How To Use Hydrogen To Decarbonize Aviation and Air Mobility

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HyPoint

Enabling zero emission air transport

2020 NASA iTech CYCLE II WINNER

ALCHEMIST ACCELERATOR

FCHEA Fuel Cell & Hydrogen Energy Association

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Aviation goes electric

HyPoint solves Zero Emission Aviation

There is a Problem

Batteries cannot store enough energy – **~250 Wh/kg**

Low Temperature Fuel Cells cannot provide enough power – **~1000 W/kg**

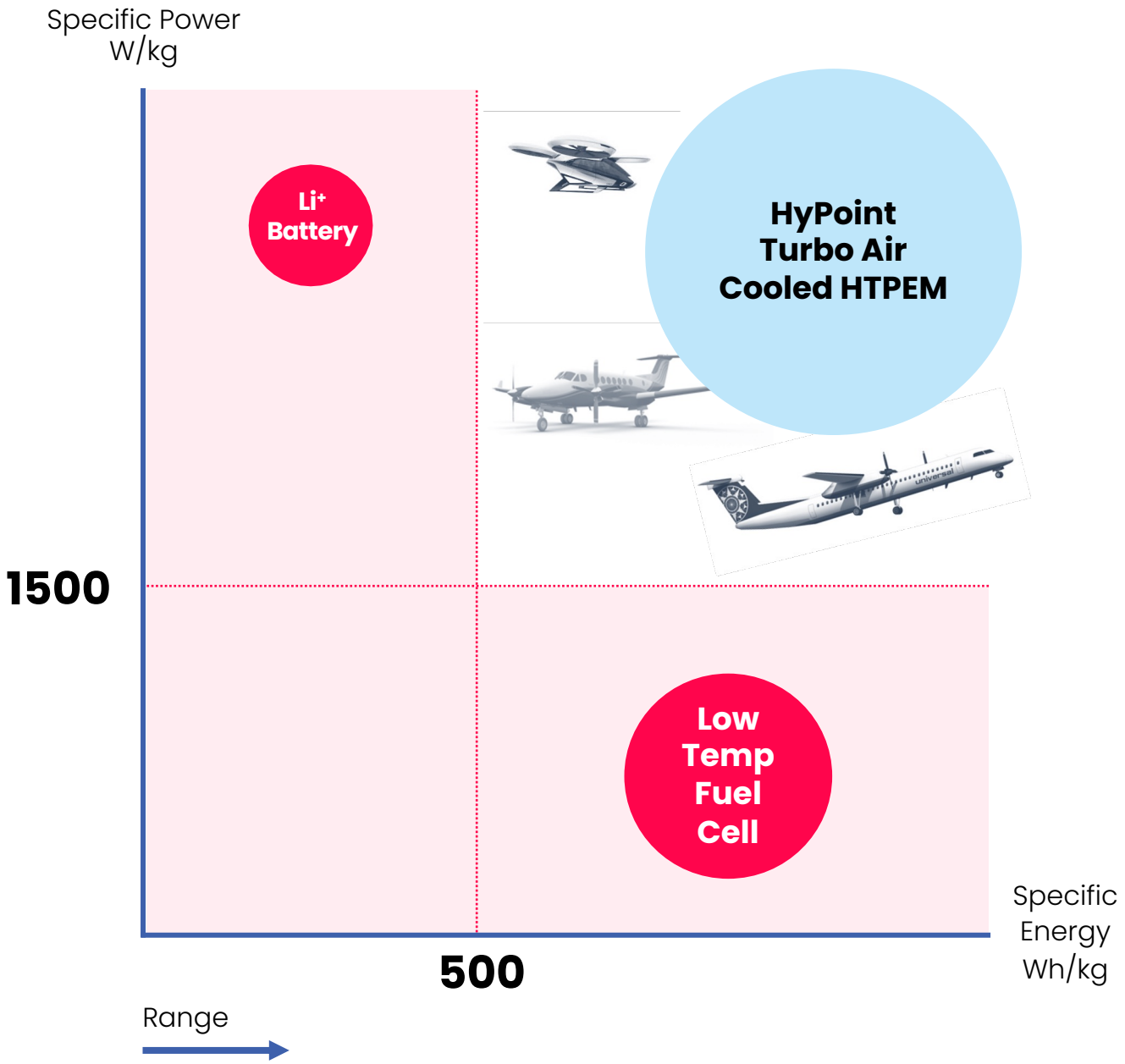
HyPoint has the Solution

Turbo Air-Cooled High Temperature FC

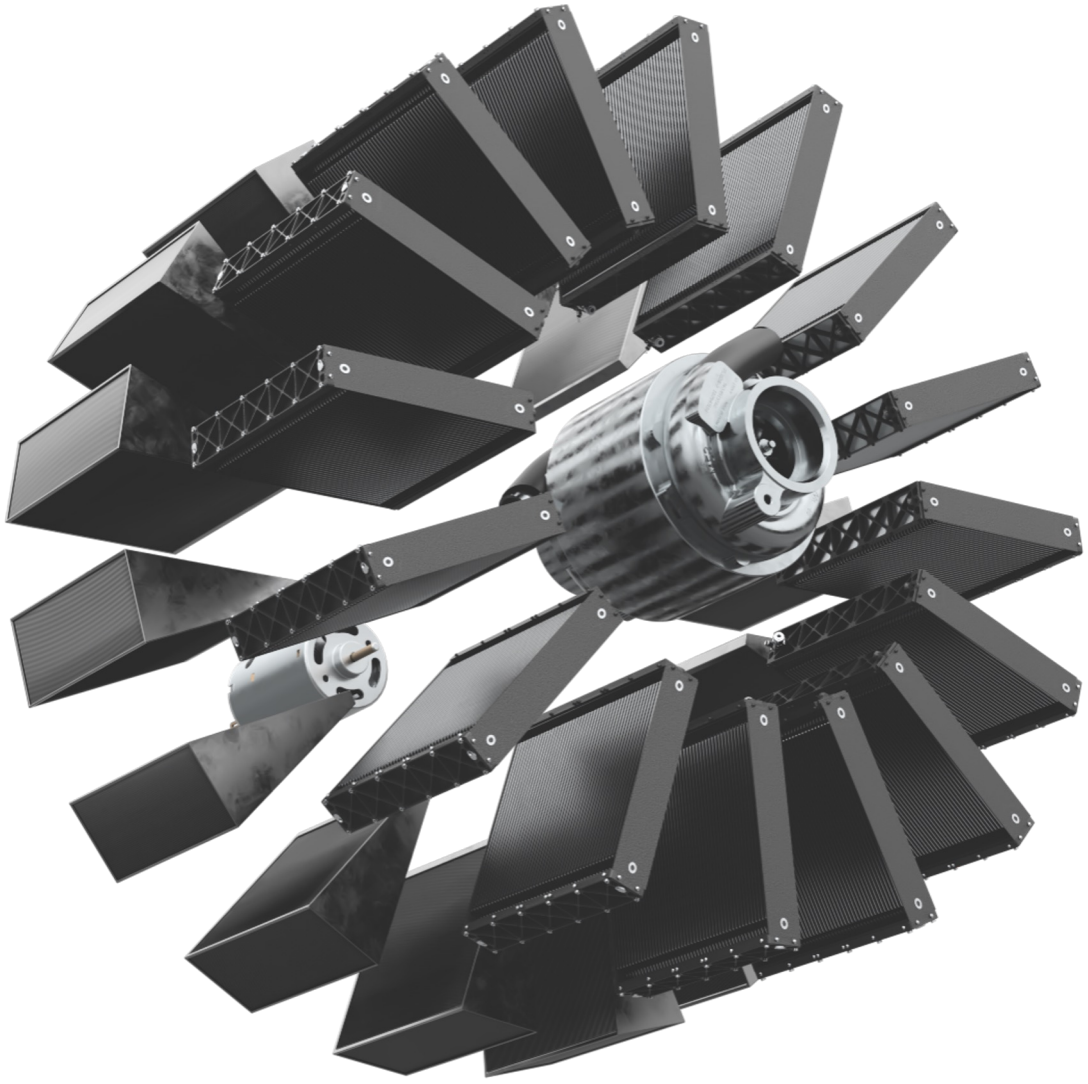
2000 Wh/kg

1500 Wh/kg

@System Level!



We Have a Solution



Turbo Air-Cooled HTPEM Fuel Cell

Today
2,000 w/kg

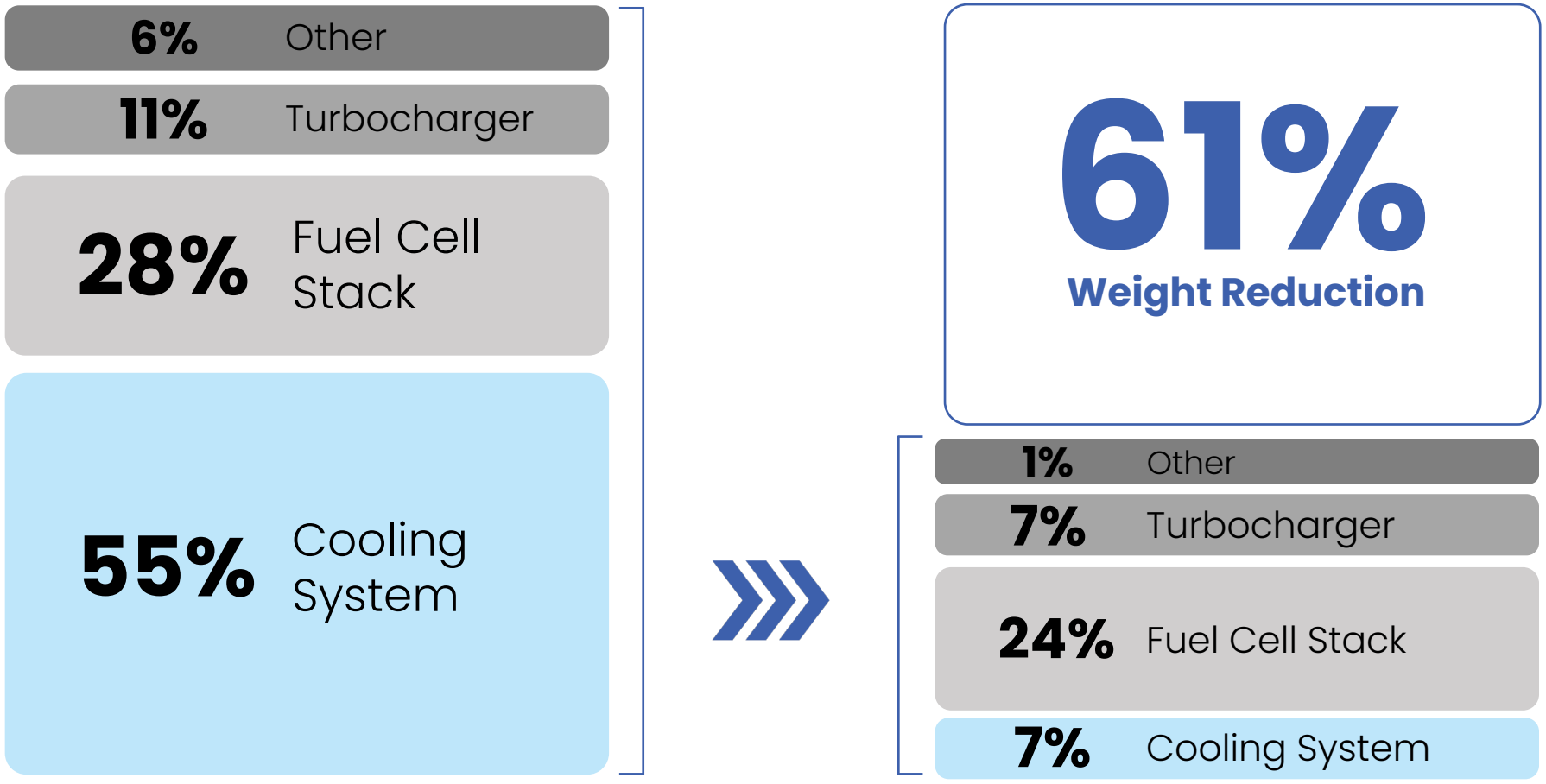
Tomorrow
4,000 w/kg

BASF
We create chemistry

Competitors
1,000 w/kg

Specific Power at System Level –
that's what matters for aviation

Fuel cell specific power challenge



Traditional LTPEM Power Unit

HTPEM Turbo Air-Cooled Power Unit

The solution is unique

- Turbo Air-Cooled Hydrogen Fuel Cell
- Lightweight Bipolar Plates with Coating
- Core Chemistry (catalyst, HTPEM membrane instead of LTPEM)

6 patents/applications
+ 5 know-hows

180kW Turbo-Air Cooled Fuel Cell

Real Traction

$0.3m → **$8.6m** → **$200m+**

Feasibility Studies | Signed Development Agreements | in order book since **2025**

$1.1m

Revenue in 2021

4 customers

Qualified Pipeline

GKN AEROSPACE · Honeywell · Rolls-Royce · SAFRAN · Pratt & Whitney A United Technologies Company · EMBRAER · Bell · BOEING

$1B

10 years revenue

Range of Products

If hydrogen aviation happens,
HyPoint will be the
leading supplier of fuel cell systems

