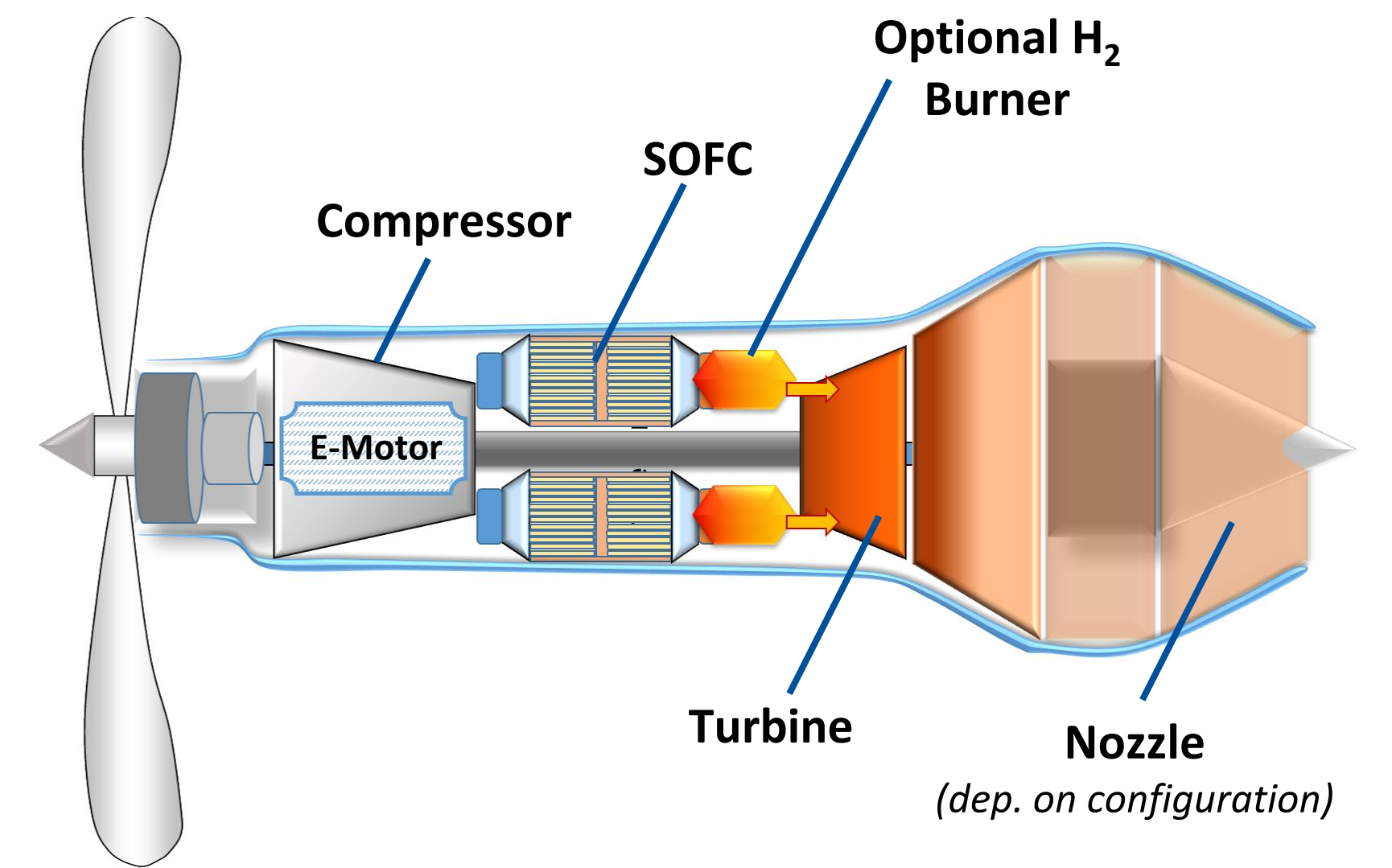
Using Fuel Cell for more sustainable aviation



... to high-temperature self-cooled SOFC-Systems



From external cooled low-temperature PEMFC-Systems ...



Integration and combination of **Solid Oxide Fuel Cells (SOFC)** with turbomachinery to utilize both the electrical and thermal energy to maximize propulsion energy

What is HYLENA?

