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Arbeitskreis Luft- und Raumfahrt

Invitation to an RAeS lecture in cooperation with the DGLR and VDI

Hybrid Elektrische Antriebe – Paradigmenwechsel für den Flugzeugentwurf?

Dipl.-Ing. **Peter Rostek**
Airbus Operations GmbH, Hamburg

Lecture
followed by discussion

Entry free !
No registration required !

Date: **Donnerstag, 07 April 2016, 18:00**
Location: **HAW Hamburg**
Berliner Tor 5, (Neubau), Hörsaal 01.12

Hochschule für Angewandte Wissenschaften Hamburg
Hamburg University of Applied Sciences
Praxis Seminar Luftfahrt

Hybrid elektrische Antriebe sind in bestimmten Marktsegmenten nichts Neues. Sie kommen bereits zur Anwendung bei PKW's, LKW's, Bussen oder Schiffen. Die große Herausforderung besteht darin, diese Technologie in den Luftfahrtmarkt zu übertragen.
Die Kombination von Verbrennungskraftmaschinen und elektrischen Komponenten sowohl mit hoher Energie- als auch Leistungsdichte wäre die Grundlage für zwei wesentliche Veränderungen:
• Eine hybride Architektur würde zu einer Verbesserung des Gesamtwirkungsgrades der Antriebskette beitragen.
• Synergien zwischen Technologiebausteinen würden zu einer Erweiterung des Flugzeugentwurfsraumes beitragen
Dieser Vortrag liefert allgemeine Informationen über das Potential hybrid elektrischer Antriebe in der kommerziellen Luftfahrt und über aktuelle Entwicklungsaktivitäten im Rahmen von Clean Sky 2.

Peter Rostek arbeitete nach seinem Abschluss an der TU Berlin 1999 für fünf Jahre dort als wissenschaftlicher Mitarbeiter im Institut für Leichtbau. Seit 2004 hat er in verschiedenen Positionen für das FPO bei Airbus in Hamburg gearbeitet, speziell im Bereich Rumpfauslegung und Nutzlastintegration. Seit Mitte 2013 konzentriert er sich inhaltlich auf neue langfristige Konzepte. Seit 2014 ist Herr Rostek Technology Product Leader Novel Energy bei Airbus in Hamburg.

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Edited version of original presentation

Download from
http://hamburg.dglr.de
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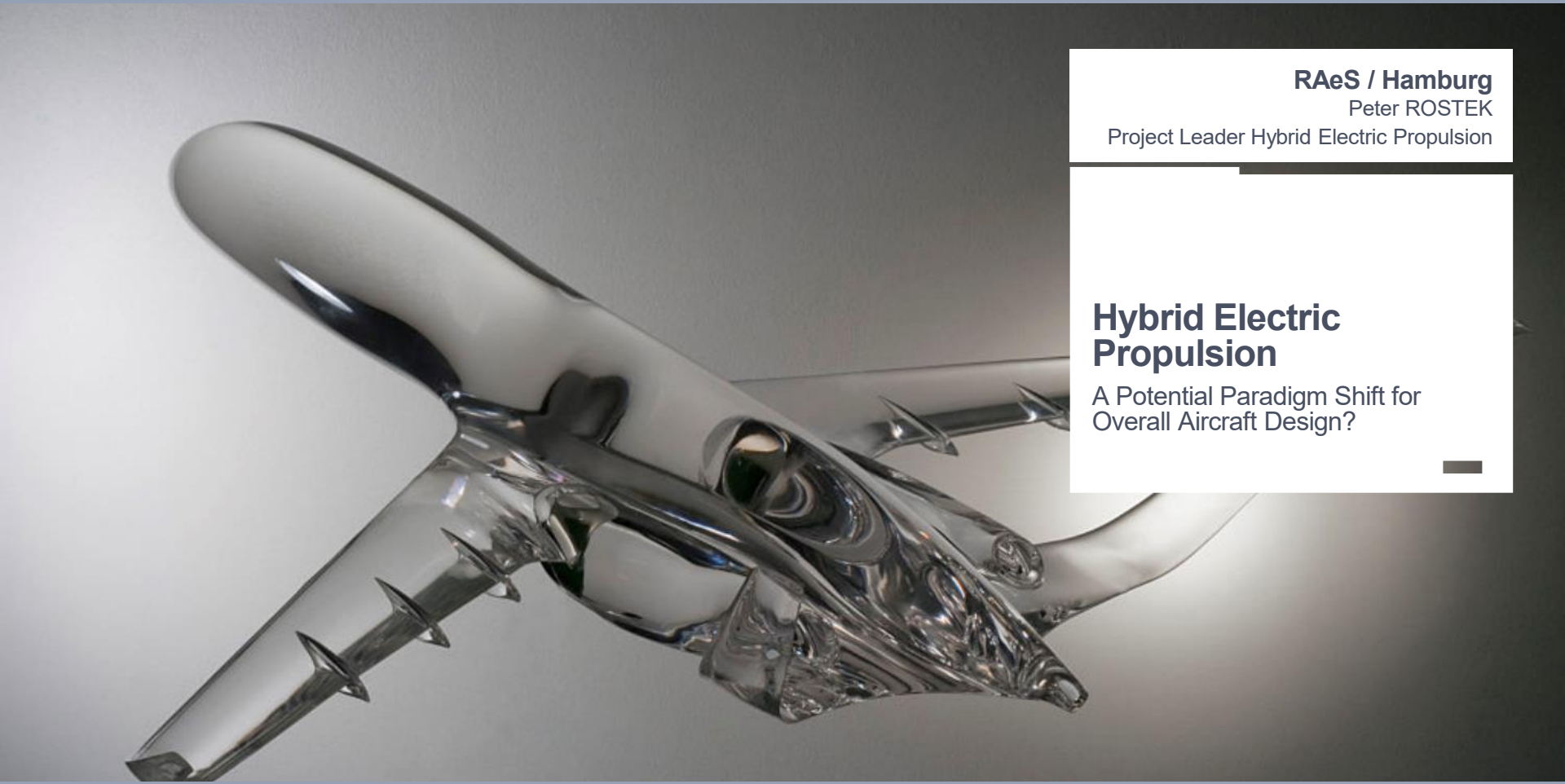


RAeS / Hamburg
Peter ROSTEK
Project Leader Hybrid Electric Propulsion

Hybrid Electric Propulsion

A Potential Paradigm Shift for Overall Aircraft Design?