Helicopters
300-700 kW

e-VTOLs
200-950 kW

e-Aircraft
0.6-4 MW

Strategic Partners for each market segment

Timeline

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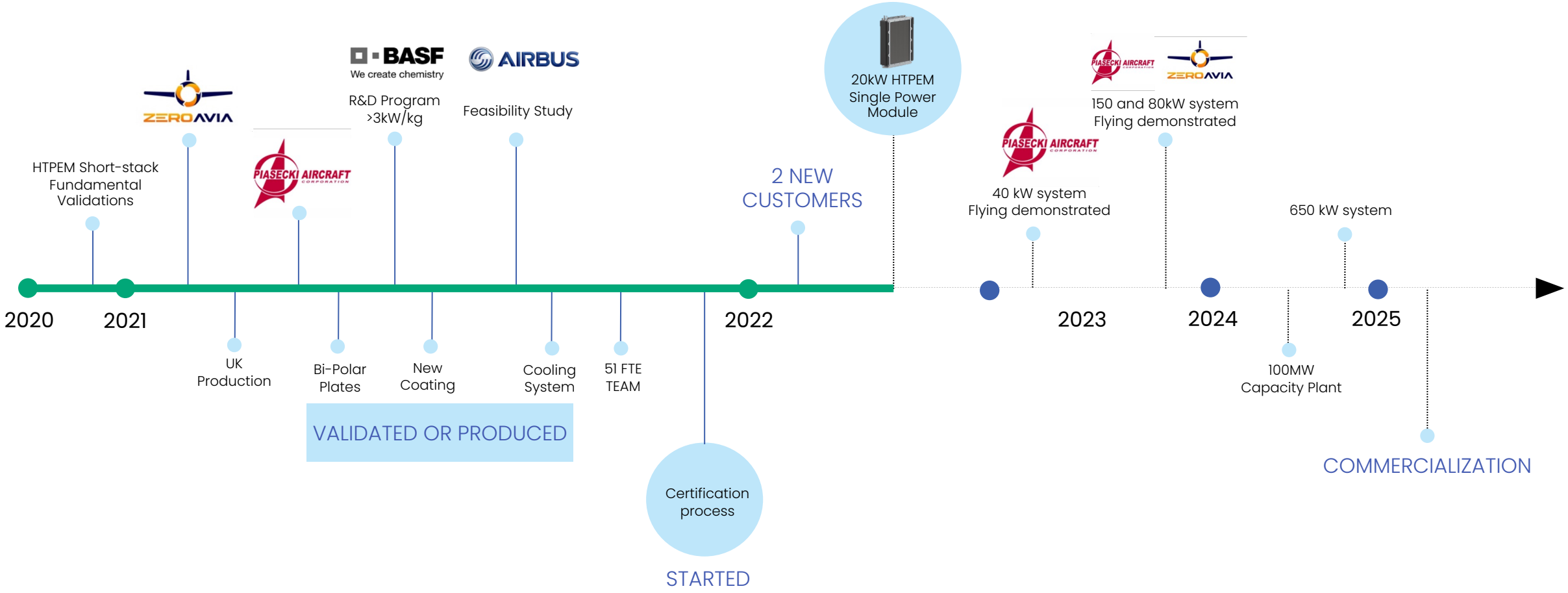
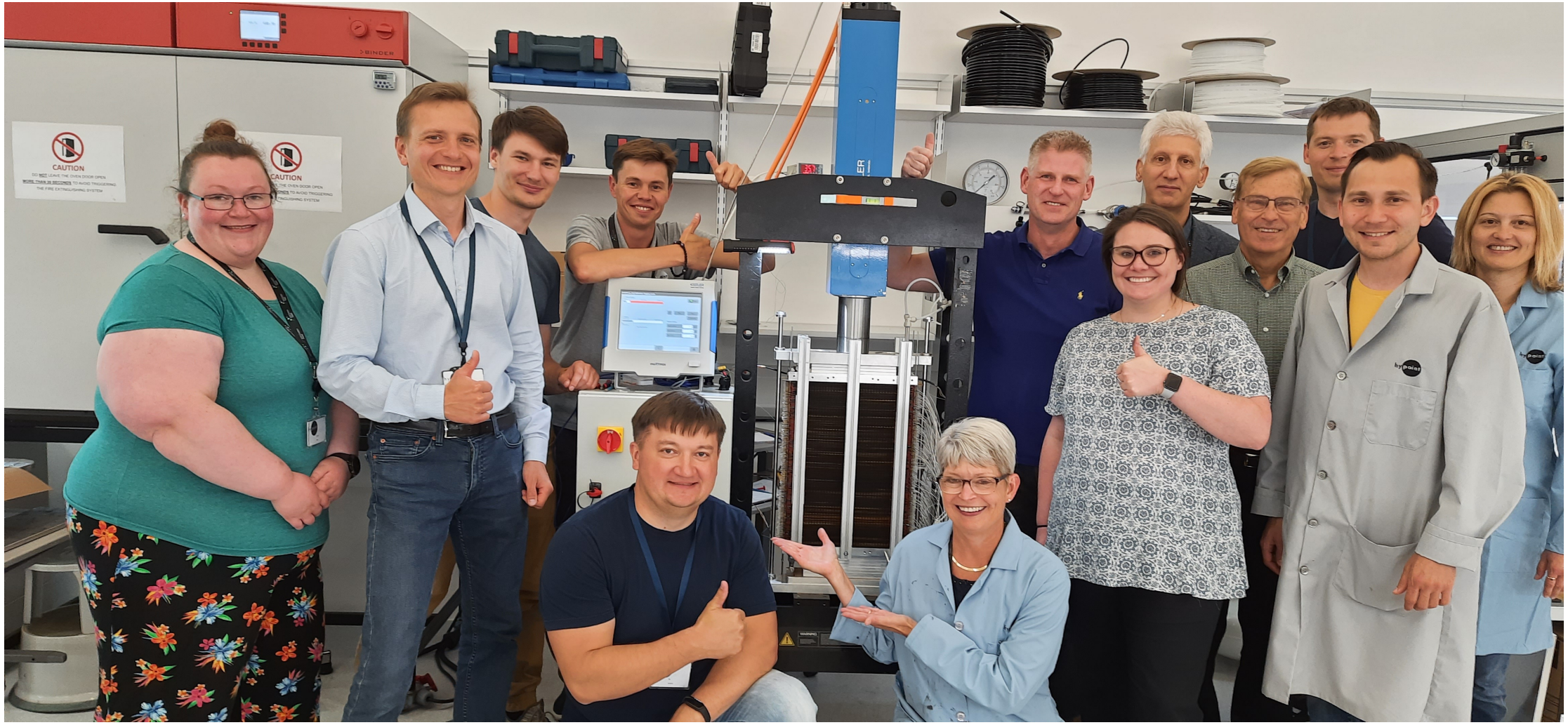


Assembled Single Power Module



HyPoint in UK:
R&D and Production site

Discovery Park Developing and Innovation Hub

Assembly area 130 sq.m.