AIRBUS
LePMI
Grenoble - Chambéry

Leibniz Universität Hannover

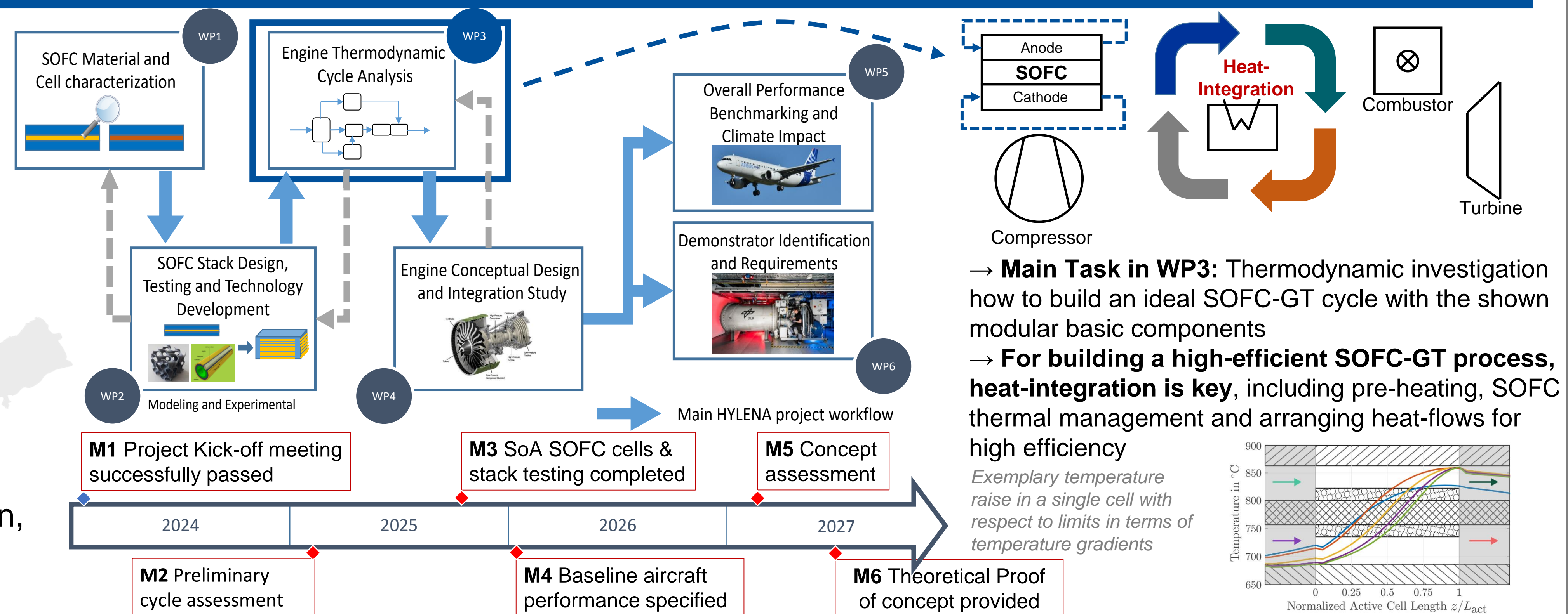
TUD
LJH DLR BHL

Bauhaus Luftfahrt
