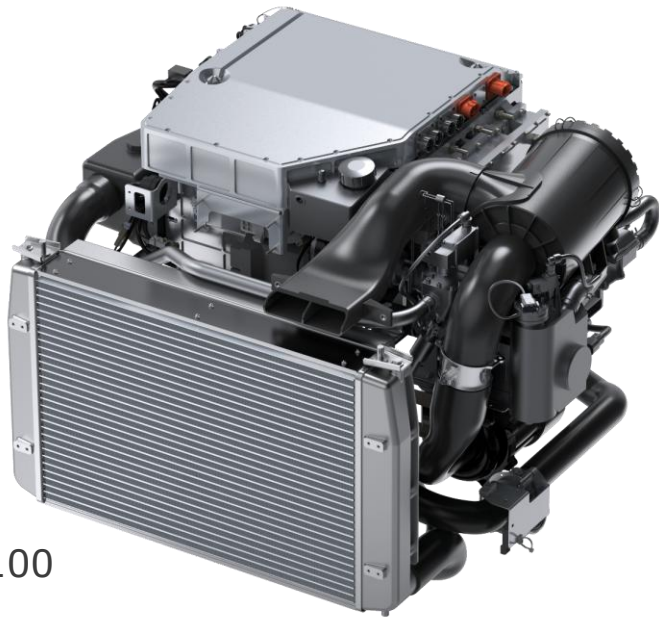


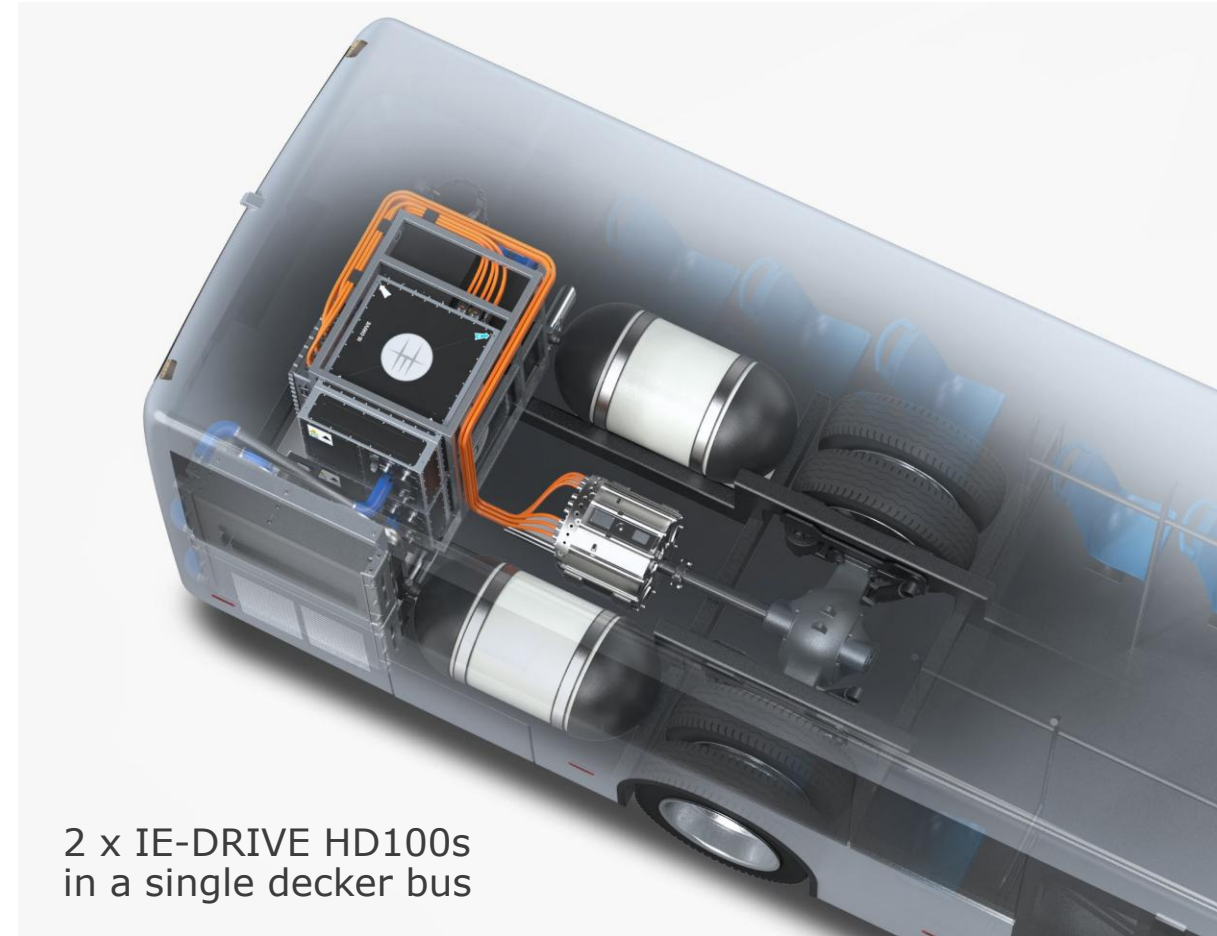
Increasing heat rejection temperature from hydrogen fuel cells, without power density and durability compromise