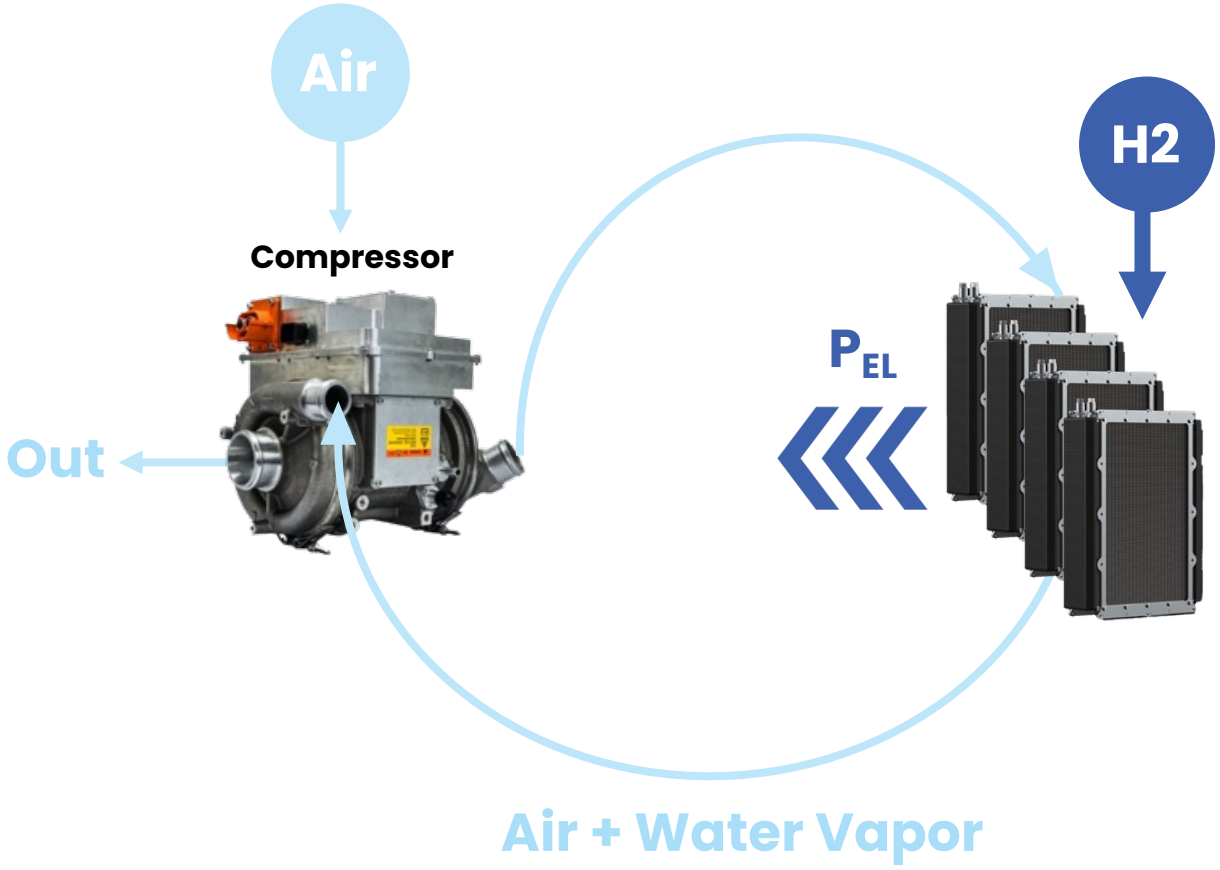
R&D Lab 60 sq.m.

Hydrogen FC testing area 130 sq.m.

Technology

How does HyPoint's High Temperature Fuel Cell **solve the weight problem?**

Proton Exchange Membrane (PEM) Fuel Cell



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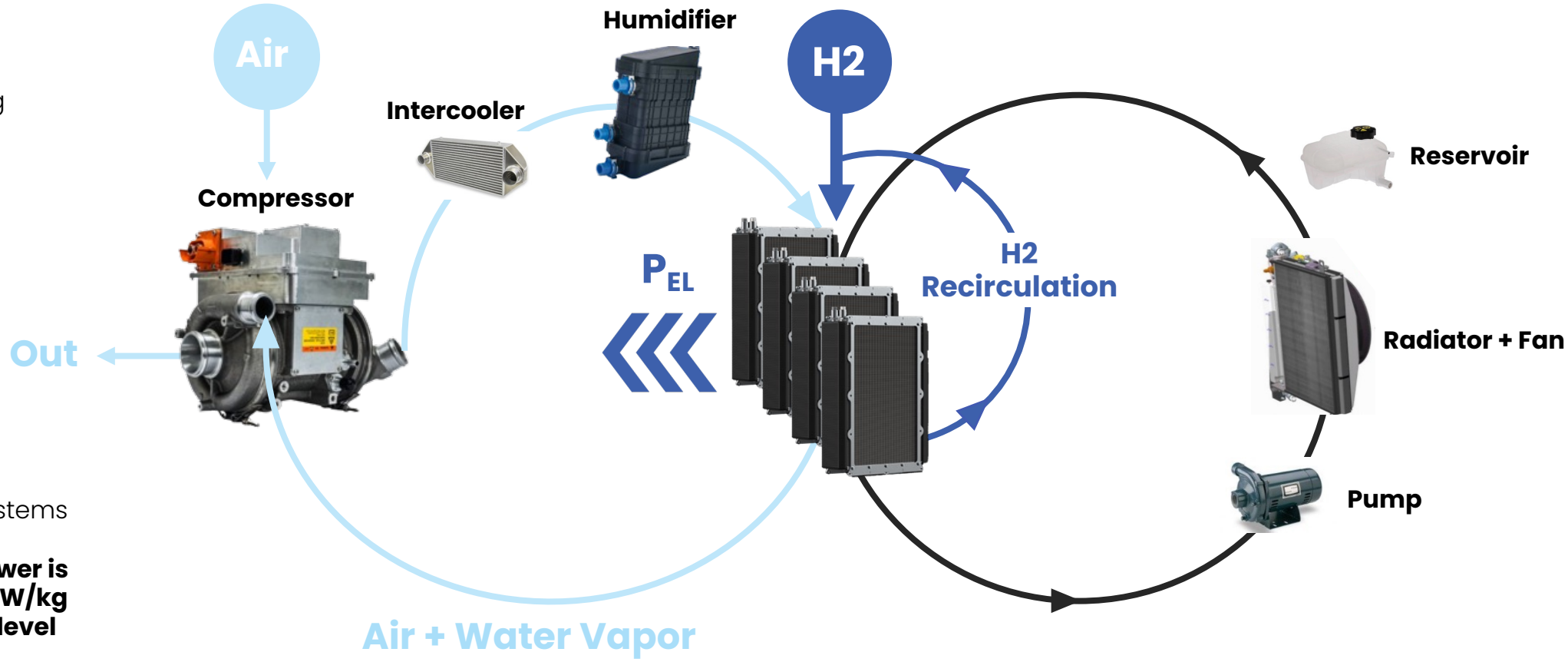
The Low Temperature PEM FC needs more

- Intercooler
- Humidifying system
- Liquid cooling system



All these systems are heavy: **specific power is about 0.5 kW/kg on system level**