The Aviation Think Tank

TU Delft

DLR

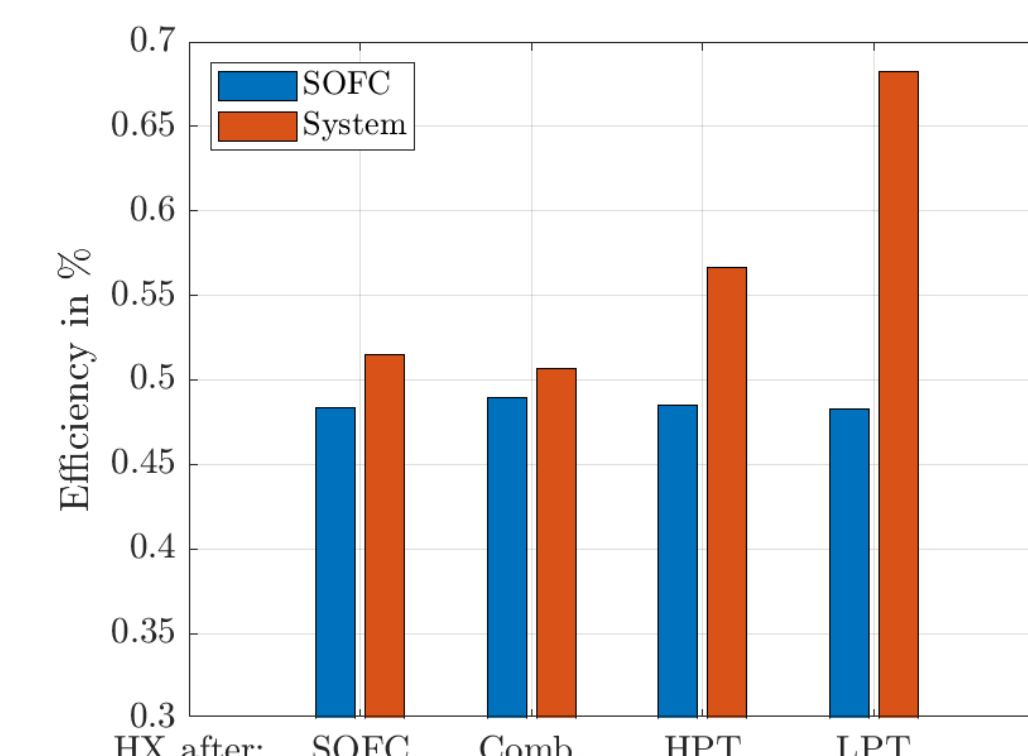
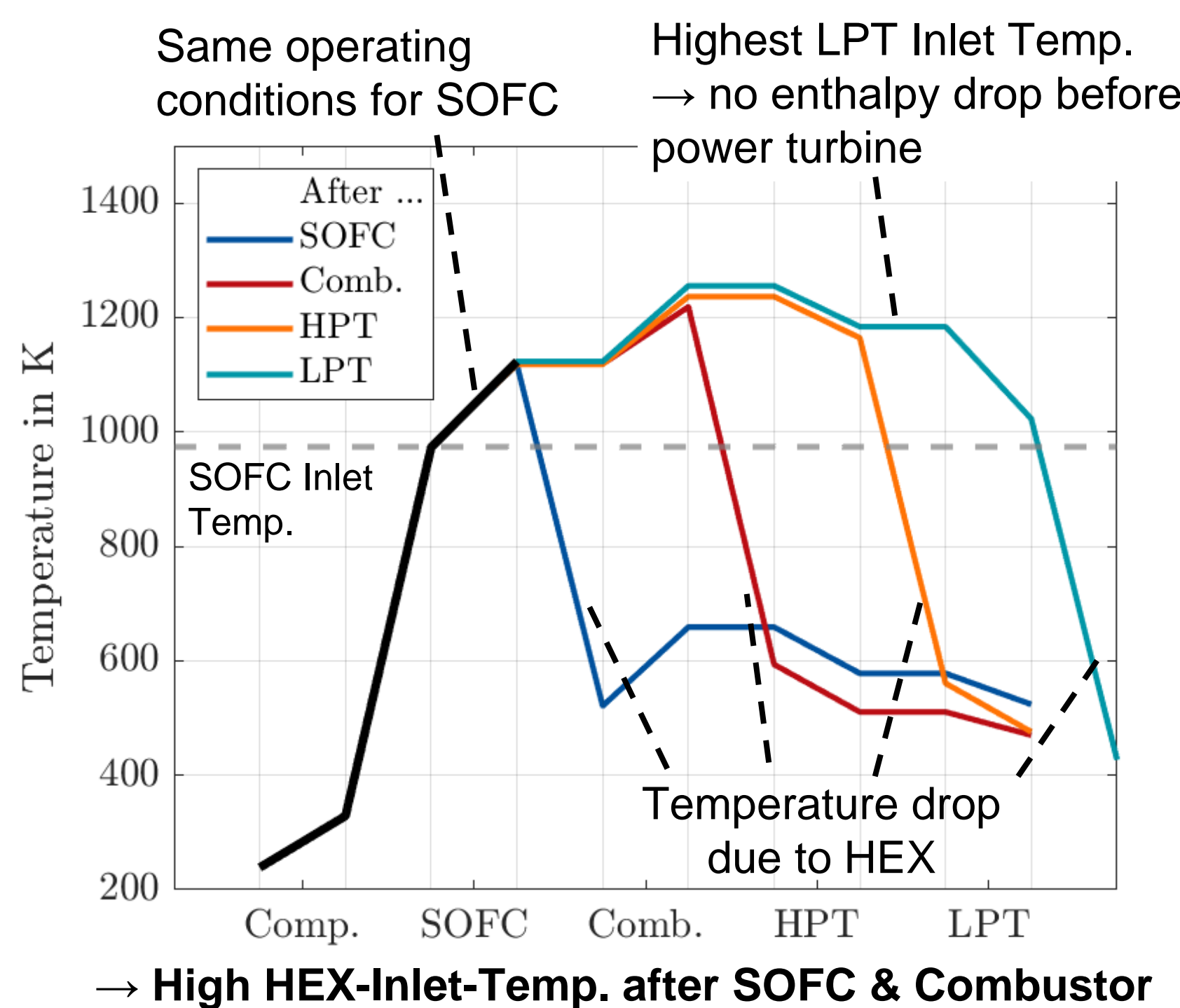
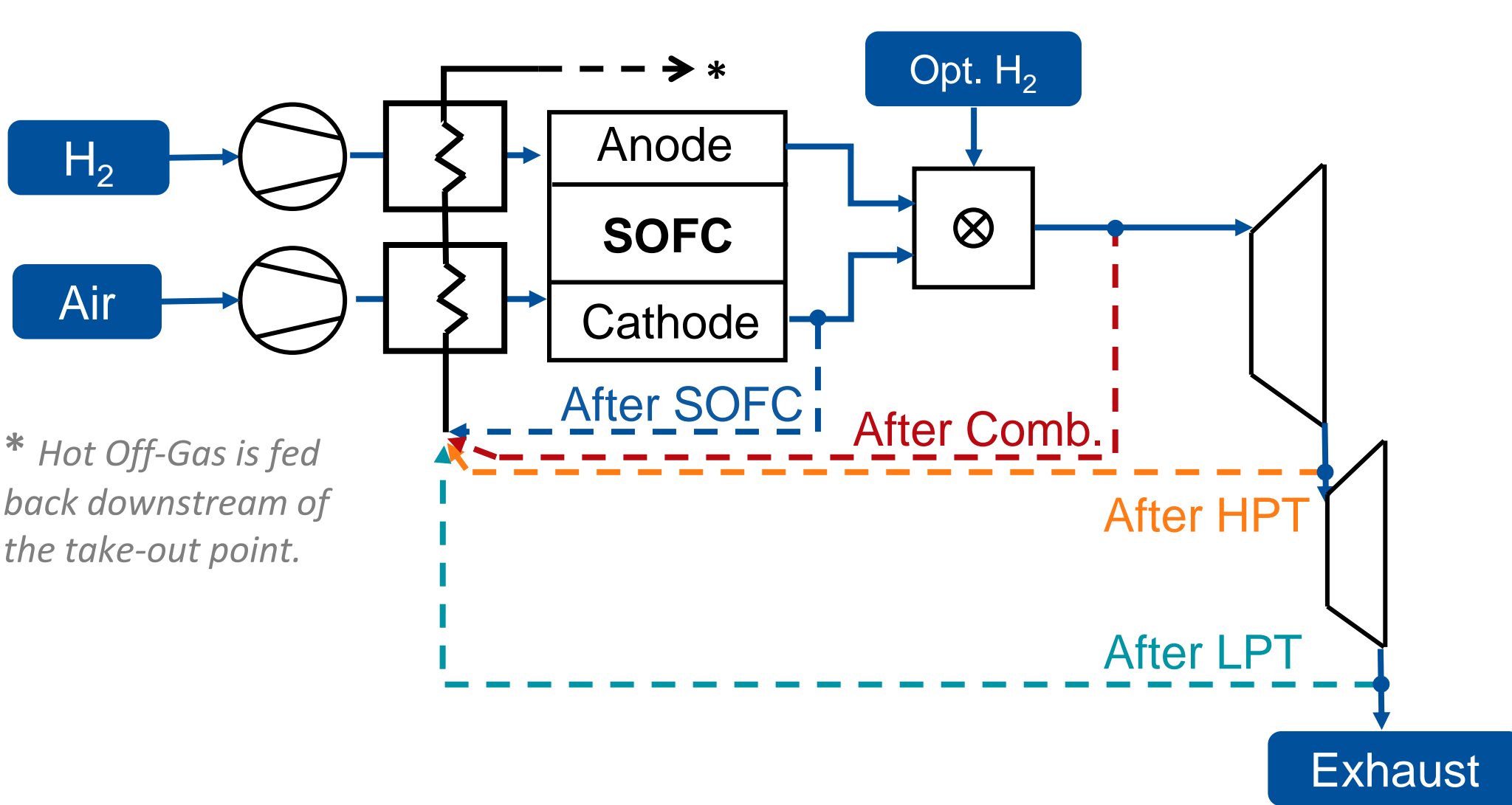
Covering expertise in aircraft & propulsion system design, SOFC (Solid Oxide Fuel Cell) technology, hydrogen combustion and climate impact assessment