Cenex Expo 2025

Jon Cole



IE-DRIVE 100

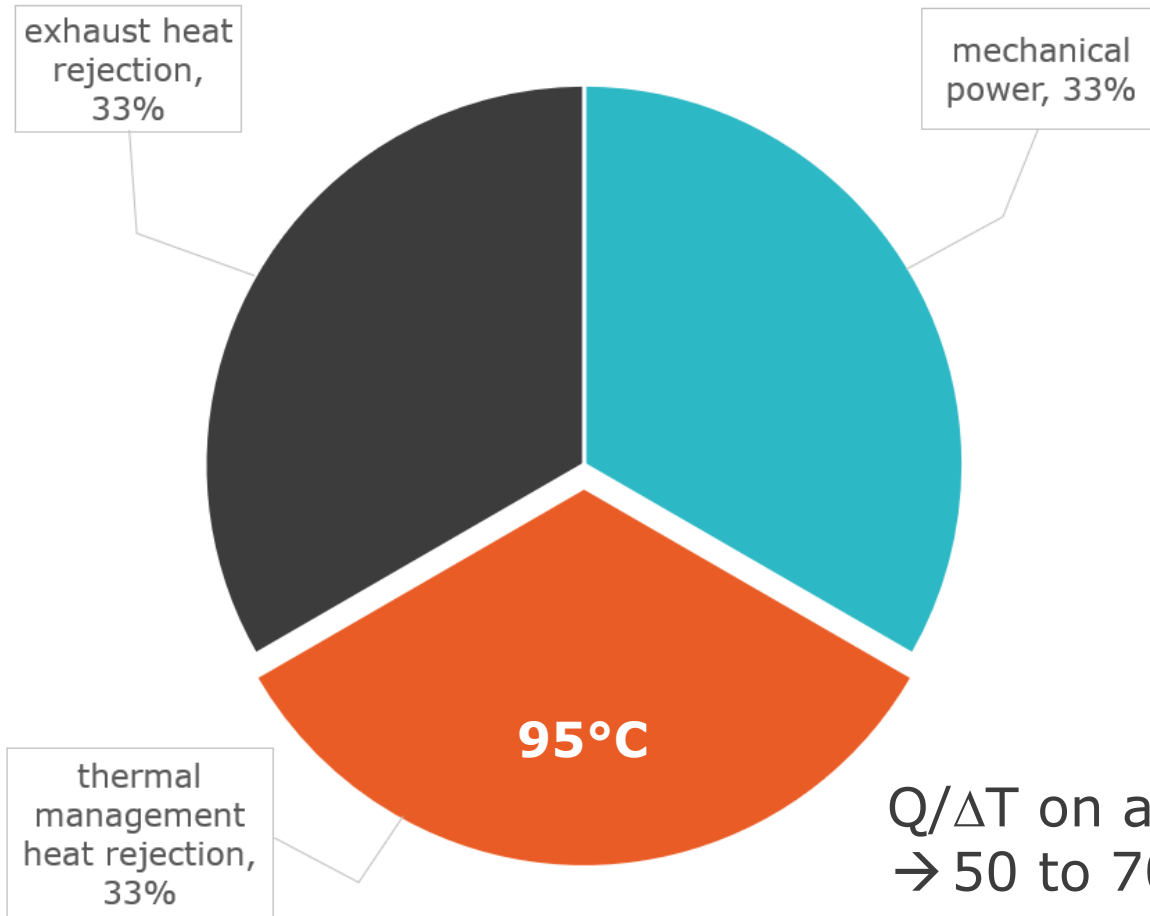


2 x IE-DRIVE HD100s
in a single decker bus

