



# Thermal Management Expo

Clearing the Runway to Electric Aviation by  
Removing Thermal Obstacles

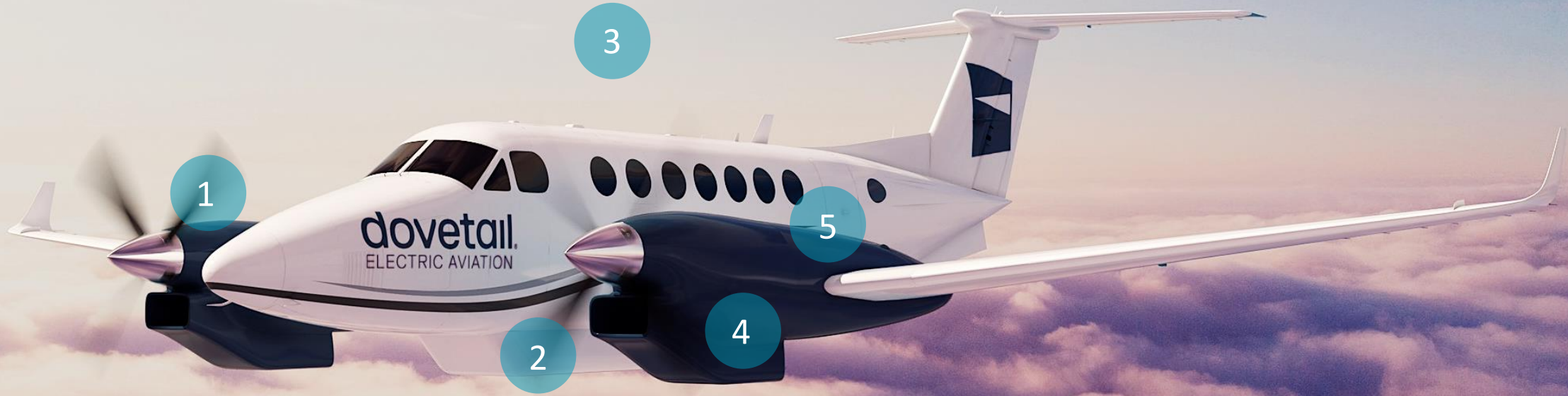


**dovetail**<sup>®</sup>  
ELECTRIC AVIATION

SECTION

# Who are we?

1



# Modular Tech Proprietary commonality

Zero emissions Electric  
from battery to hydrogen for  
existing airframes

1

## Integrated Propulsion System – **DovePower®**

Low noise, high efficiency aerospace  
propulsion system integrated and  
certified by Dovetail

2

## Aviation Proprietary Battery – **DovePack®**

Modular Battery system developed  
by Dovetail 230wh/kg at the pack  
level now, surpassing 280wh/kg in  
next version

3

## Power & Energy Management System - **DoveXAI®**

AI based energy system  
to accurately estimate  
battery charging state and  
optimize integration with fuel  
cell system

4

## Enhanced Proprietary Aerodynamics

Integrated airframe aerodynamics and  
thermal management for superior  
performance and improving efficiencies  
over conventional designs

5

## Aerospace Hydrogen System – **HyDoveGen**

Lightweight hydrogen  
system for onboard  
electricity generation



# World class electric aviation innovation

- 1st Hydrogen-electric aviation powertrain in Au-NZ-South EU



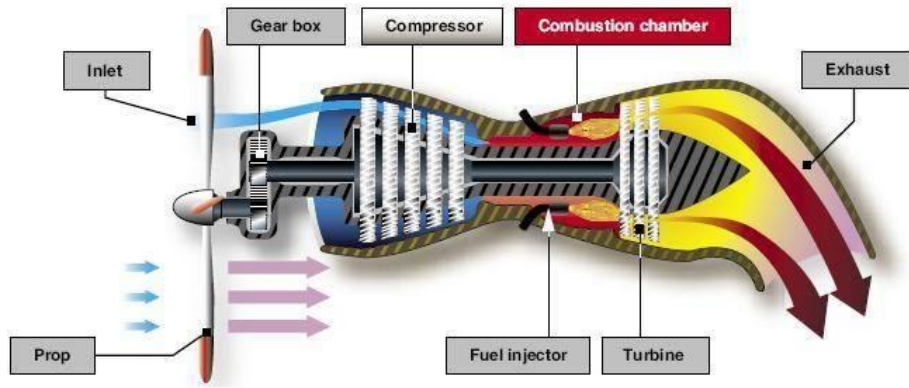
- Dovepack: Proprietary battery system
- First immersion cooling system for aviation
- Now sold to third parties