Content

- Background
- Fully Electric Propulsion
- Hybrid Electric Propulsion
- Conclusion

Background

Airbus project leader for hybrid electric propulsion

Target Setting

R&T Integration
Sector Manager

Future Projects Office

- Development of Aircraft Concepts
- Focus on Potential Future Products

Novel Energy
Technology Product Leader

Research & Technology Programme

- Development of Technology Bricks
- Focus on Hybrid Electric Propulsion

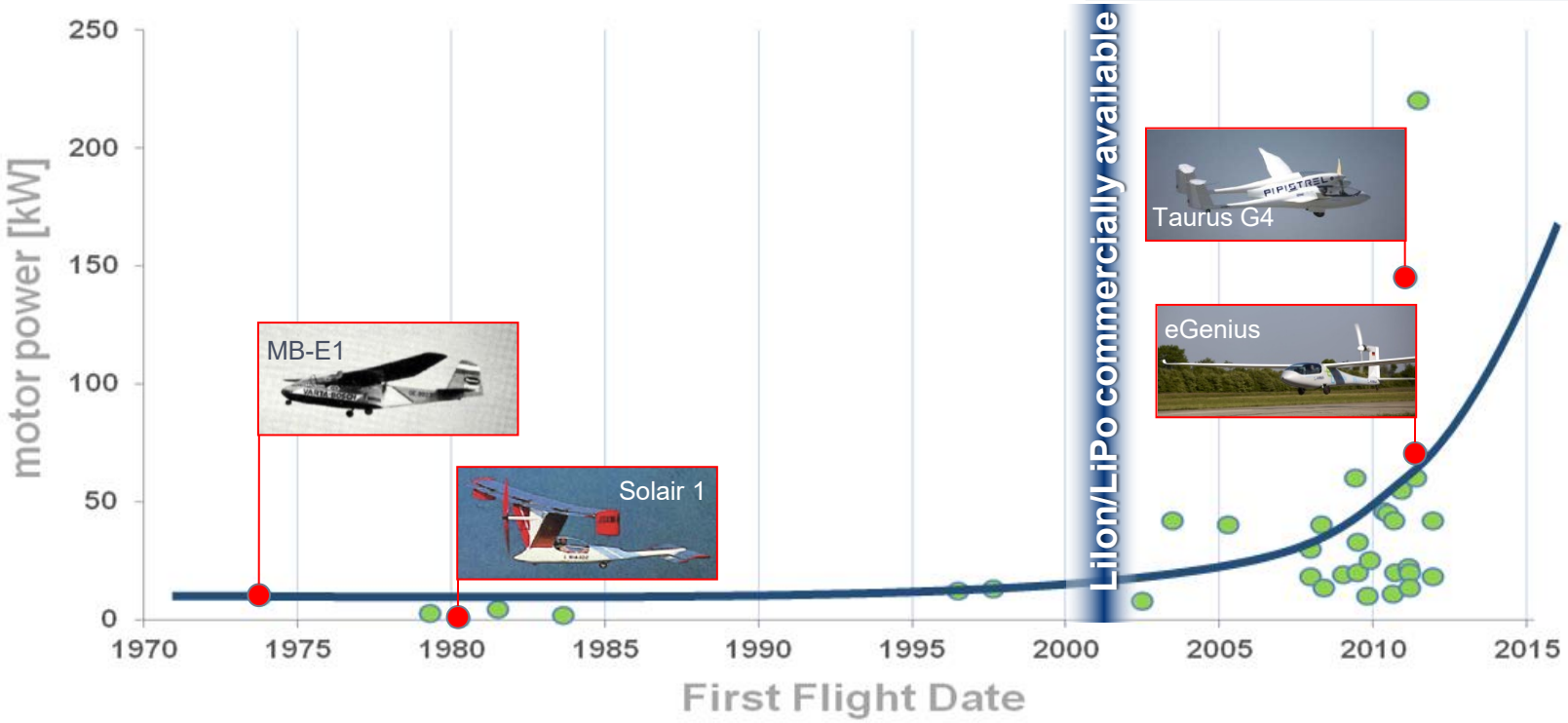
Technology Integration

Airbus is a European aircraft manufacturer with several global branches

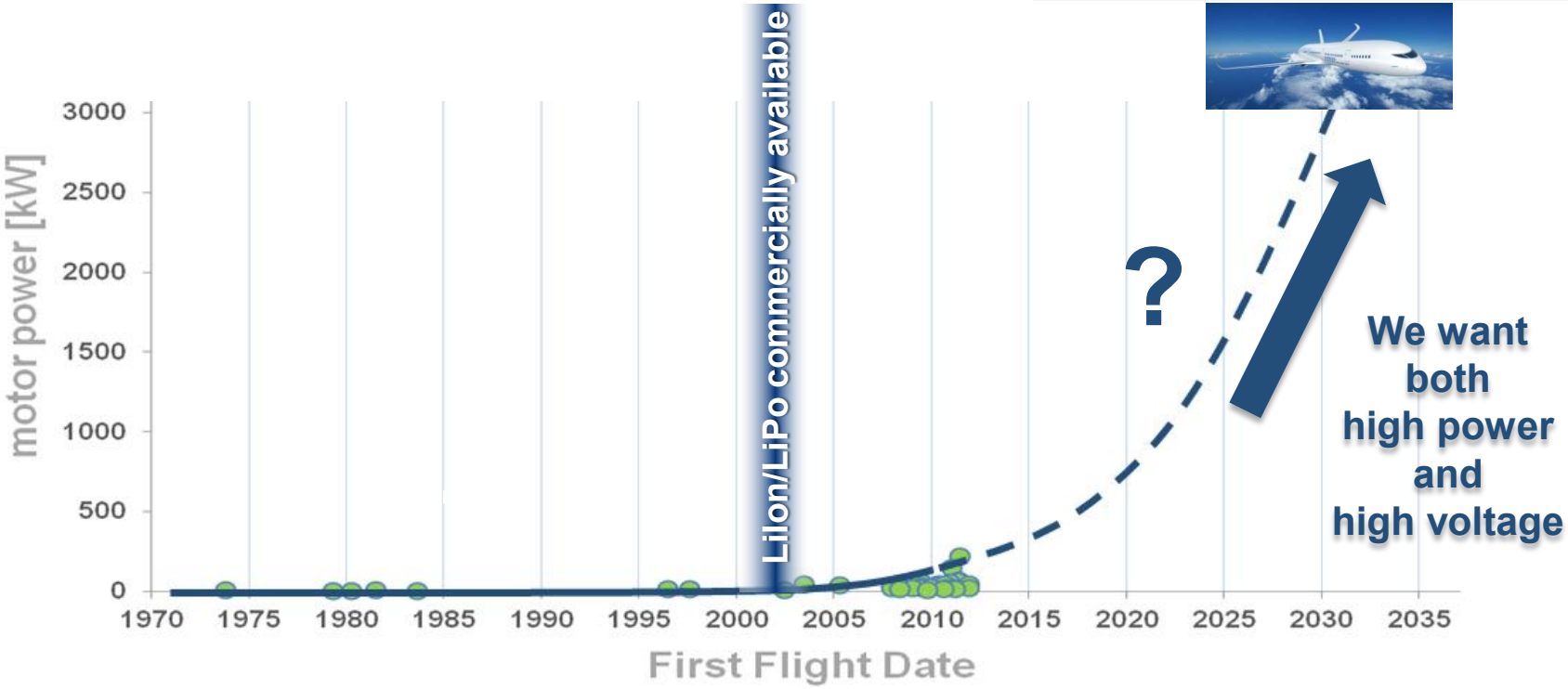
Airbus aircraft families are covering a capacity range from 100 to 500+ passenger seats