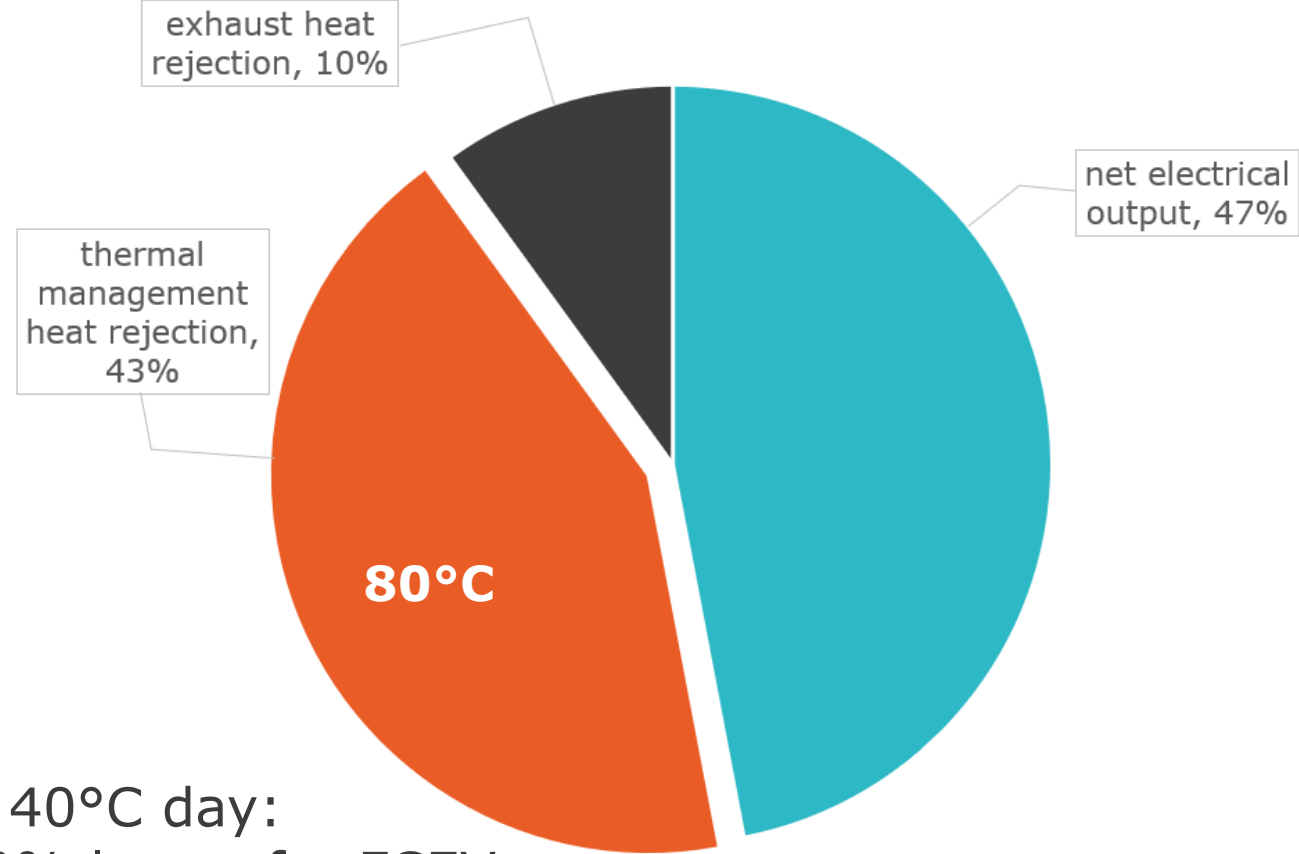
Heat rejection challenge in H₂ FCEVs where exhaust heat content is low