SECTION

# The thermal challenges

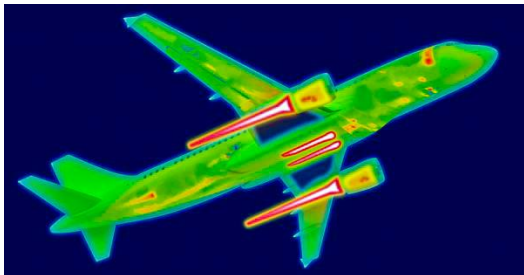
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# Turbomachine vs electrical system



≈ 35% efficient

- 1MW of power = 3 MW of heat
- High temperature & high speed heat
  - >80% heat removed by the exhaust to provide thrust (high exergy)
- Remaining heat removed by oil system, radiation & nacelle ventilation



Source: NASA



Full electric propeller test  
Source: Rolls-Royce

>90% efficient (Electric propulsion)

- 1 MW of power = <100 kW of heat
- Low-temperature waste heat.
- Distributed throughout the systems
- Complex to be removed

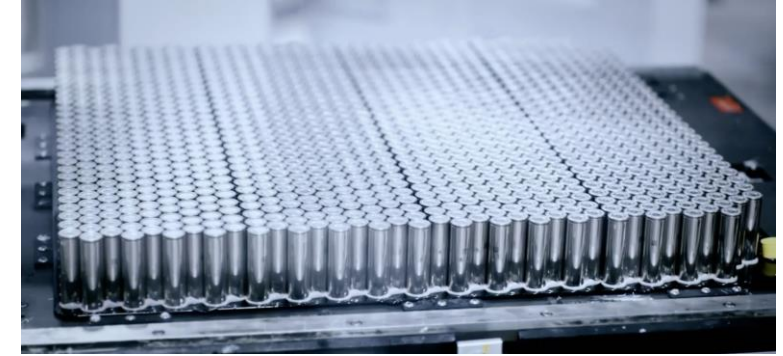
# Electric Propulsion thermal management

- Liquid cooled Propulsion system components
- Pre-conditioning for cold or hot soak
- Full monitoring
- Flow control
- Heat used to support cabin comfort

# Battery thermal management

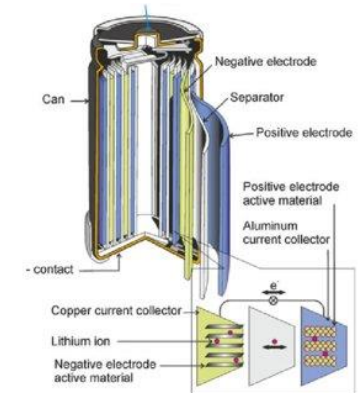
Li-ion → high energy density

- Operating range: -20 °C and +60 °C
- Optimal life and energy temp range: 20 – 30 °C
- Loss of available energy & power at low temperature
- Degraded life at high temperatures



**Challenge: Keep the cells within their optimal & safe range in all operating conditions**

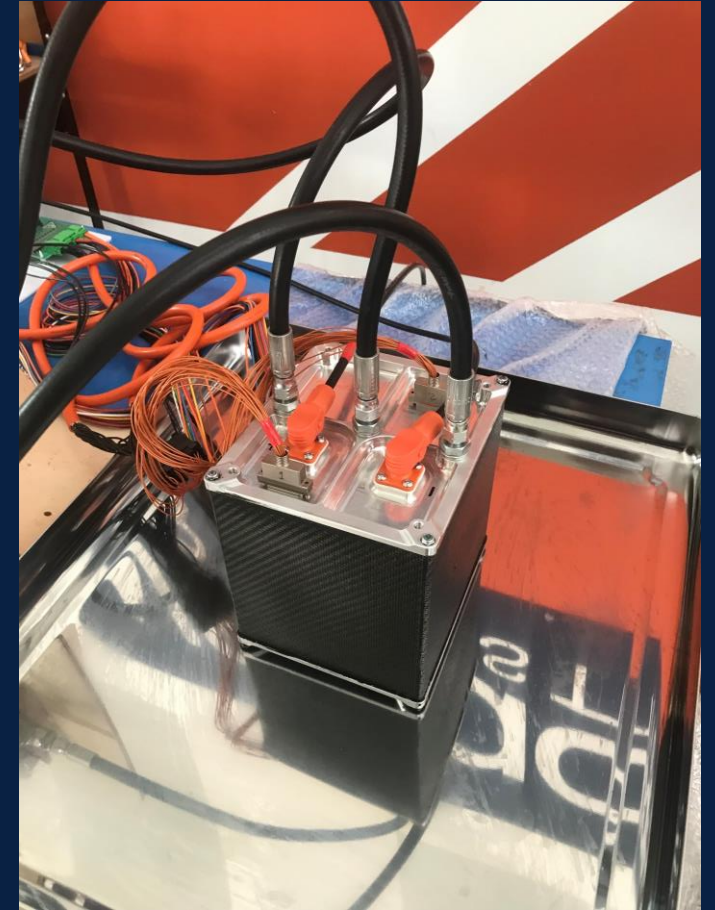
- Cell heating during charge and discharge (efficiency)
- Aircraft operating range -55° to 70 °C
- Lightweight solutions
- Fault tolerance





