EASA
European Aviation Safety Agency

Welcome to the 2016 EASA Annual Safety Conference Day 2

New Technologies and New Business Models: Meeting expectations

25 – 26 October 2016

Bratislava

Your safety is our mission.

An agency of the European Union

EASA
European Aviation Safety Agency

Is General Aviation the incubator for new technologies?

Moderator

Panellist

Stefan Ronig

Hugues Le Cardinal

Alain Cassier

Panel 4

Martin Volck

Linda Brussaard

Your safety is our mission.

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GA as incubator of new technology?

Composite materials
Laminar airfoils
And in the future?

GA as incubator of new technology?

AEROMOBIL

AEROMOBIL

From a dream to a vehicle
From a prototype to a product

- 1990 : first prototype 1.0 flight
- 2010 : prototype 2.0 flight
- **2010 : creation of the AEROMOBIL company**
- 2010 : AM 2.5 prototype in flight
- 2014 : AM 3.0 prototype in flight
- **2017 : Application for EASA Type Certificate**
- **2017 : AM 4.0 in flight**
- **2019 : AM 4.0 EASA Type Certificate target date**

AEROMOBIL design and certification challenges

- EASA Type Certification + Automotive homologation
- Aeroplane and car propulsion systems
- Integration of aeroplane and car controls
- Aerodynamics
- Weight & center of gravity

AEROMOBIL certification choices

- Use of *European Light Aircraft 1* certification procedure to be published

- Use of the future CS-23 amdt 5 to be published at the end of the year

- From prescriptive rule based system to performance based safety objectives

For example :

- Use of some automotive requirements to demonstrate the aeroplane safety level (such as occupants safety)
- Innovative means of compliance to demonstrate safety level (such as stall and spin)

AEROMOBIL Objectives

- Design and manufacture a good and safe product (listen to the voice of customer)
- Minimise certification efforts
  - Additional design develoment test to ensure product safety and excellence
  - EASA Type Certification tests should be limited to the required tests

AEROMOBIL

Electronic Assistent Systems & Hybrid electronic power plants

Is General Aviation the incubator for new technologies?

