

WILLIAMS | ADVANCED
ENGINEERING

‘FORMULA ONE TO FLIGHT’

Global Urban Air Summit 2019

4th September 2019

Stu Olden, Senior Commercial Manager





F1 DERIVED TECHNOLOGY

The Motorsport environment provides an excellent platform for innovation and development.

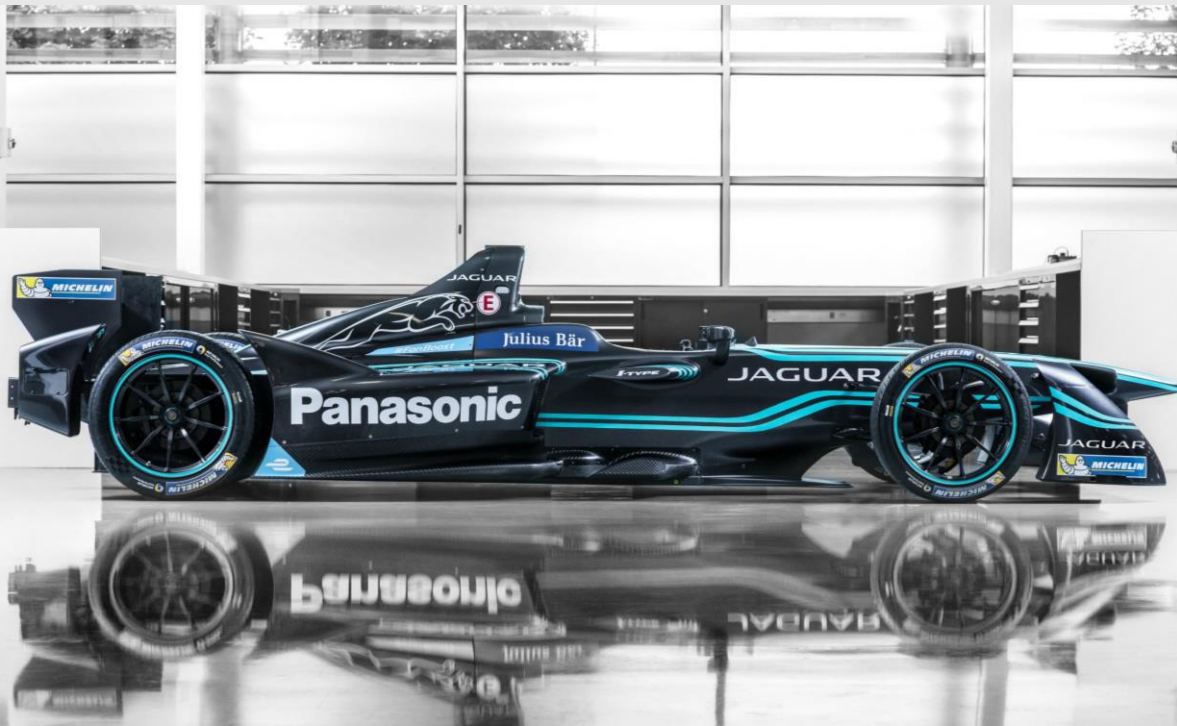
Rapid development cycles – 18 months 'cradle to grave'

Challenging deadlines

A need to remain competitive & leverage latest technology

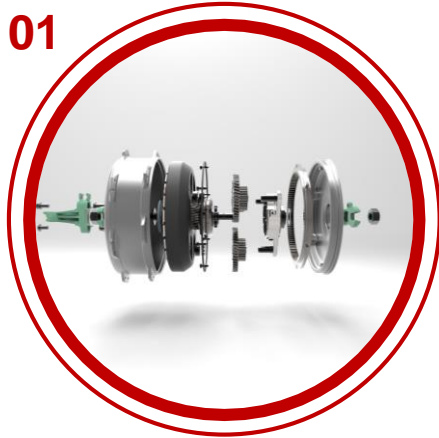
Opportunities for technology transfer across a range of markets

Williams Advanced Engineering formed to exploit & commercialise knowledge & technology ...