Fully Electric Propulsion

More development activities resulted in higher power levels



What are the limits of fully electric propulsion



With current battery technology fully electric propulsion is impossible in commercial aviation

A319: 800 nm / 140 PAX

Conventional Kerosene

➢ 30 kg Kerosene per PAX

Fully Electric

➢ 1000 kg Battery per PAX

	Assumptions
Energy Density of Kerosene	12000 Wh/kg
Energy Density of Battery	120 Wh/kg
Efficiency Factor of eMotor	3

How to build a bridge between small fully electric a/c and large hybrid electric a/c

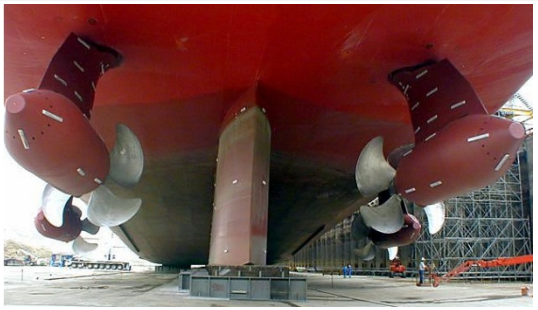
Hybrid Electric Propulsion

The huge challenge is to transfer this technology into the commercial aviation market

Hybrid Electric Propulsion...

Porsche Panamera Hybrid
0.07 MW / 5500 rpm
1 to 2 kW/kg

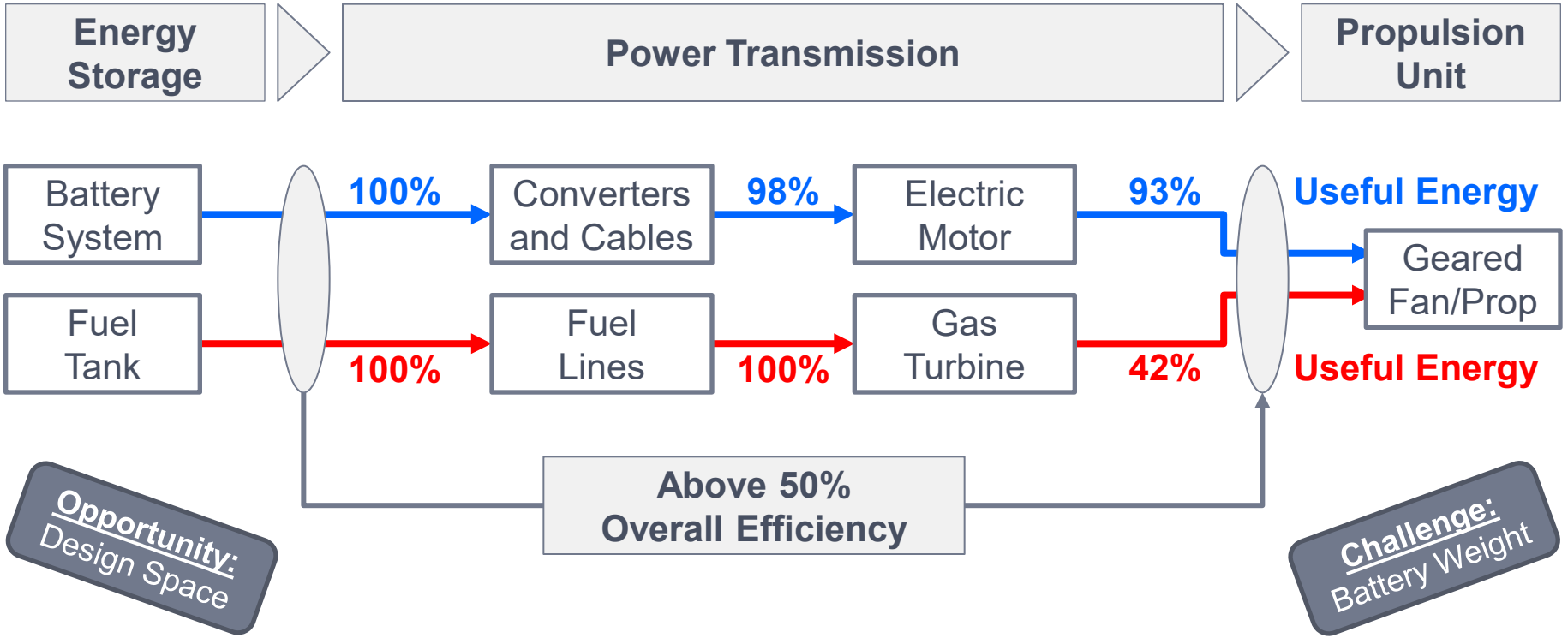
Liebherr Mining Truck
3 MW
0.25 kW/kg



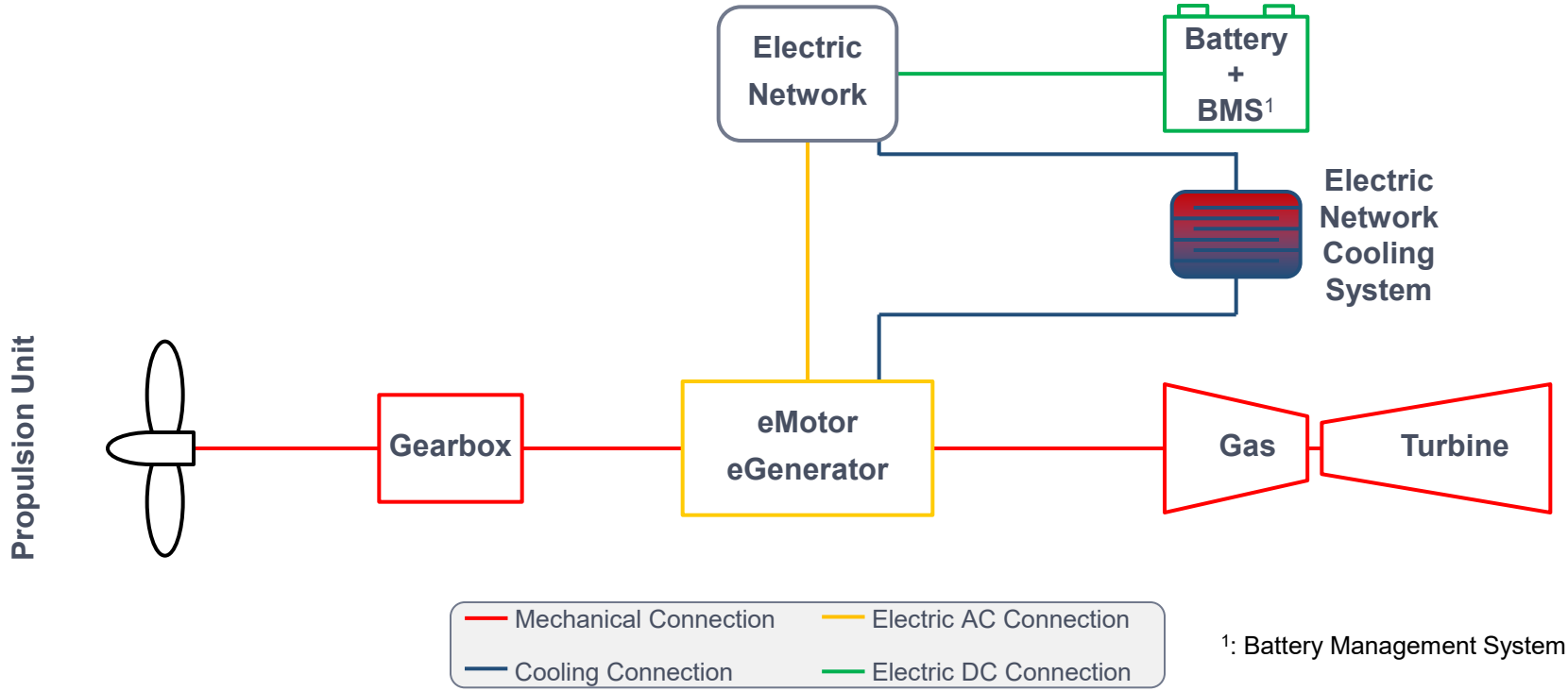
Queen Mary 2
20 MW / 180 rpm
0.2 to 0.4 kW/kg