EASA Annual Safety Conference 2016

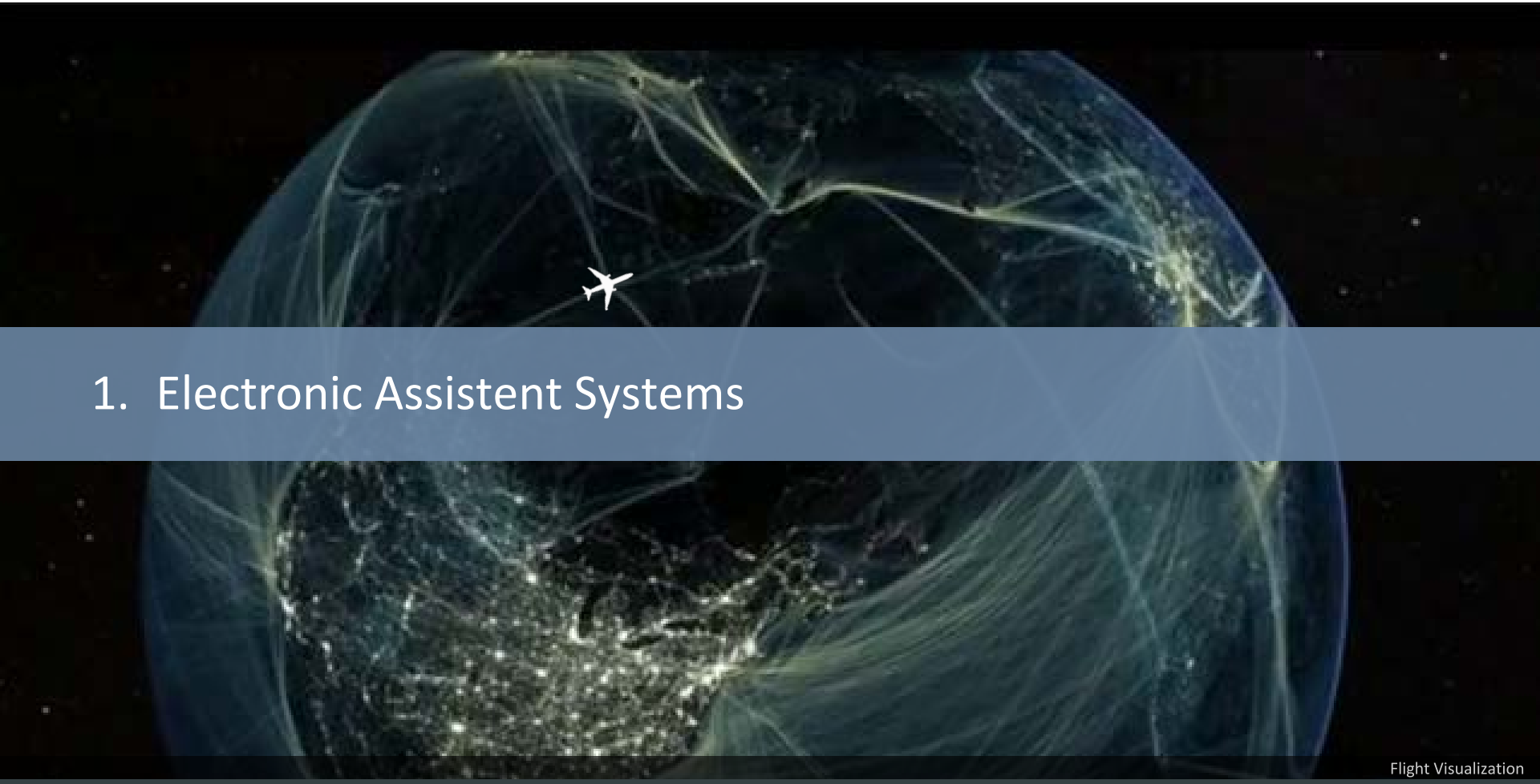
Martin Volck | Diamond Aircraft GmbH

www.diamond-air.at

Synthesis Design + Architecture (SDA) + Volvo Collaborate to Create Portable Car-Charging, Pavilion, Courtesy of SDA

Content

1. Electronic Assistance Systems
   1.1 eSafe
2. Hybrid electric power plants
   2.1 HEMEP
3. Future Projects
   3.1 Diamond Aircraft