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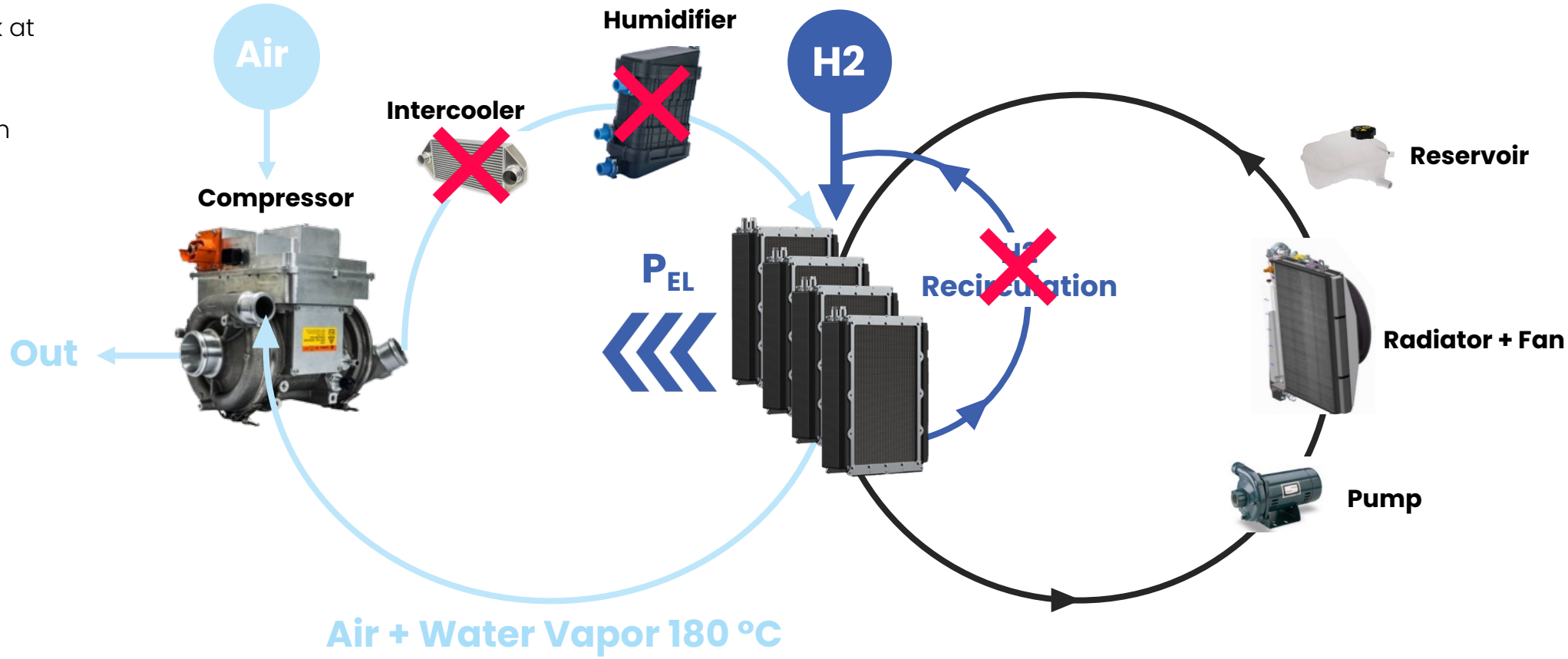
There must be a better way – HTPEM FC

What if the fuel cell

? Could work at say 180 °C

? Was ok with dry air



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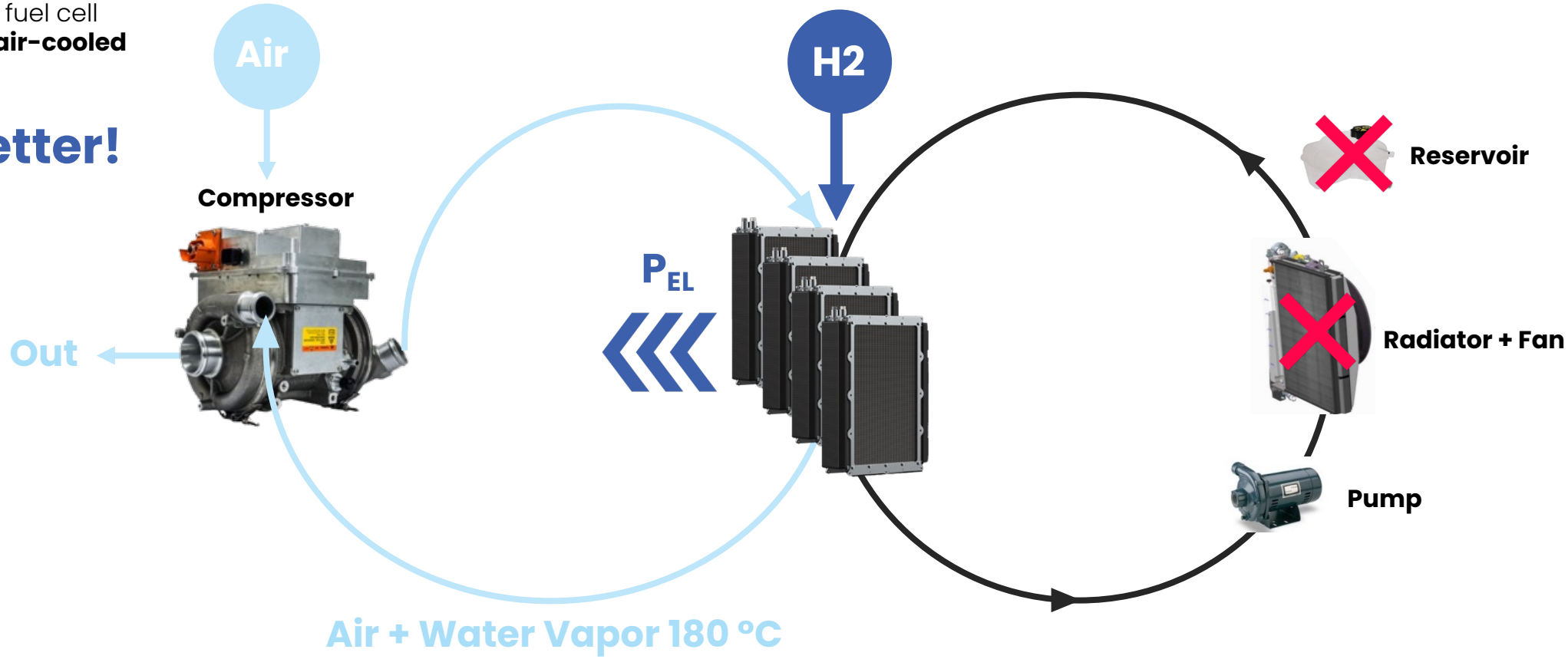
The HTPEM Simplifies the System

Now the fuel cell is **liquid cooled** and the radiator is **air cooled**

What if the fuel cell itself is **an air-cooled radiator**

Much better!