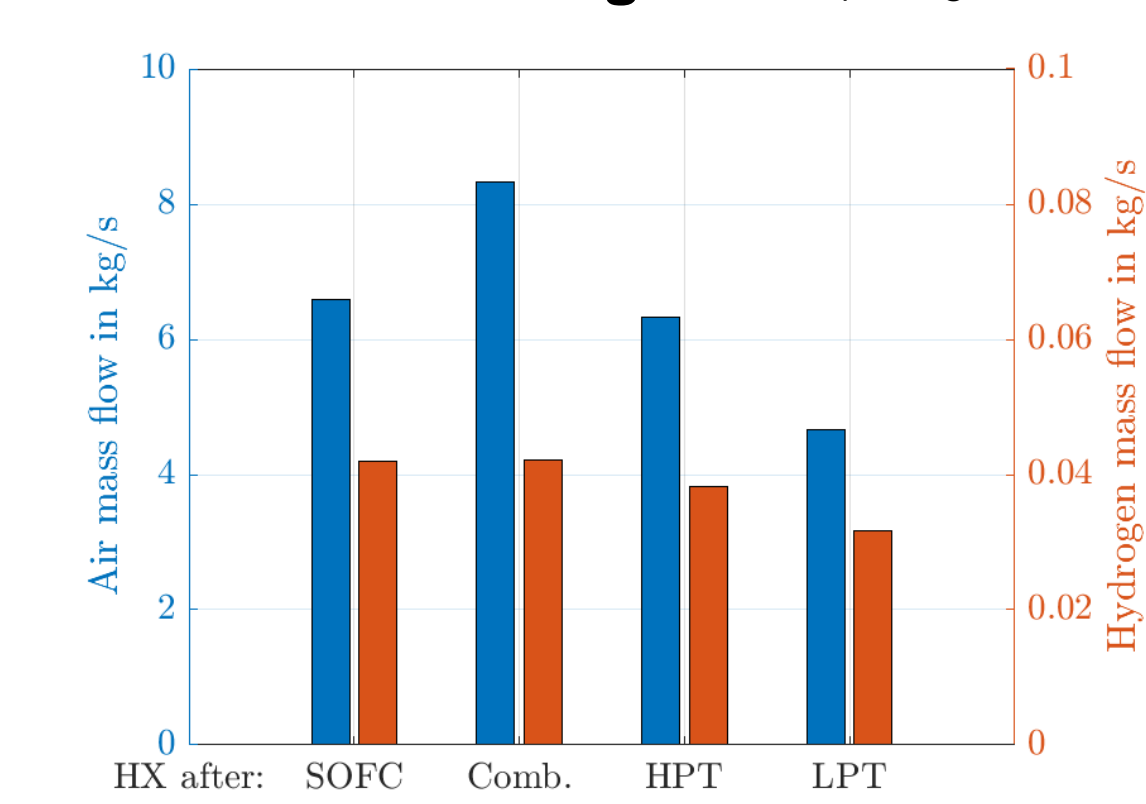
WP3 – Engine Thermodynamic Cycle Analysis

How does the HEX-position effect the thermodynamic cycle?