1. Electronic Assistent Systems

Flight Visualization

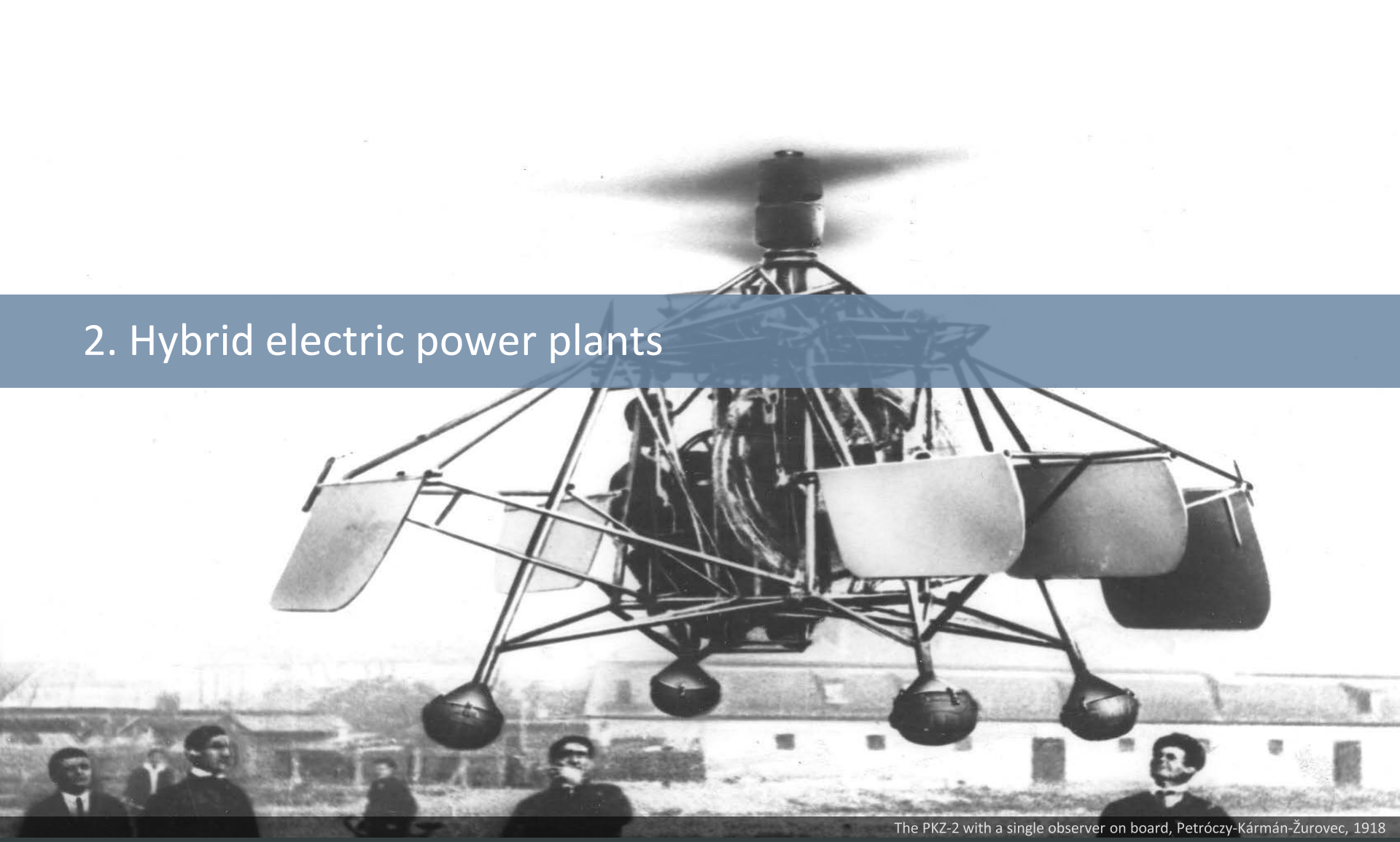
1.1 eSafe

Evolution of Assistance Systems

Human Pilot

- Autopilot
  - Envelope Protection
    - eSafe
      - High Authority Autopilot with
        - Automated Take Off and Landing
          - Full Fly-by-Wire
            - Fully autonomous flight

2. Hybrid electric power plants



The PKZ-2 with a single observer on board, Petróczy-Kármán-Žurovec, 1918

2.1 HEMEP

Hybrid Electric Multi Engine Plane

Project goal

"INTEGRATION OF A HYBRID POWER PLANT TO REDUCE FUEL CONSUMPTION, EMISSIONS AND INCREASE EFFICIENCY"

- **HETEP**: basic developments of a hybrid-electric twin engine airplane realized
- **HEMEP**: integration of a serial, hybrid-electric power plant into a prototype of Diamond Aircraft

- Proof of concept
- Development of a certification basis
- Confirmation of successful integration
- Verification of increased efficiency and reduced noise level

Consortium

- **Airbus Group Innovations**
  Battery System
- **Diamond Aircraft Industries GmbH**
  System Integration and Flight Test
- **Johannes Kepler University Linz – Institute of Fluid Mechanics**
  Aerodynamic simulation and improvement
- **Siemens AG**
  Complete electric power train, incl. controls
- **Tera Group GmbH**
  Design of the interface elements and static and dynamic analysis

The project is driven under the supervision and financement of the Bundesministerium für Wirschaft (BMWi, german ministery of economics) and the Forschunsförderungsgesellschaft mbH, FFG (Society for the develompent of the research, Austria).