# Battery thermal management

- Direct immersion cooling for optimal thermal management & safety
- Offboard and onboard thermal conditioning system
- Cells within optimal temperature range in all expected operating conditions



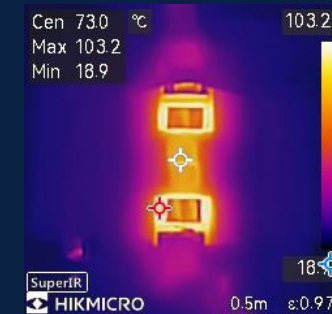
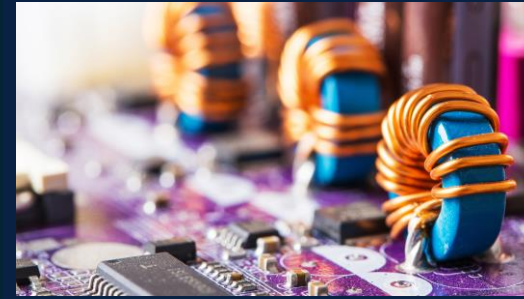
*Battery submodule functional test  
Source: Dovetail*

# Electrical systems

- High efficiency but distributed
- Low temperature, low-exergy heat generated
- Localized heat sources

**Challenge: Remove the local hot spots in the power electronics and the overall heat generated throughout the system**

→ Liquid + air cooled techniques

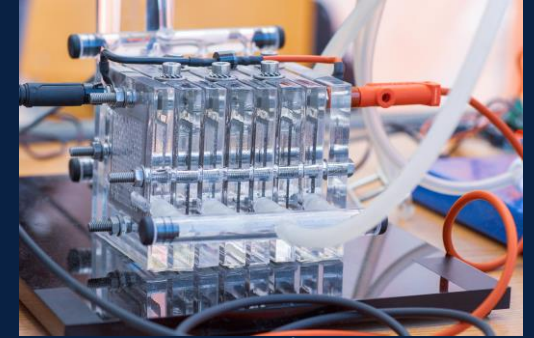


Power electronics testing  
Source: Dovetail

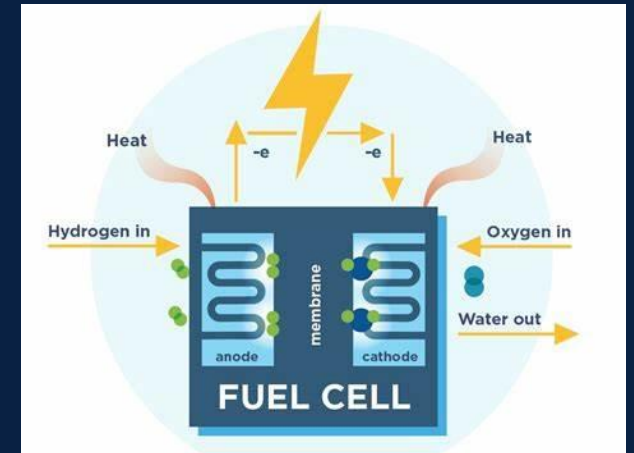
# Fuel cell systems

- Very high energy dense molecule
- Conversion of  $H_2 + O_2$  into electricity, water and heat
- Efficiency:  $\approx 50\%$ 
  - 1 MW of power = 1 MW of heat
  - Low exergy heat

Challenge: remove the heat in all operating conditions (high altitude, high temperature, high power)



Hydrogen fuel cell  
Source: Kobobuilding



Source: National Hydrogen Association

# Fuel cell systems

- High efficiency, lightweight fuel cell systems in the 0,5-MW range
- High performance Balance of Plant & heat exchanger systems
- Optimization of heat exchanger systems to remove heat more efficiently