IC engine



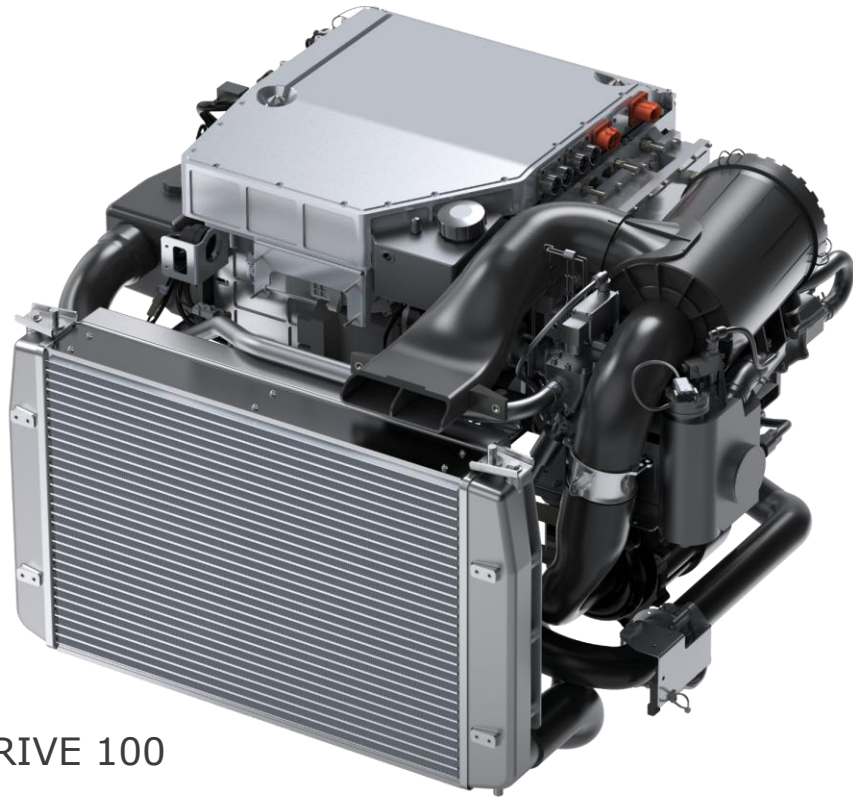
PEM FC



$Q/\Delta T$ on a 40°C day:
→ 50 to 70% larger for FCEV

Indicative figures for illustration only

Thermal integration in an FCEV essential developments



IE-DRIVE 100

How do we make it work?

- **Hybridisation**
electric powertrain,
power rating on FC different to IC,
reduce thermal load
- **Improved heat transfer**
new manufacture techniques,
hybrid co-flow / cross-flows,
phase changing fluids ✓
- **Raising heat rejection temperature**
new HT-PEM cell design, ✗
additional balance of plant ✓

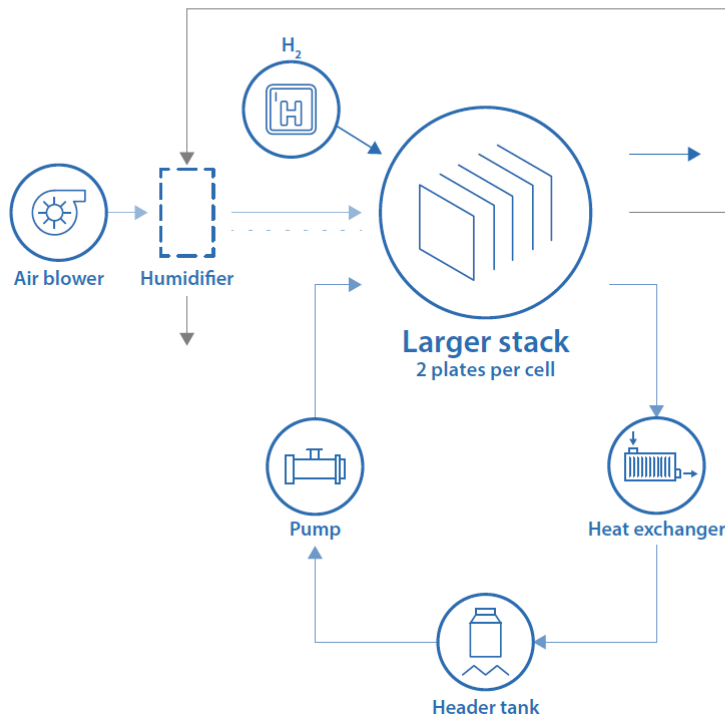
Improved heat transfer: evaporative cooling