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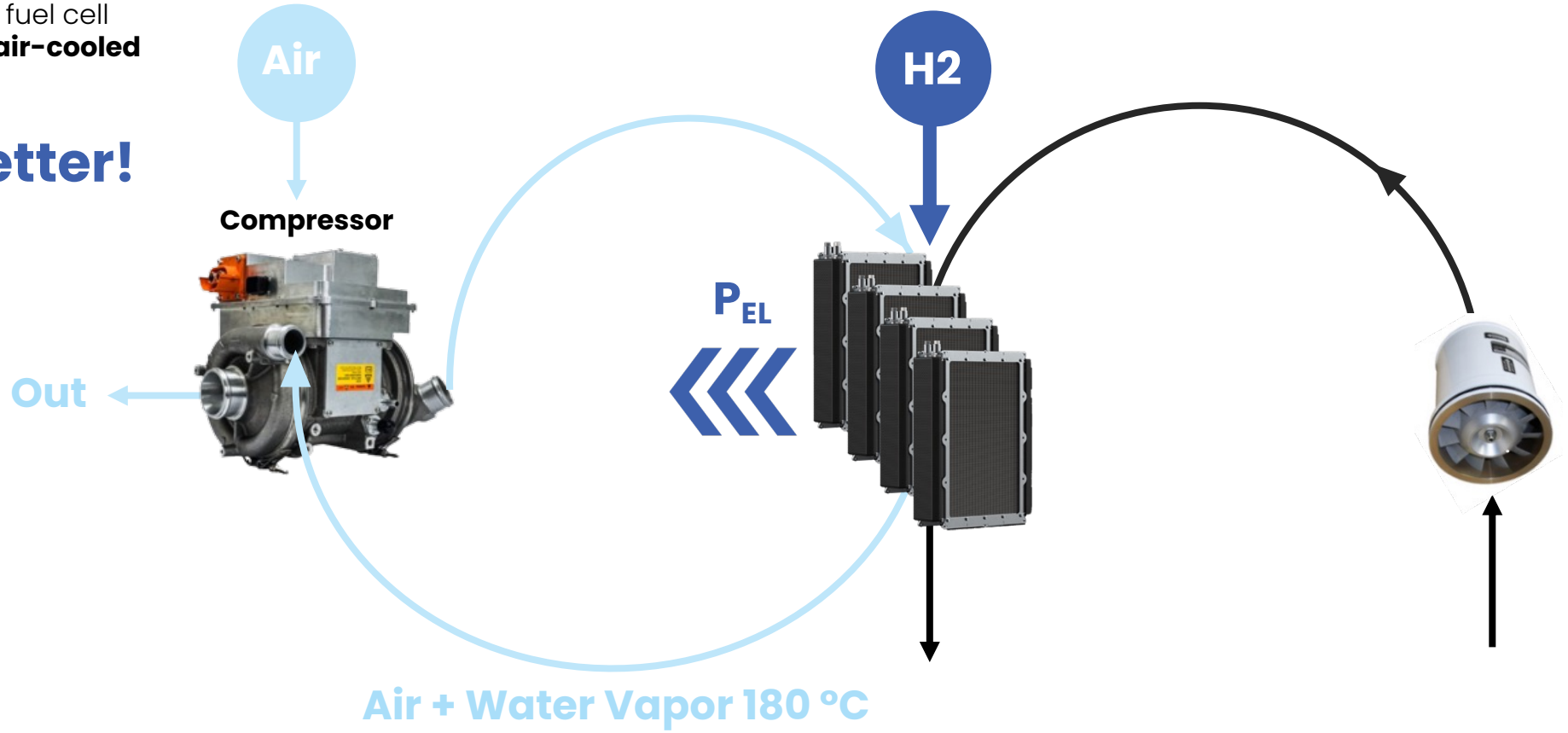

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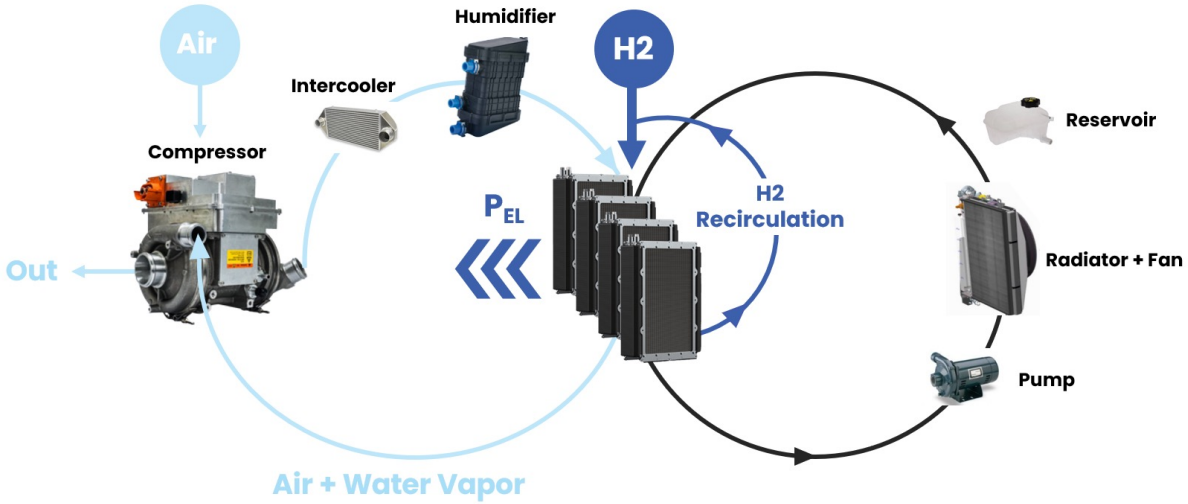
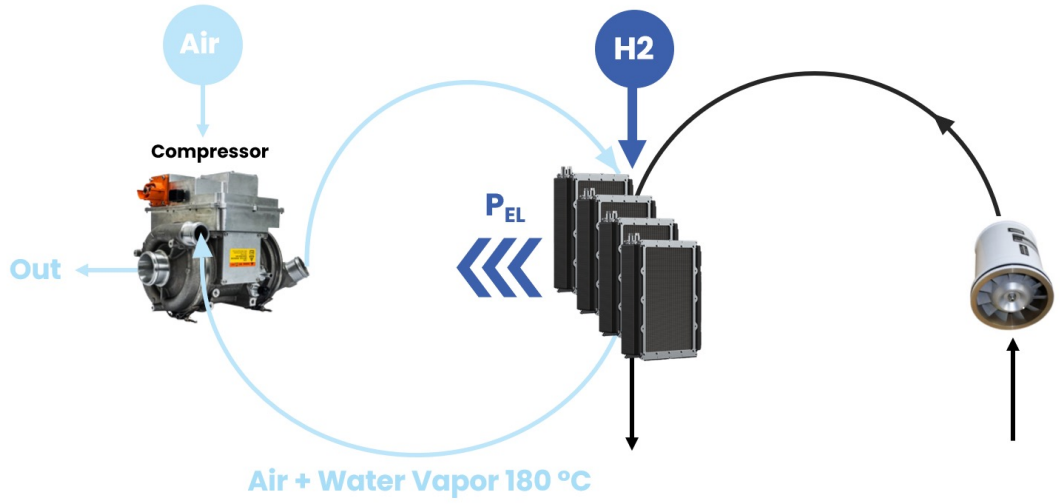
HyPoint's TAC HTPEM System is Simpler, Lighter, More Reliable