DIFFERENT MARKETS, SAME CHALLENGES

01



02



03



04



05



01 PACKAGING

- Systems Engineering approach
- Analysis & Design

03 ELECTRIFICATION

- Hybrid & EV architectures
- High density power & energy
- Advanced battery technology (thermal management, energy harvesting & storage, rapid/efficient charging, condition monitoring, predictive maintenance, battery management)

05 AERODYNAMICS

- Formula 1 aerodynamics approach
- Aircraft aerodynamics require similar approach to efficiency

02 LIGHTWEIGHTING

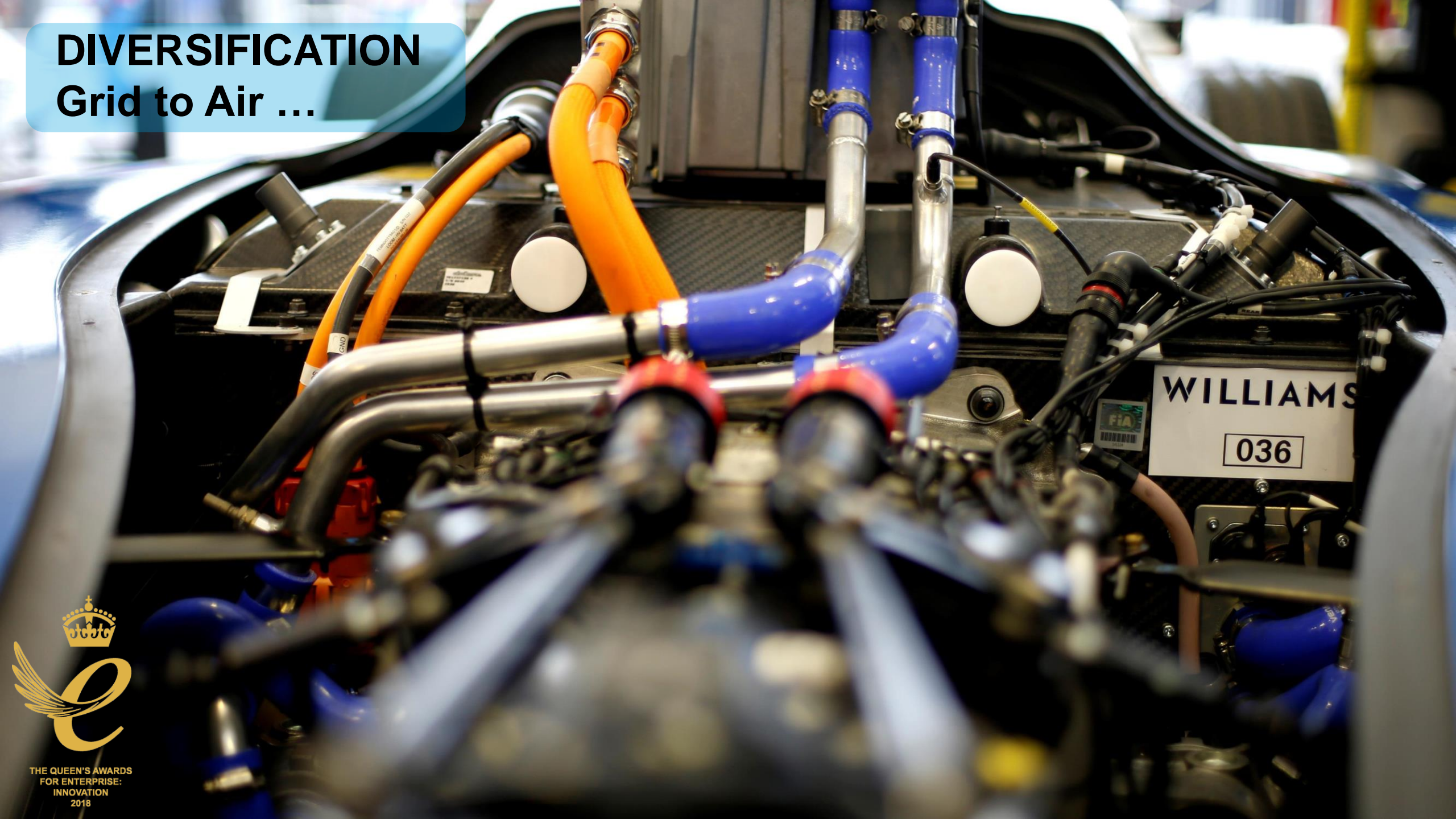
- Composite & AM technology
- Minimising parasitic waste
- Increasing load capacity & range

04 CONNECTIVITY

- Secure systems & pipeline
- Data collection & analytics
- Sensor systems
- Information management & display

DIVERSIFICATION

Grid to Air ...