Smaller heat exchanger, rapid transient performance

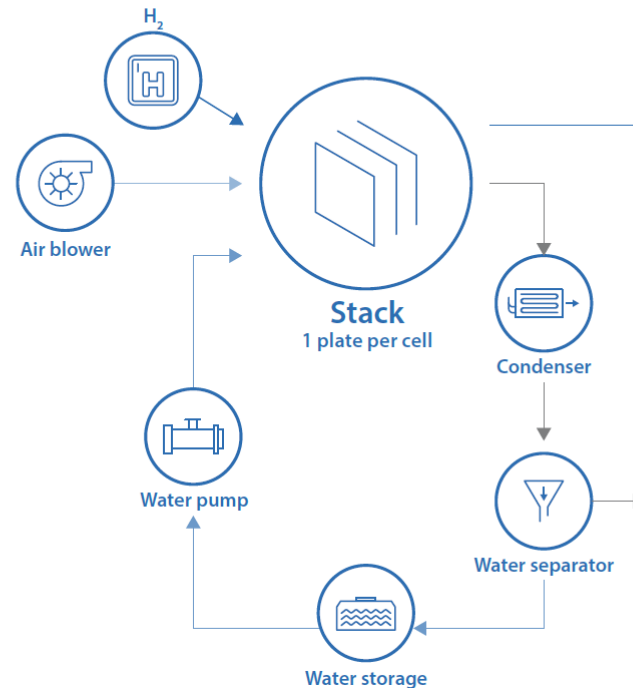


Other fuel cell providers

Liquid cooled technology Separated coolant and oxidant channels