...is nothing new for other markets.

High efficiency of electric sub architecture to boost overall efficiency of hybrid system architecture

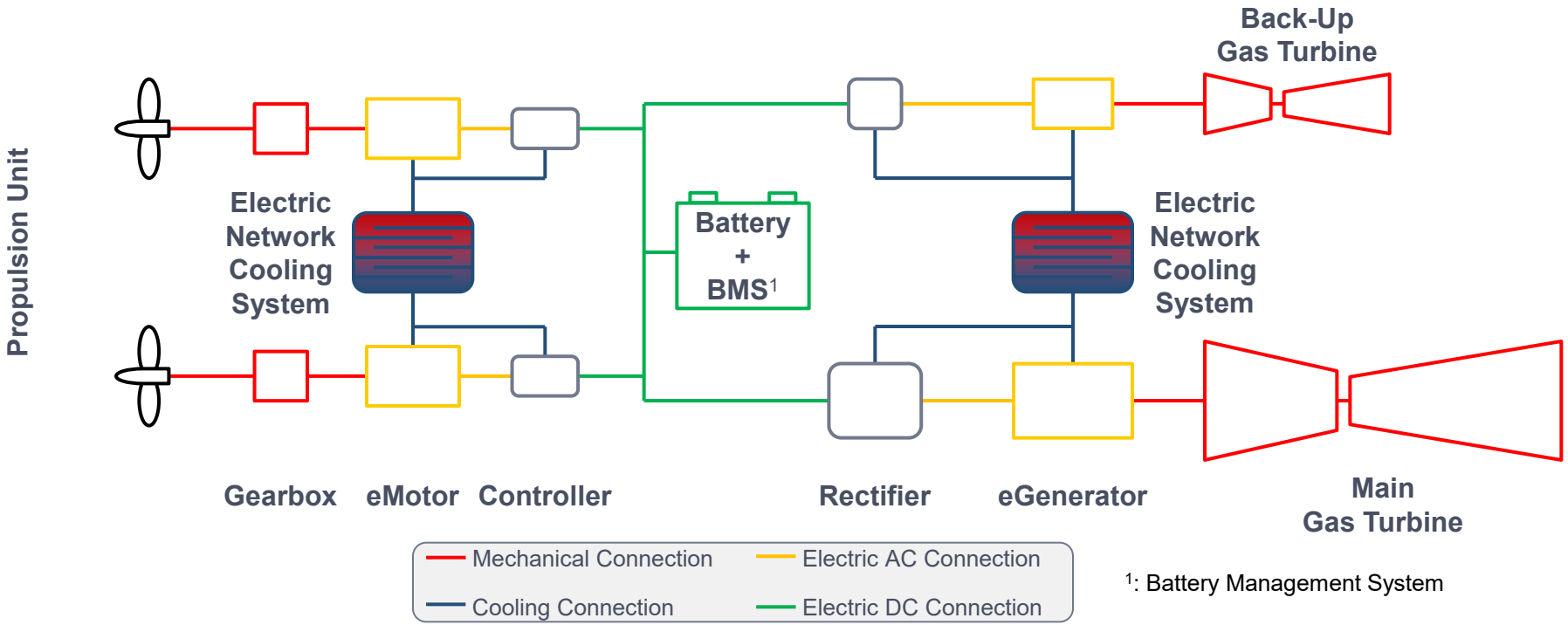


Parallel system architecture to provide additional drive power for specific flight phases