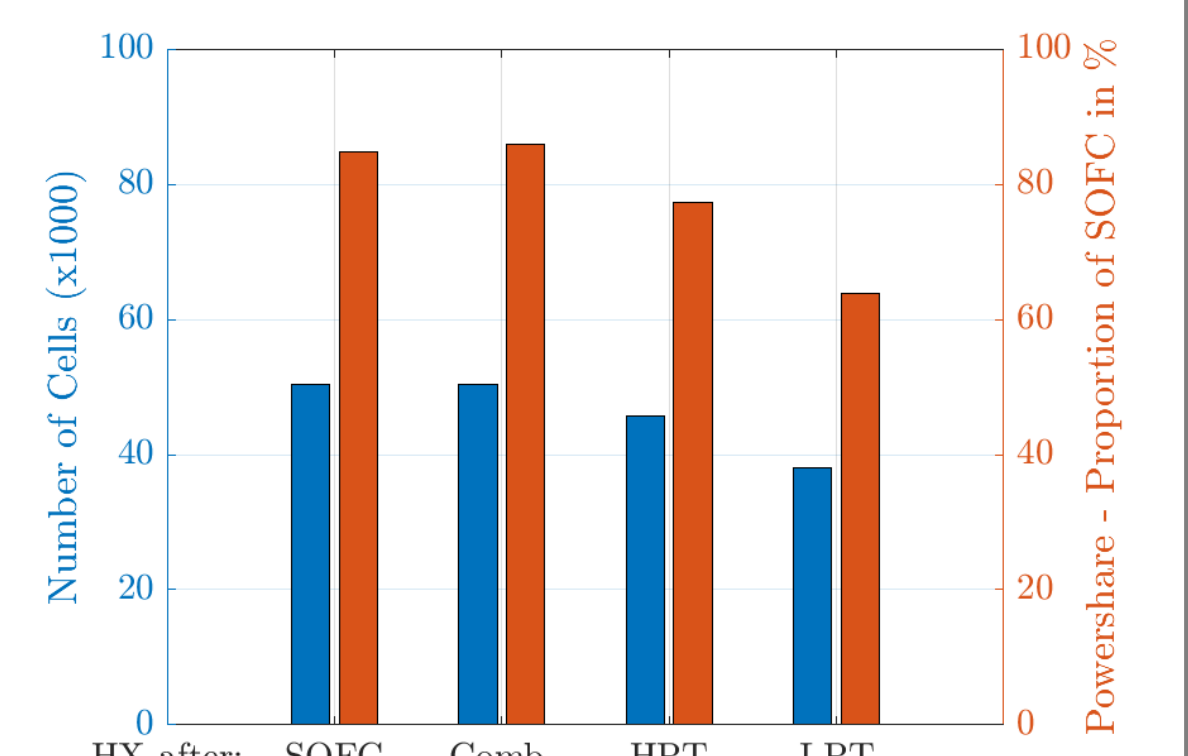
1st option: Using heat-exchanger (HEX) at different hot-gas locations



→ **Radical increase of efficiency and decrease of number of cells due to better heat-integration** (changes in turbomachinery efficiency due to different mass flows neglected)



→ **less air flow for smaller turbomachinery**



→ **Possible sizing penalty with 'after LPT' positioning, but reduced complexity compared to HPT**

Boundary Conditions for each simulations (FU = 80 %, $i = 0.5 \text{ A/cm}^2$, $p = 1 \text{ bar}$), $P_{out, mech} = 2597 \text{ kW}$ (incl. 120 kW POT); no pressure & heat losses to environment, constant isentropic efficiencies (Compressor: 85 %, Turbine: 88 %), Turbine enables expansion to ambient pressure; SOFC: simulation at cell level (not stack), ASR for electrolyte supported cells used, air mass flow is defined due to cooling requirement for SOFC, System-efficiency is defined from fuel to mechanical shaft power.

Outlook and further activities

- In-depth sensitivity study of impact parameters to the overall system architecture and initial weight estimation
- Off-Design study with more detailed turbomachinery
- Enhanced study on the exergetic (2nd law) behavior
- Eliminating HEX to reduce overall system weight with different heat-integration methods
- 1st public deliverable with technical details in Q1 2025