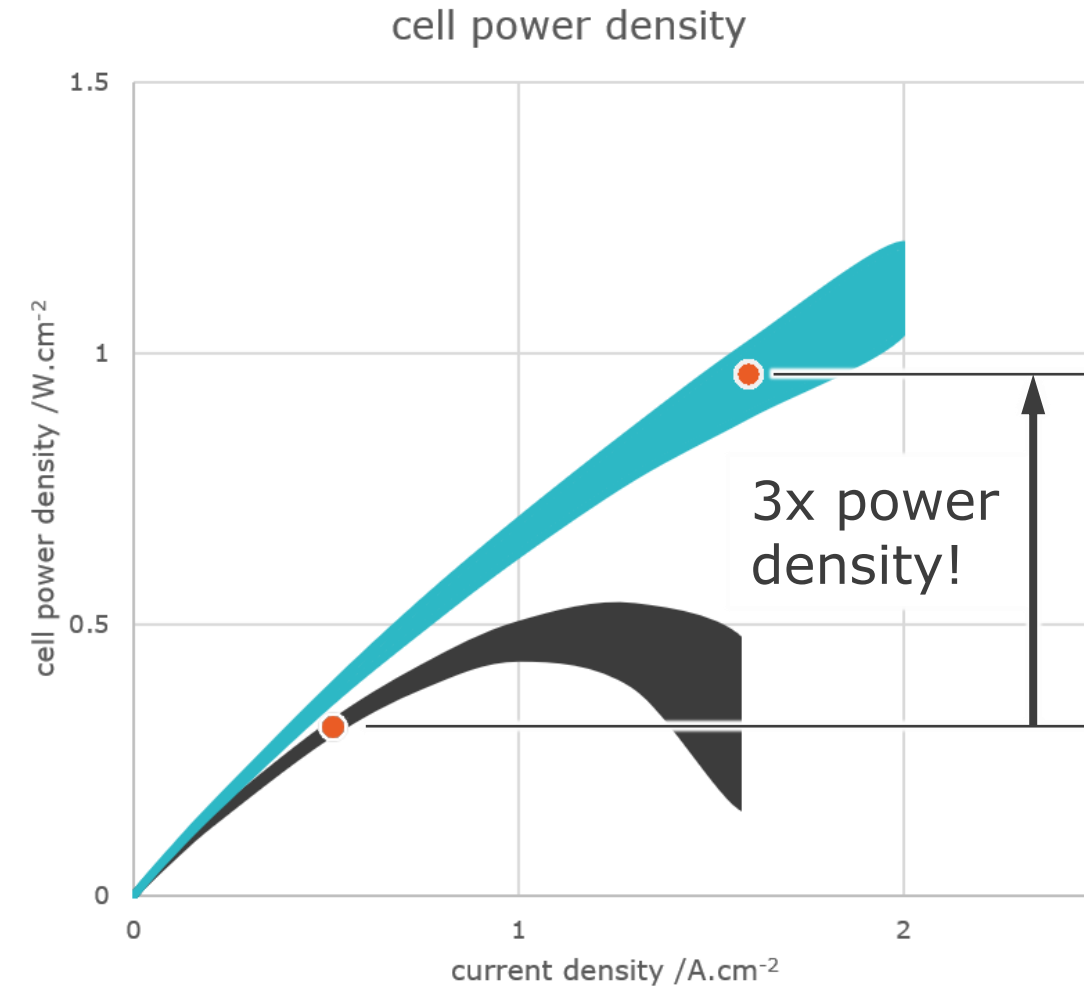
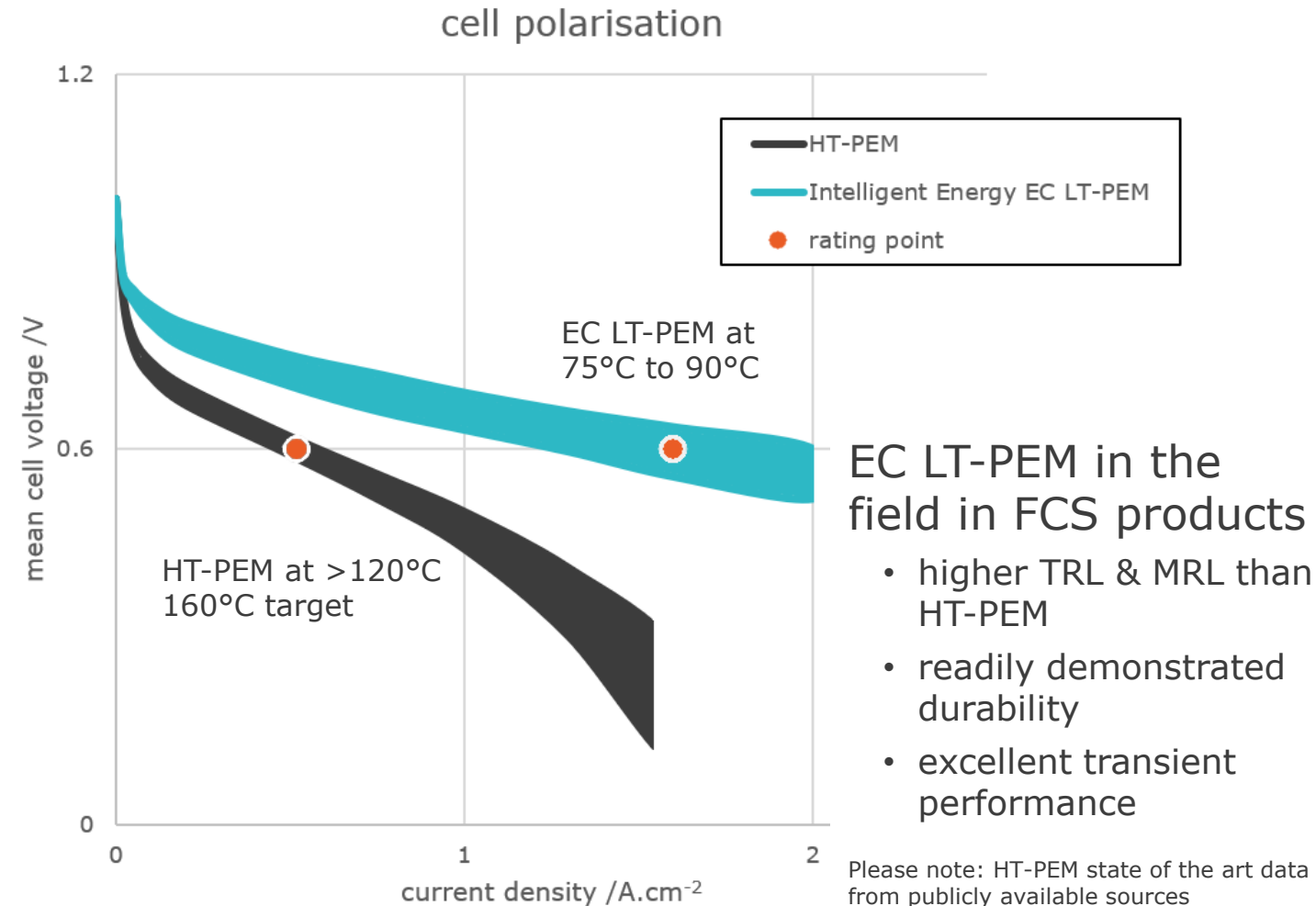
Evaporatively cooled technology Combined coolant and oxidant channels