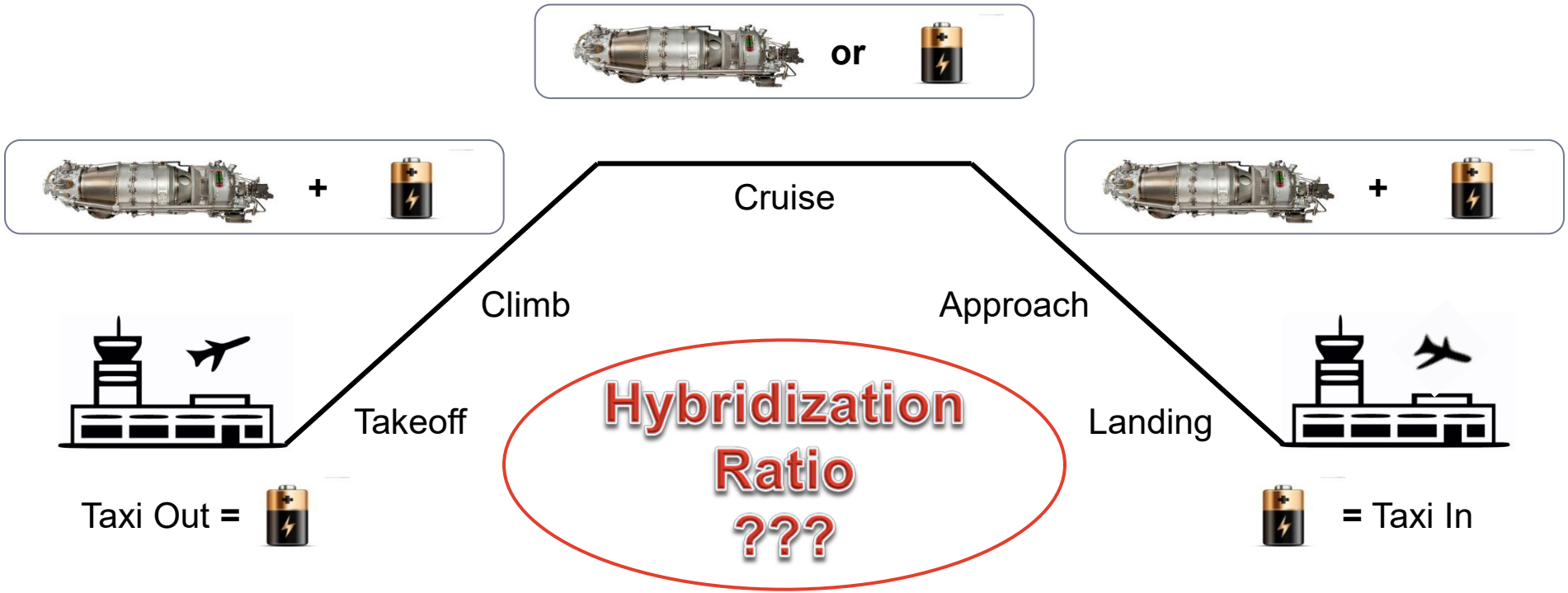
1: Battery Management System

Serial system architecture to separate power generation from thrust generation



1: Battery Management System

Energy management over mission profile is key to boost efficieny

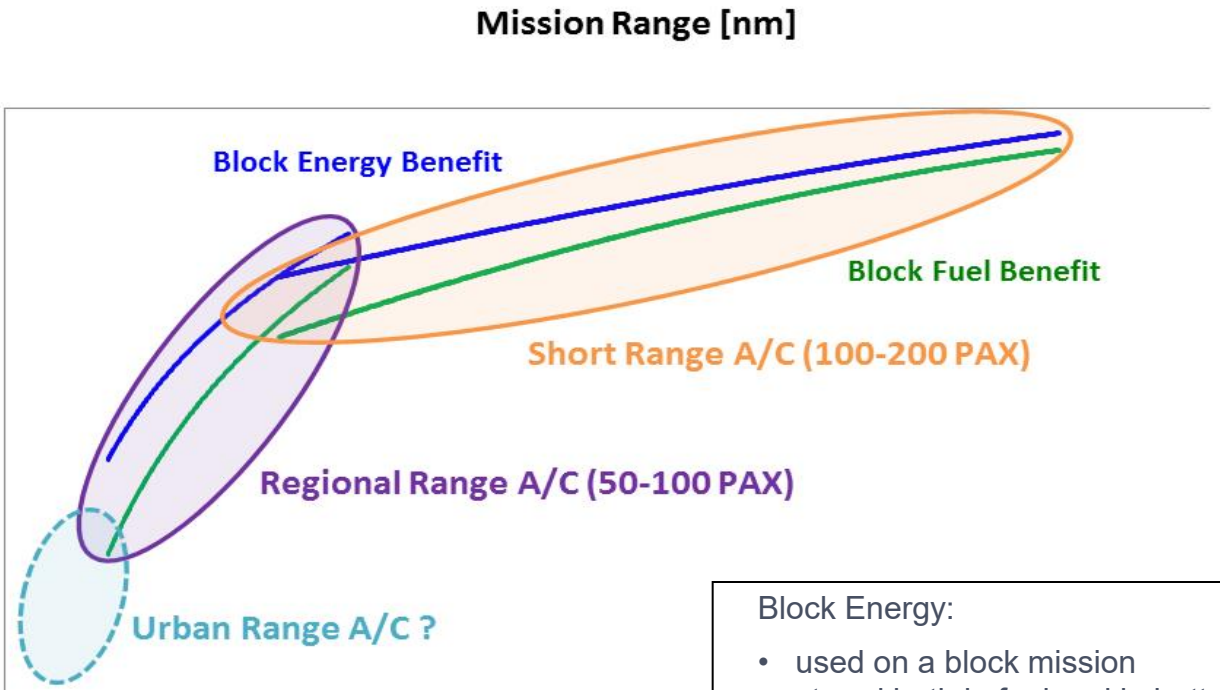


Energy management over mission profile is key to boost efficieny

There is a potential for hybrid electric propulsion – Initially for regional range a/c

Block Energy Benefit
Hybrid vs. Conventional

Hybrid A/C more efficient than Conventional A/C

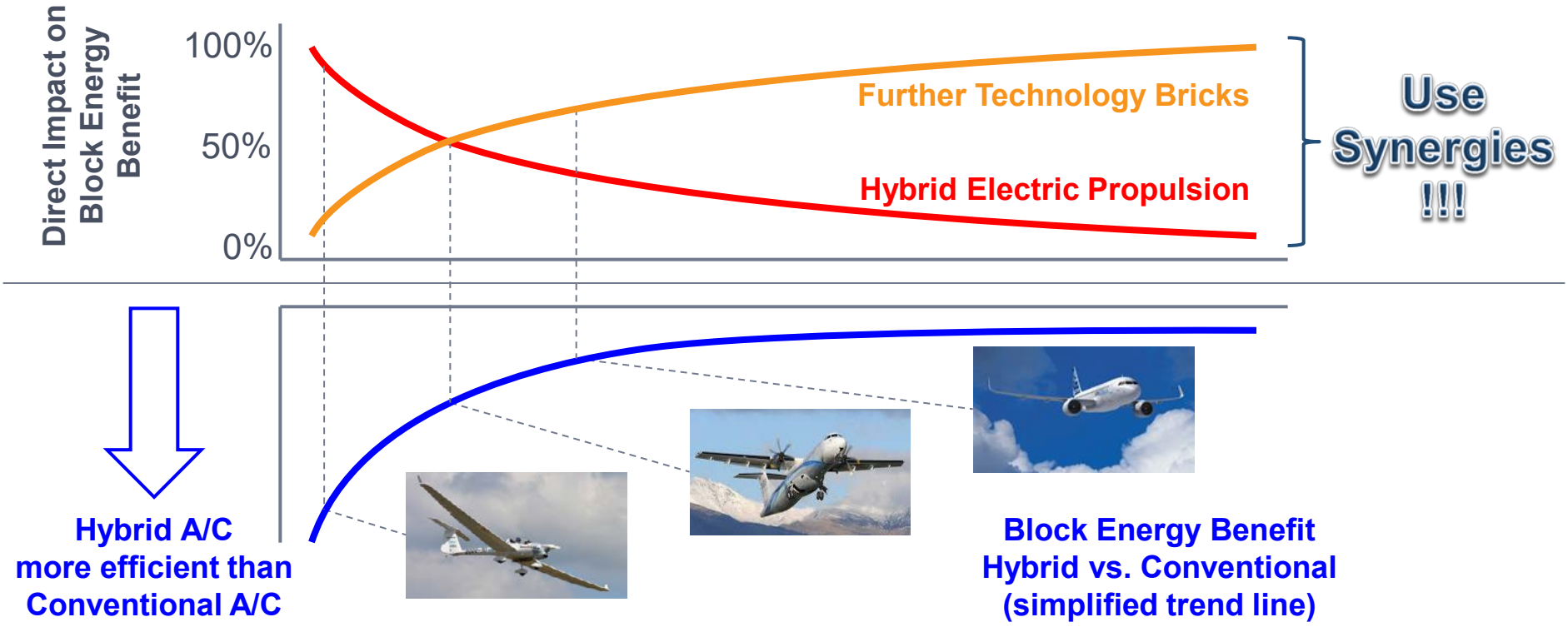


Block Energy:

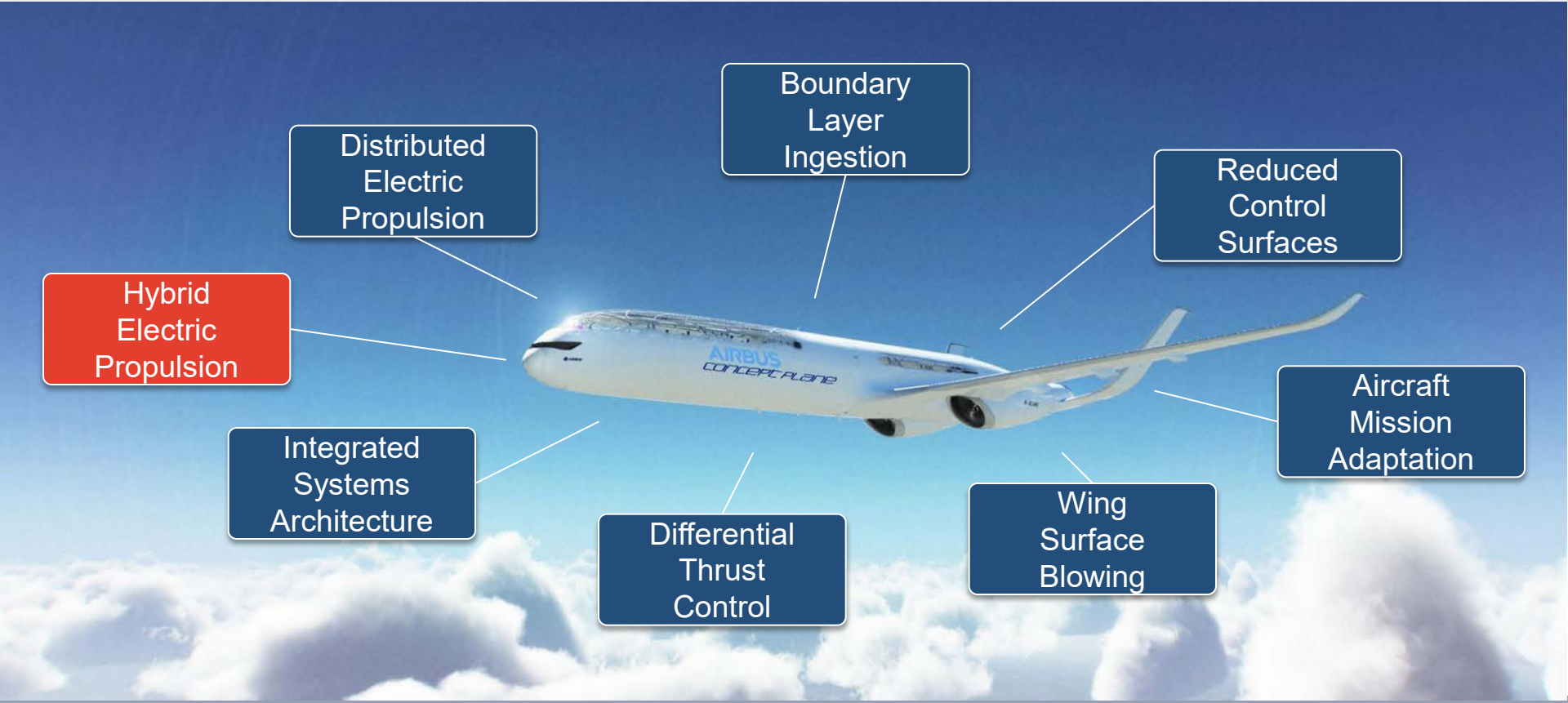
- used on a block mission
- stored both in fuel and in batteries

Block Energy Benefit < Block Fuel Benefit

For big commercial a/c hybrid electric propulsion is the key enabler for further technology bricks



Synergies between technology bricks will open the design space for overall aircraft design



Distributed Electric Propulsion – Example

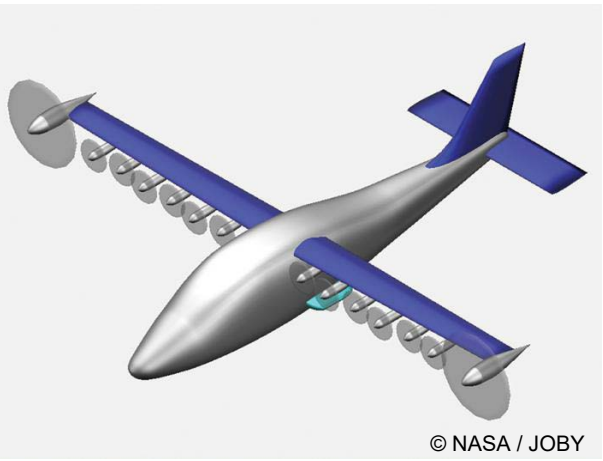
NASA “X-Plane” to demonstrate an increase in cruise efficiency by using a wing that is sized for cruise and not for take-off and landing

LEAPTech Project Concept:

Tecnam P2600T twin-engine light aircraft modified with a distributed electric propulsion wing

HEIST Ground Demonstrator:

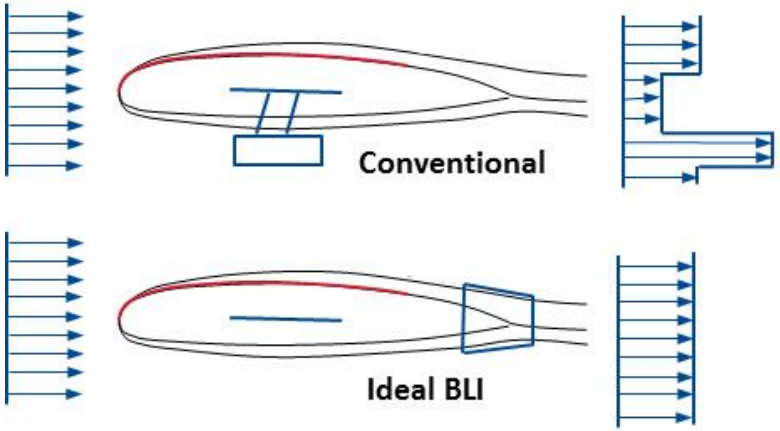
Validate lift augmentation at low speed provided by electric propellers blowing air over the wing