THE QUEEN'S AWARDS
FOR ENTERPRISE:
INNOVATION
2018



EV TO EVTOL

BATTERY TECHNOLOGY DEVELOPMENT

- A need to:
 - Drive down cost & mass
 - Improve volumetric energy density
 - Prove safety
 - Realise 'in air' certification
- Li-ion:
 - Cell energy density doubled in 15 years, but still need for improvement for eVTOL applications (>500Wh/kg pack)
 - Pack costs reduced significantly (<\$250/kWh), but way to go
 - Electrode chemistries continue to be developed (safety, conductivity, stability & cost)
- Other chemistries emerging (but predominantly still lab scale):
 - Li-S, Li-Metal
 - Na-ion
 - Metal Air
 - Solid State
- Systems Approach needed
 - Thermal Regulation & Battery Management Systems
 - Motors, Invertors & control electronics



WHAT ARE WE DOING?



Williams Advanced Engineering made the battery and power systems for the Jaguar CX75 prototype hypercar, which featured in the James Bond film Spectre

Williams plans to put Britain at front of race among electric cars

Grand prix team's parent company to build battery factory

by Peter Lee, Industrial Editor

Williams is to get its first manufacturing dedicated to making batteries for electric cars.

Williams Grand Prix Holdings, the company of the Williams Formula One racing team, is working to start production for its first electric supercar.

The plant will open in the British motor factory that has petrol exhaust be home to carmakers for 50 years.

boost for the automotive industry and the government's industrial strategy, which has identified electric cars as a key pillar of future growth.

The facility initially will create 100 high-skilled jobs and will supply the battery-powered version of Aston Martin's existing petrol-driven Rapide model.

The joint venture, called Hyperbat, aims to make 10,000 battery and power systems a year at the site and is targeting not only Aston Martin but Britain's other high-end manufacturers, such as Jaguar Land Rover, Rolls-Royce and Bentley.

The first batteries for the Rapide could be twice as powerful as those in the Tesla, the American electric vehicle brand.

Britain's only other battery manufac-

turing plant is a Nissan facility next to its car factory in Sunderland assembling power packs for the all-electric Nissan Leaf produced on the site.

The joint venture and new facility will be announced today at a government zero emissions summit led by Greg Clark, the business, energy and industrial strategy secretary.

Speaking ahead of the announcement, Mr Clark said: "Hybrid and electric vehicles will play a key part in Britain's cleaner and greener future. Through the industrial strategy, the government is building on our world-leading strengths, making the UK the go-to place for these technologies."

Williams will supply the design engineering and chemistry technology and Unipart the manufacturing processes and supply chain knowhow.

Williams Grand Prix Holdings is quoted in Frankfurt and controlled by Sir Frank Williams, the Formula One veteran.

The subsidiary involved in the venture is Williams Advanced Engineering, set up in 2010 to exploit Formula One technologies in mainstream sectors. It is based at Grove, Oxfordshire, close to the grand prix engineering team. One of its first projects was the electric battery and power systems for the Jaguar CX75 prototype hypercar, which featured in the James Bond film Spectre.

Hyperbat was formed by a government-funded collaboration between the two at Warwick's Advanced Propulsion Centre. Sir Vince Cable, the former business secretary,