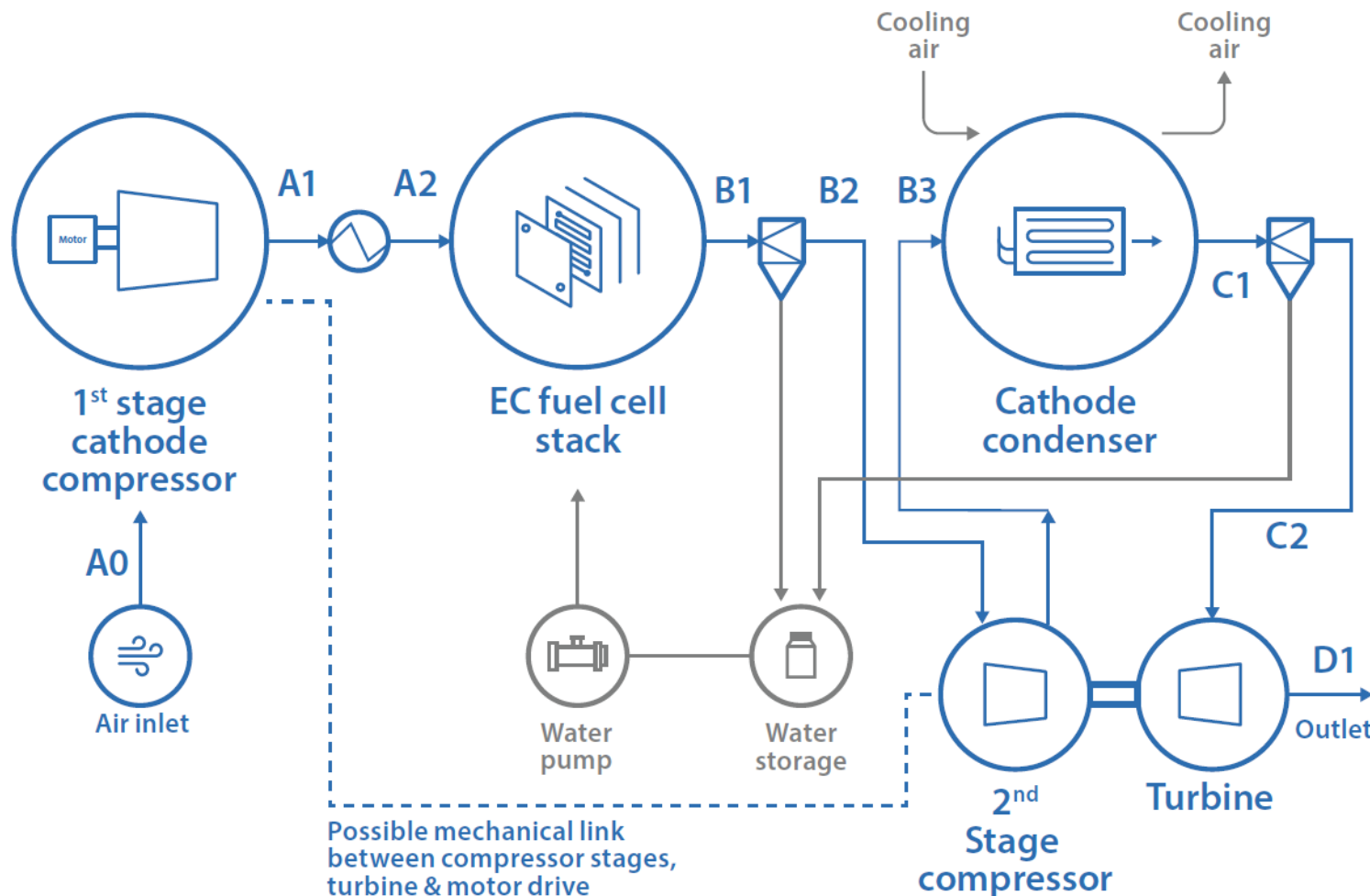
Why evaporative cooling?

- **Fewer components**
single plate per cell
- **Smaller heat exchanger**
condensing hot-side,
reduced frontal area
- **Rapid transient response**
no external humidifier,
direct water injection,
heat transients isolated
through phase change

Raising heat rejection temperature new HT-PEM cell design? can we really wait?



