



The Vertical Flight  
Technical Society

**Hybrid VTOL Propulsion**  
**5<sup>th</sup> Transformative Vertical Flight Workshop**  
**19 January, 2018**

Delivering Excellence Through Innovation & Technology

[www.ricardo.com](http://www.ricardo.com)

# Battery technology is rapidly improving, but on-board power generation may offer opportunities to overcome near-term battery limitations

eVTOL Targets	
Battery Pack	140 kWh
Minimum Reserve Energy	20-30%
Range	25 miles average 60 miles maximum
Battery Pack Energy Density Estimated Cell Energy Density	300 Wh/kg ~400 Wh/kg
Maximum Charge/Discharge	3C
Cycle Life	500 to 1000



## Challenges

System Energy Density (Range)

Life Cycle

C-rates

Battery Cost

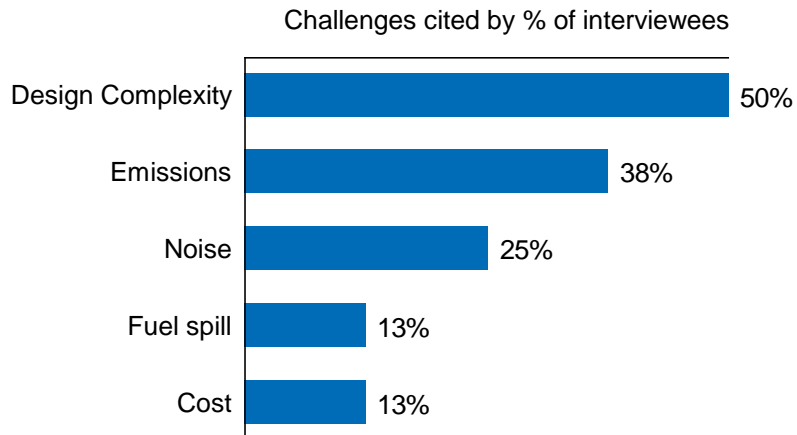
Hotel Loads (HVAC)

# Hybrid propulsion comes with its own challenges which need to be addressed

50%

**of industry experts** interviewed by Ricardo consider Hybrid propulsion to be viable for long range trips (>60 miles)

## Mixed views on challenges with Hybrid VTOL



## Challenges

Noise

Emission

Design Complexity

Maintenance

Fueling

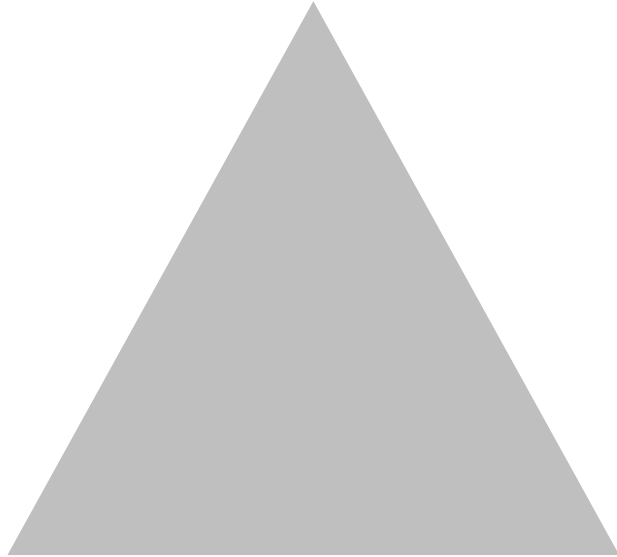


# Hybrid propulsion design priorities will drive the development and selection of appropriate technologies



## What are the design priorities ?

Emission



Weight

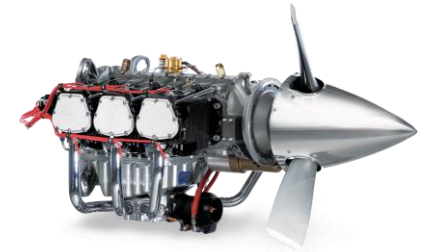
Cost



## Suitable hybrid engine types ?



Gas Turbines



Piston Engines



## Views on different fuel types ?

JetA

High Octane

Leaded fuel

Bio-fuel