+ Hyperbat Joint Venture

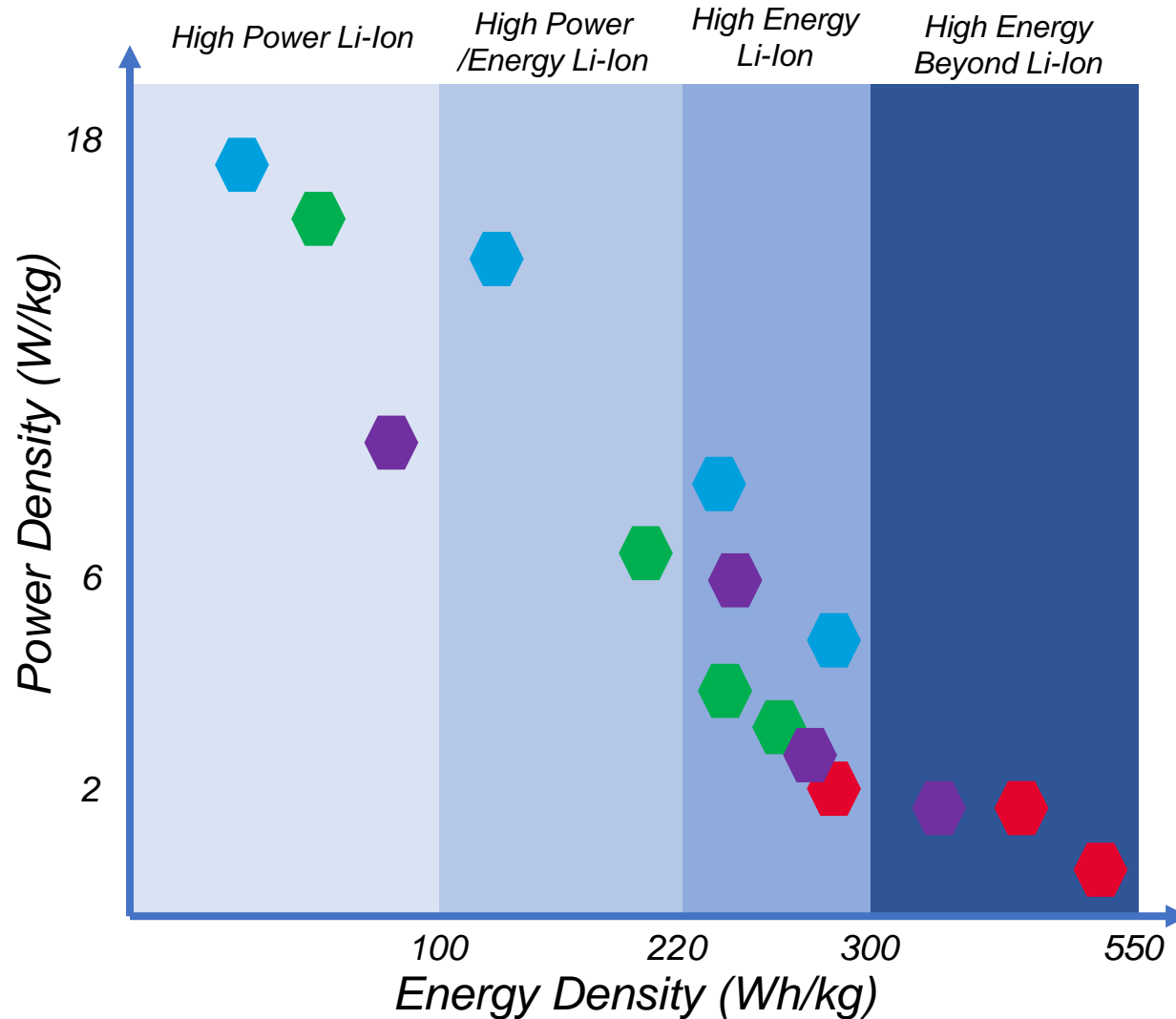
+ Academic research partners

- Improve energy & power density
- Hybrid cells

+ Cell supplier monitoring & engagement

- Drive down cost
- Improve recyclability
- Increase longevity

+ DIVERSITY OF BATTERY DEVELOPMENT ACTIVITY



Project Description:

- Motorsport (Spec)
- Motorsport (Competitive)
- Automotive (High-Performance BEV)
- Automotive (High-Performance PHEV)
- Aerospace – Novel Cell Chemistries
- Specialist Products

Significant technology diversity within product portfolio

+

Advancing the Pace of Development



Implementation
Real & Controlled Environments

First-Principles Approach
Joint Electrochemical, Mechanical, Thermal
Engineering

Collaborative Engineering
Joint Cell & Pack Engineering

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