Low Temperature PEM System

0.5 kW/kg



High Temperature PEM System

1.5 kW/kg*

Target is 3 kW/kg

*1.5 kW/kg for 250 kW system
2.0 kW/kg for 500 kW system
>3.0 kW/kg with next gen membrane 2025

Weight Comparison
500 kW System

Building Block	HTPEM 500 kW, kg	HTPEM 500 kW 2025, kg	LTPEM 500 kW for aviation, kg	APU APS5000 450 kW, kg
Dry System (no inverter)	**255**	167	800	279
Coolant	**0**	0	80	~5 (oil)
Radiator	**0**	0	~40	0
TOTAL	**255**	167	920	284
System Specific Power kW/kg	**1.96**	**2.99**	0.54	1.61

Additional Advantages

Air Cooling and High Temp Membrane

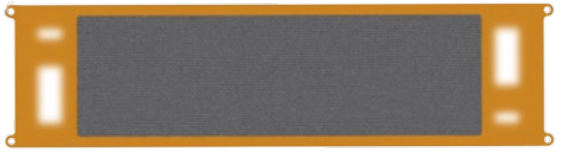
Lower membrane cost

FC can operate in very hot environments (e.g. desert climate)

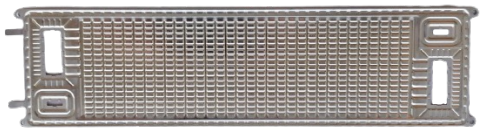
H_2 impurity tolerance (robustness)

Tolerant to high power draw - no need for buffer battery to support takeoff

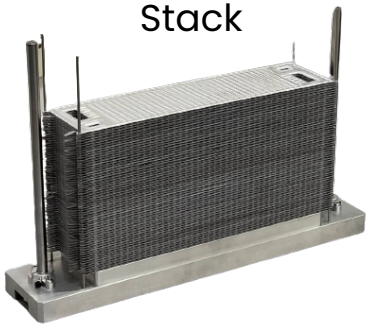
Membrane Electrode Assembly (MEA)



Bipolar Plate



Stack



Fuel Cell Module
Development Status

Feb ‘22: successful test of Mini-Stack (6 instead of 150 individual cells)

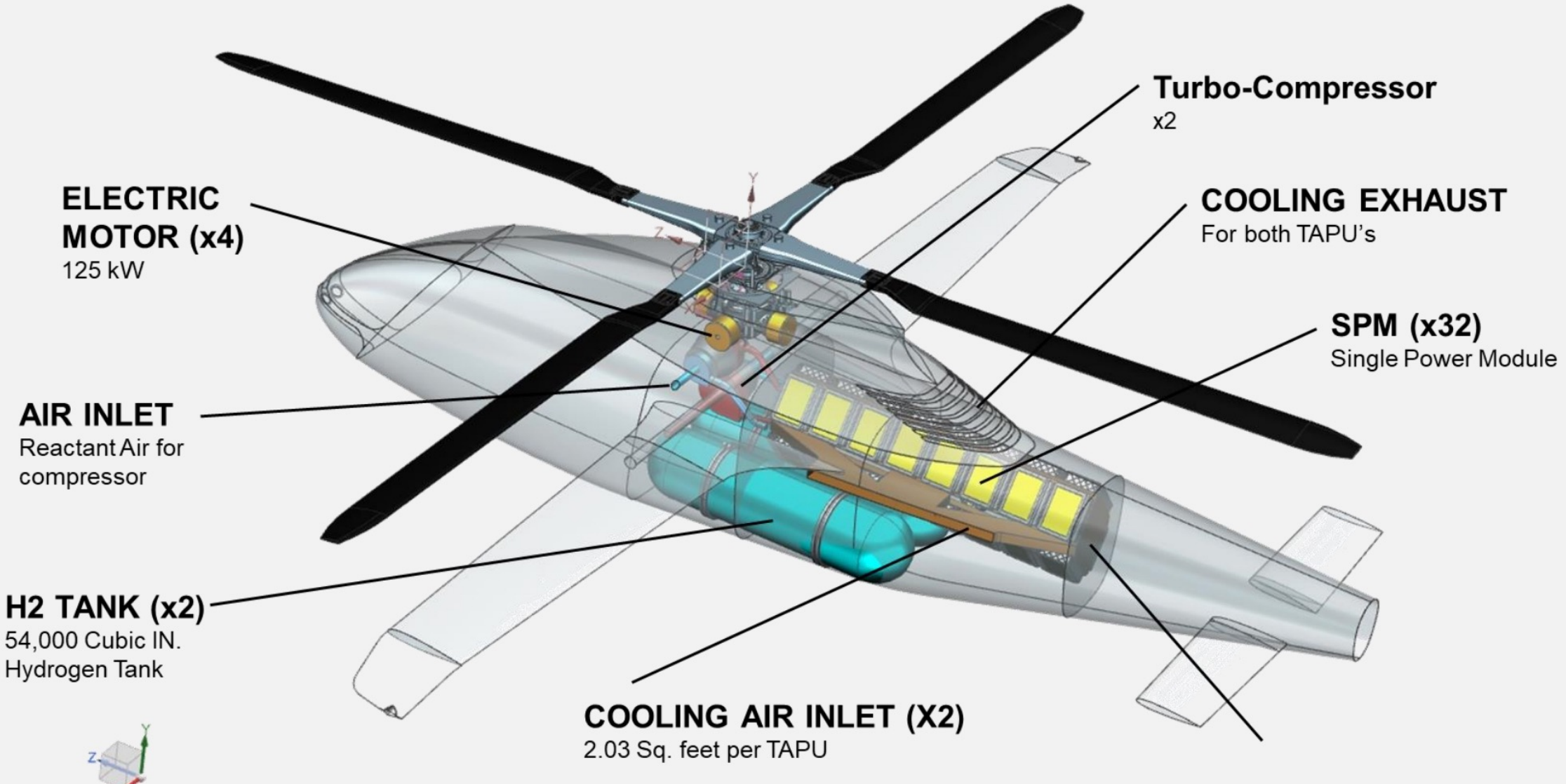
- Representative prototype functioning at system level
- Key technologies validated