Raising heat rejection temperature use existing power dense cell, add BoP



New HT FCS architecture

- **Pressurised condenser**
hot-side inlet bulk flow $>100^{\circ}\text{C}$,
reduced condenser size,
more resilient to high ambient temperature,
lower aerodynamic drag & mass
- **Same EC cell**
retains power density,
durability and transient performance
- **TRL3 tests conducted**
demonstrated increased heat loss / condensation rate

New ATI programme



HEIGHTS

PROPELLING FUTURE ZERO-EMISSION FLIGHT

- Modular aerospace hydrogen fuel cell
- Cutting-edge thermal management
- Fast-tracking market deployment

POWER GENERATION SYSTEM

Conceptual integration of IE-FLIGHT fuel cell in future fixed wing propulsion system



PARTNERS



BENEFITS

£17m
investment

£19.6 billion
market unlocked

1,600
future UK consortium jobs

25.6 million
tonnes of CO₂ saved per annum

2030
entry into service

APPLICATIONS



Why use H₂ fuel cells in aviation?

- **Energy density**
3 to 5x greater than batteries
- **Safety**
aerospace industry views hydrogen safety as manageable
- **Operations**
rapid refuelling,
faster turnaround,
reduced maintenance costs with electrified propulsion systems

Developing new FCS BoP for 300kW net output with higher temperature heat rejection

Applying IE-DRIVE knowhow into IE-FLIGHT

HEIGHTS
PROPELLING FUTURE ZERO-EMISSION FLIGHT



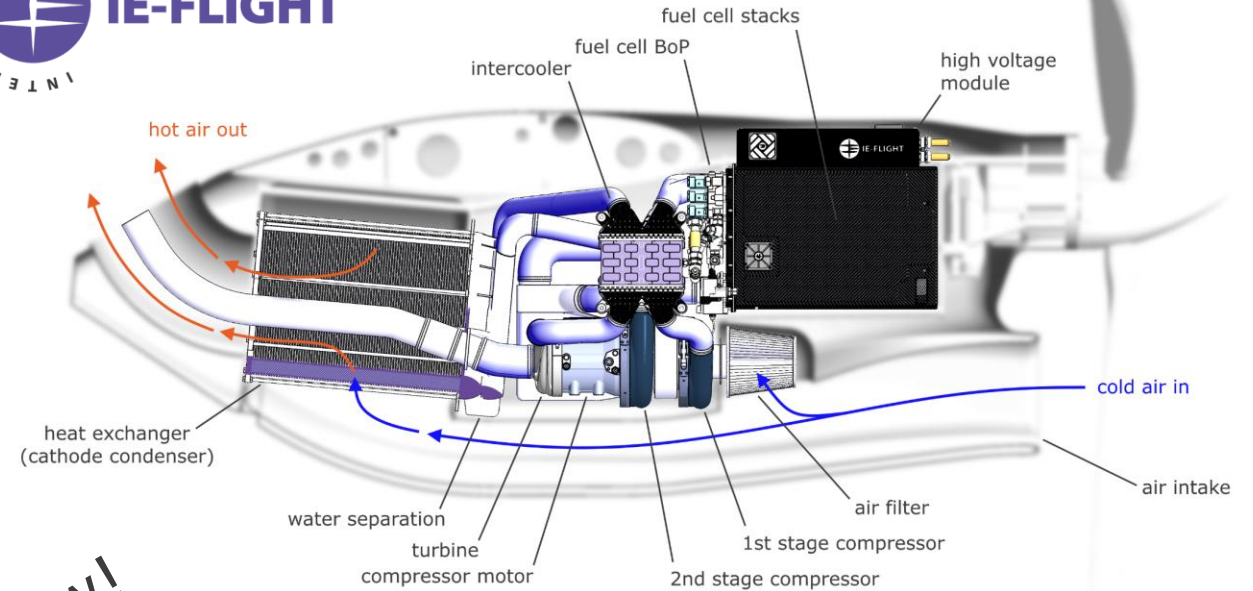
ESTHER

IE-DRIVE HD100 fuel cell system



Latest generation of power dense cell & stack only

Development of new test hardware & capability



New!

IE-FLIGHT 300 fuel cell system

New HT architecture: [IE White Paper](#)
[YouTube video of concept](#)

Powering the Hydrogen Future with our fuel cell products



SOAR 800W-24kW



LIFT 1kW-30kW



POWER 1kW-32kW



DRIVE 100-300kW



FLIGHT multi-MW



GRID 100kW-1MW



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