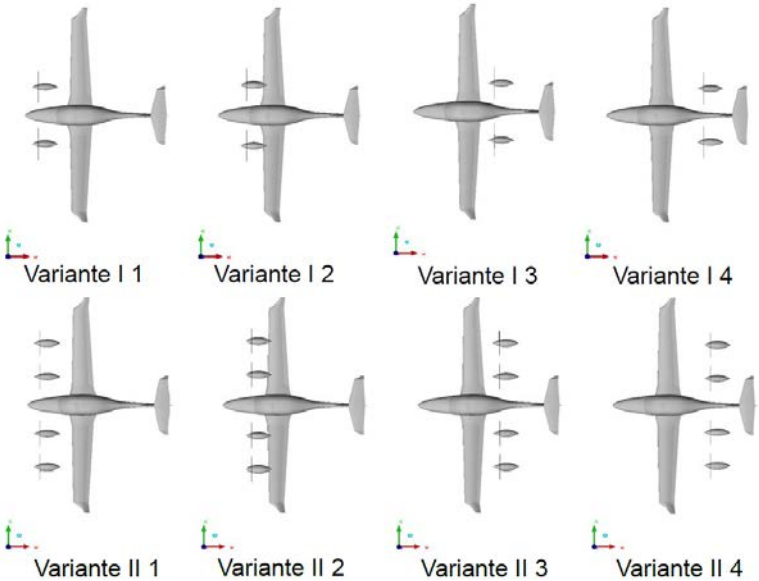
Aircraft specifications

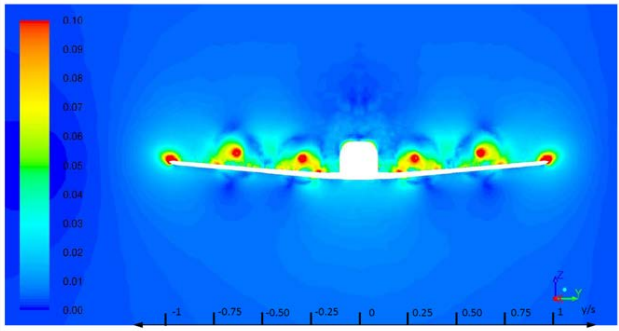
- Airplane (fuselage/carrier): Modified DA40 (four seated)
- Power Generator Engine: AE300 Diesel/JET A1
4 Cylinder
- Electrical Motors & Propellers: 2, located on canard wing
at fuselage nose
- Take-Off Mass: 1380 kg
- Take-Off Power: 150 kW
- Full Electric Flight: 30 min

Aerodynamic simulation

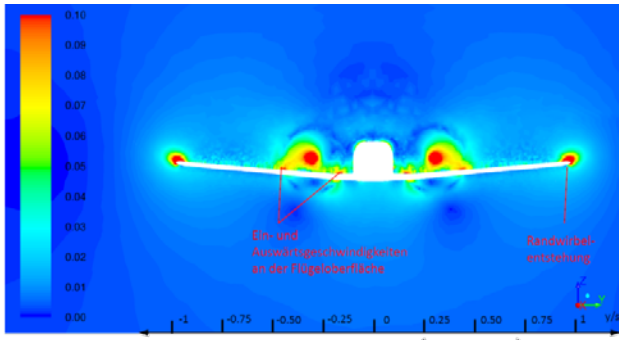
Johannes Kepler University Linz

- Identification of the aerodynamically best configuration by means of CFD simulations





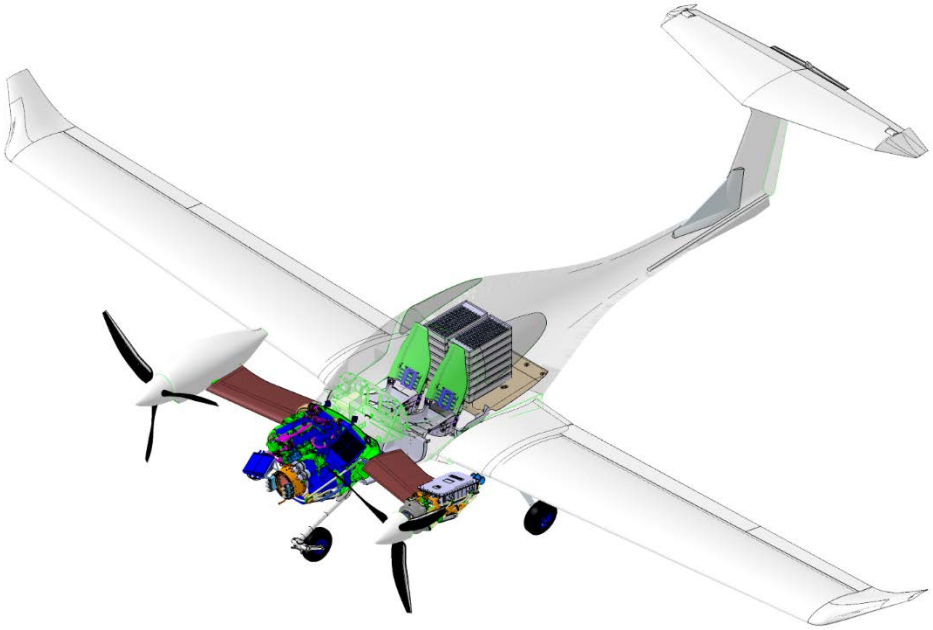
Normalized transversal velocity



Normalized transversal velocity $= \left(\sqrt{u_y^2 + u_z^2}\right) / u_\infty$

Component integration

- All hybrid components (except Battery System) are located in front of the firewall (fuselage nose)
  - Small changes to existing fuselage structure
  - Beneficial for stability and climb performance
- Additional canard wing that carries both Motor Units