Next Milestone: test of full 20 kW module August ‘22

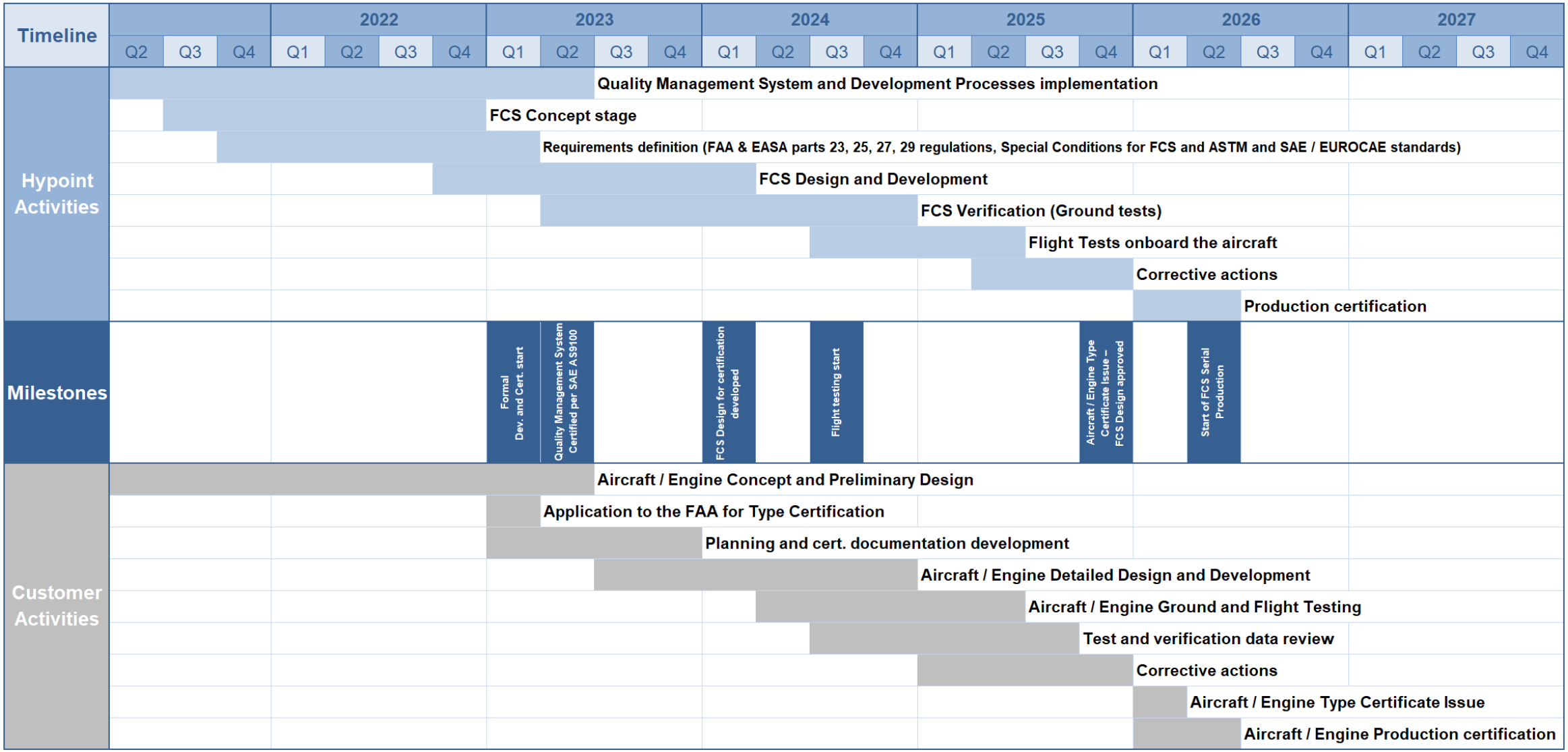
Current TRL 4-5.
Hardware is being manufactured, available for test Q2’22 → TRL 5

Component	Design	Make / Buy	TRL	MRL	Manufactu-rability Risk	Specific Materials Needs
Fuel Cell (SPM)	HyPoint	Make	**4**	4	Medium	No
MEA	BASF/ HyPoint	Buy complex part Partner BASF	**5**	9	None	Platinum
Bipolar Plate	HyPoint	Buy Complex machining Multiple sources	**4**	5	Low	No
Coatings	HyPoint	Make	**5**	4	Low	No
Management Electronics	HyPoint	Complex part Multiple sources	**4**	9	Low	No
Balance of Plant	Off the shelf, custom	Buy	**5**	6	Low	No

Customers: Piasecki PA890 650 kW fuel cell system



HP Certification Roadmap



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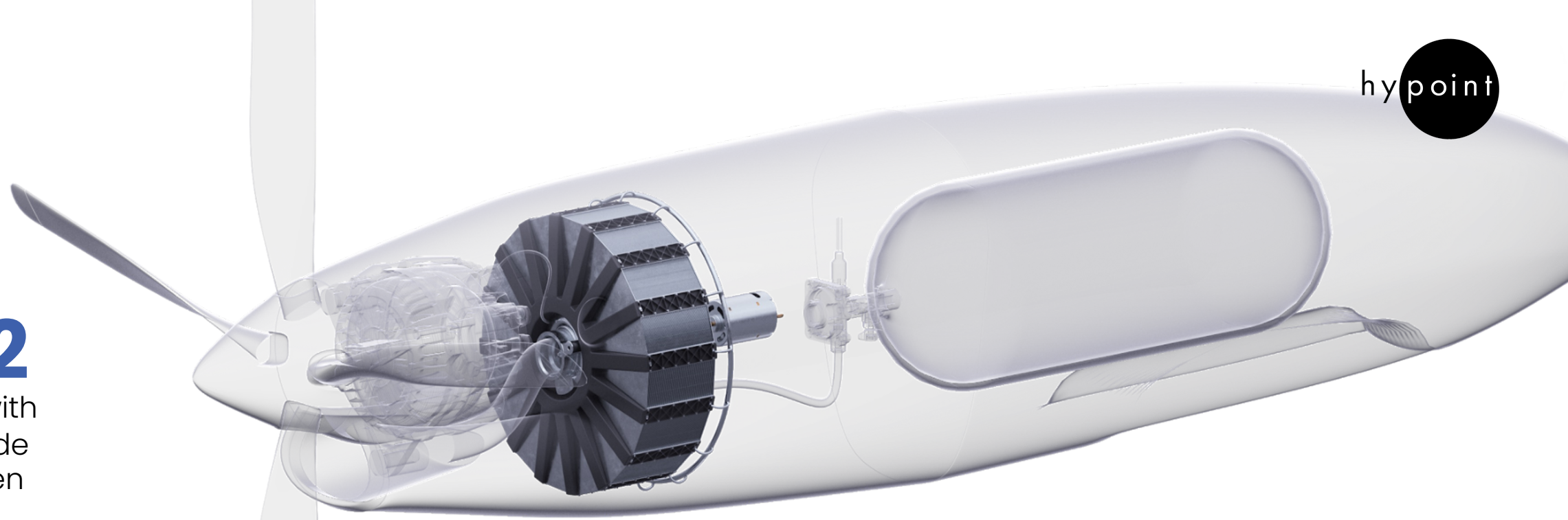

H_2

Works with low grade hydrogen

x3

Specific power

-60...+60°C

Climate-independent

x5

Flight range

FAST

refueling

Thank you!

Alex Ivanenko
www.hypoint.com