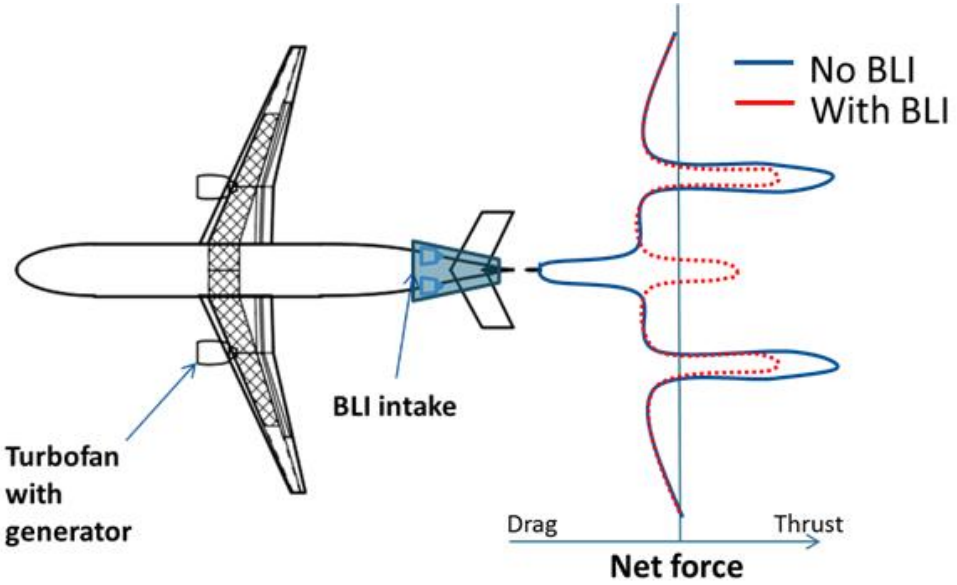


SCEPTOR Flight Demonstrator:

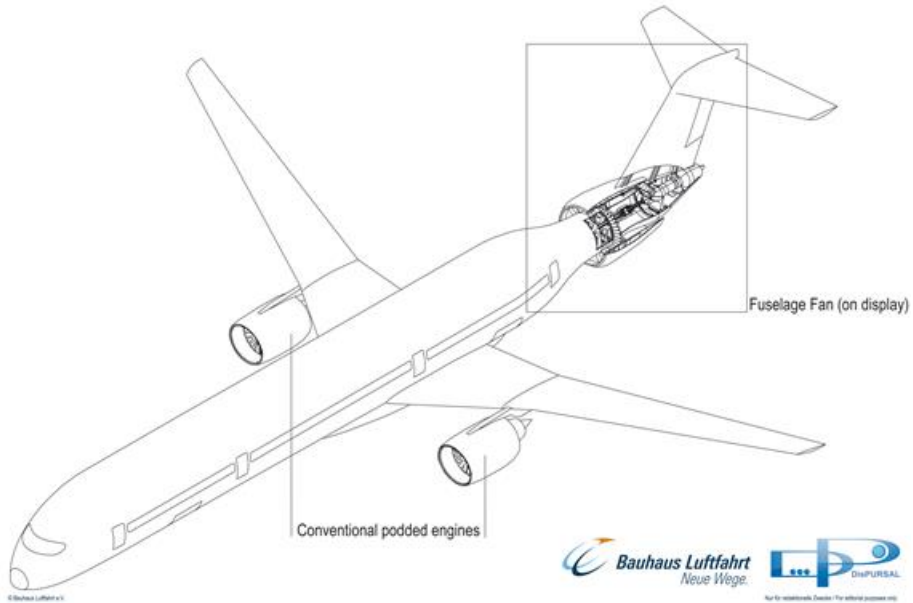
12 high lift props (Ø0.6m, 14kW@55kt, 4550rpm) plus 2 cruise flight props (Ø1.5m, 48kW@150kt, 2250rpm)

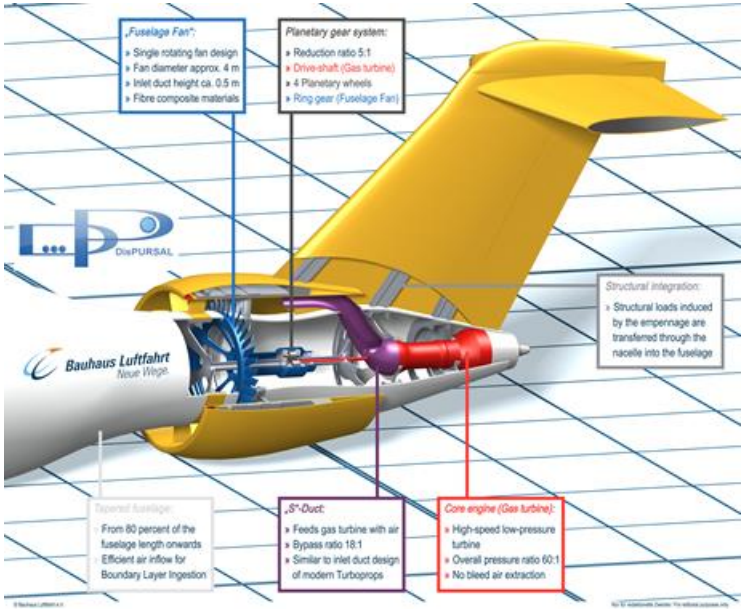
Boundary Layer Ingestion – Example





Bauhaus Luftfahrt “Propulsive Fuselage” to reduce the effective drag of the aircraft while the propulsive efficiency of the powerplant is improved





Potential Paradigm Shift for Overall Aircraft Design: Propulsion system architecture will become a driver for overall aircraft design

Classical OAD:

⇨ A/C Performance First

⇨ Systems Integration Last

Less Compromises

Paradigm Shift

More Synergies

Future OAD:

⇨ Systems Architecture First

⇨ Aircraft Configuration Last

Technology demonstrators to validate basic assumptions and to drive technology maturations

Hybrid G/A

Hybrid UAV

Hybrid H/C

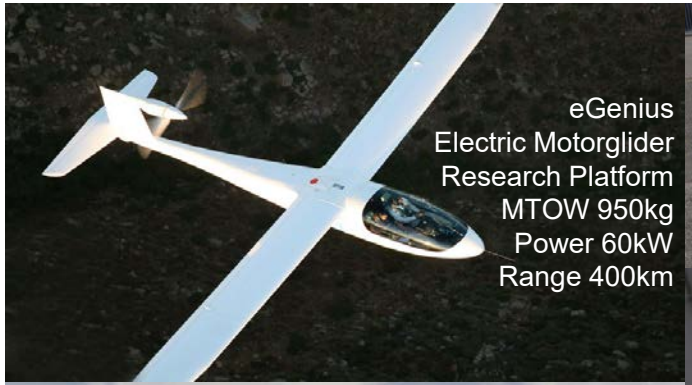
Hybrid NRA

2030+

Hybrid Ground Demonstrator 1.0

Hybrid Ground Demonstrator 2.0

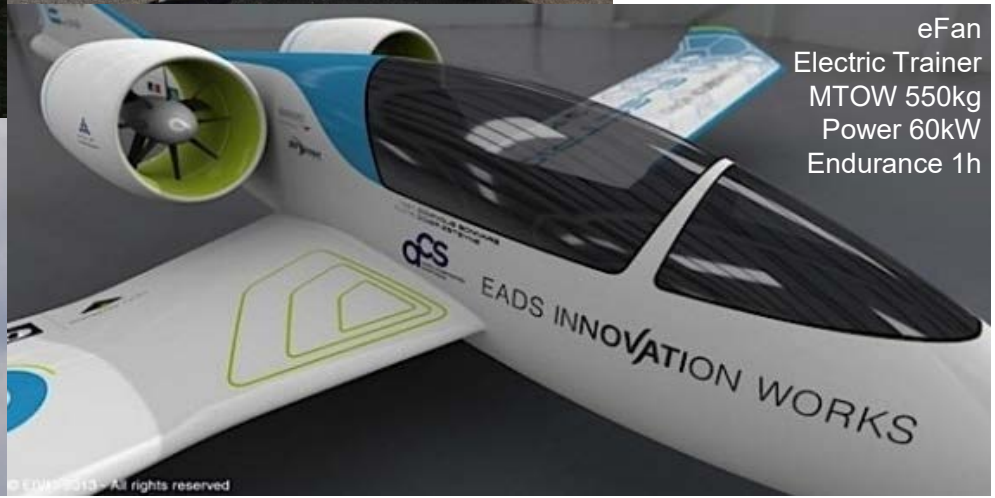
Airbus Group is already in the air: eGenius, CriCri, Hybrid Dimona and E-Fan 1.0



eGenius
Electric Motorglider
Research Platform
MTOW 950kg
Power 60kW
Range 400km

Green CriCri
Testbed
MTOW 180kg
Power 11kW

Diamond E-Star 2
Serial Hybrid Motorglider
MTOW 900kg
Power 65kW



eFan
Electric Trainer
MTOW 550kg
Power 60kW
Endurance 1h

http://wemakeitfly.airbus-group.com/

The European research project CleanSky2 is aiming for potential future products in 2035

Clean Sky 2

One of the Main Topics:

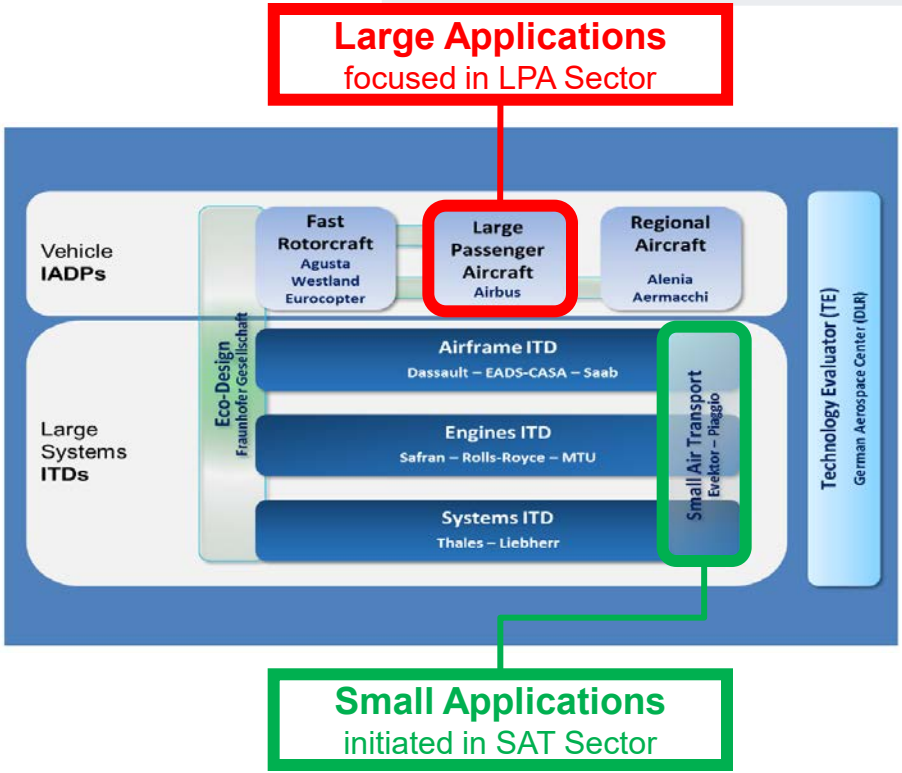
Demonstration of Hybrid Electric Propulsion

(System Test Bench 2014-19)

Small Applications

are small steps on the road to

Large Applications



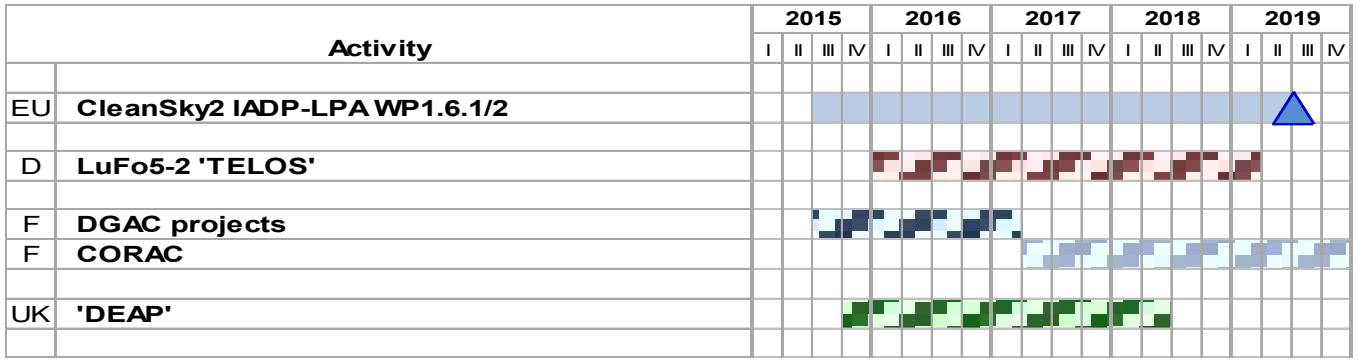
AIRBUS

Several National research initiatives are connected to CleanSky2

- Both European and National research projects are open for SME and for universities/research entities.
- Generally National research projects are of bigger funding volume to tackle bigger projects.
- Beyond public funded research there is also substantial self funded research with partners at Airbus.

Projects and Partners Proposal	
CleanSky2 EU	RollsRoyce
	DLR
	ONERA
LuFo5-2 D	Siemens
	KIT
	TUM
DGAC F	Safran
TSB UK	RollsRoyce
	Cranfield University

Status: Proposed



Challengers on system component level could enrich this research partnership network

Conclusion

The challenges we see will only be met on a joint European Research Platform

- Hybrid electric propulsion is **the key enabler** for further technology bricks and towards European targets for energy saving
- **Synergies** between technology bricks will open the design space for overall aircraft design
- **New aircraft configurations** are essential to use hybrid electric propulsion to its full potential
- In the frame of **CleanSky2** a research partnership network is under preparation together with some champions on system component level
- **Challengers** on system component level could enrich this research partnership network

Some people can hardly wait to fly hybrid electric !

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