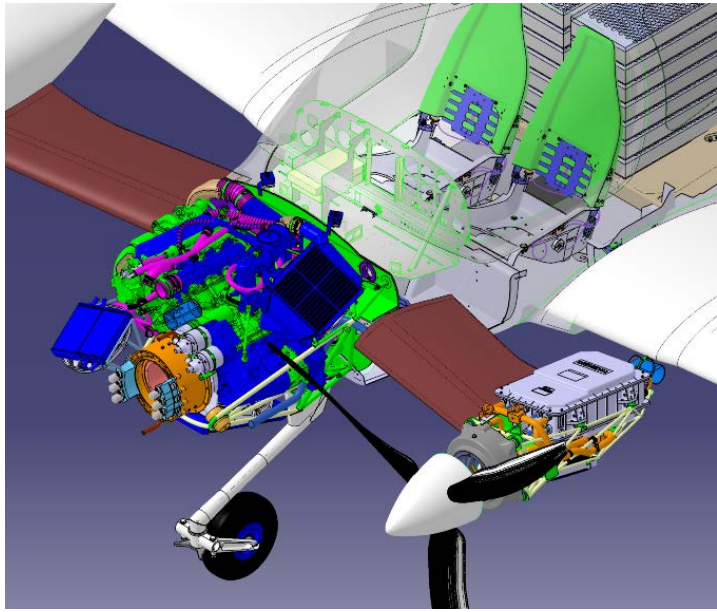


Component integration

Power Unit

- Generator Rotor directly coupled to AE300 crankshaft
- Generator Stator mounted to AE300 case instead of gearbox (same position)
- Mechanical analysis and design by Tera Group
- Modification of Engine Mount to support

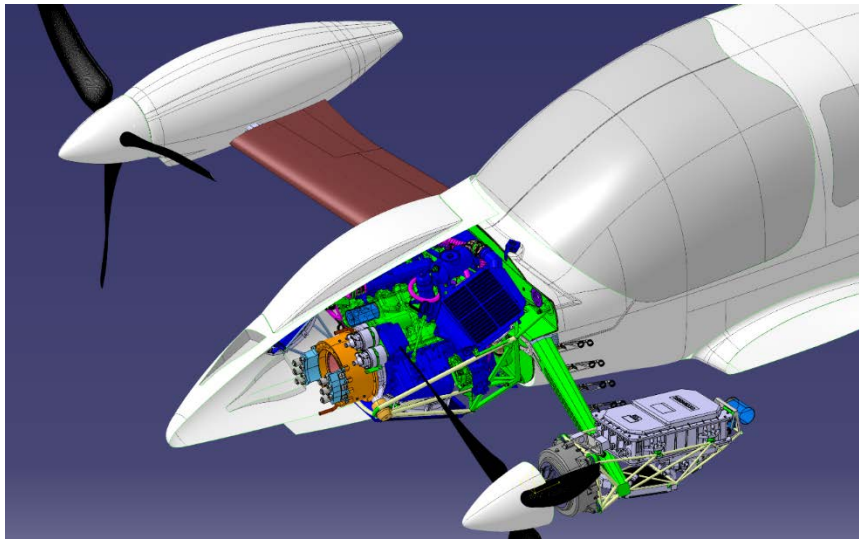
  - ➢Engine/Generator unit
  - ➢Generator cooling



Component integration

Motor Unit

- E-Motor directly drives propeller (Ø 1,90 m) (no gearbox)
- Propeller and E-Motor Rotor bearing to be combined (Siemens)
- Cooler of E-Motor and Inverter combined and located in additional air scoop at lower part of cowling
- Approximate total component mass: 40kg

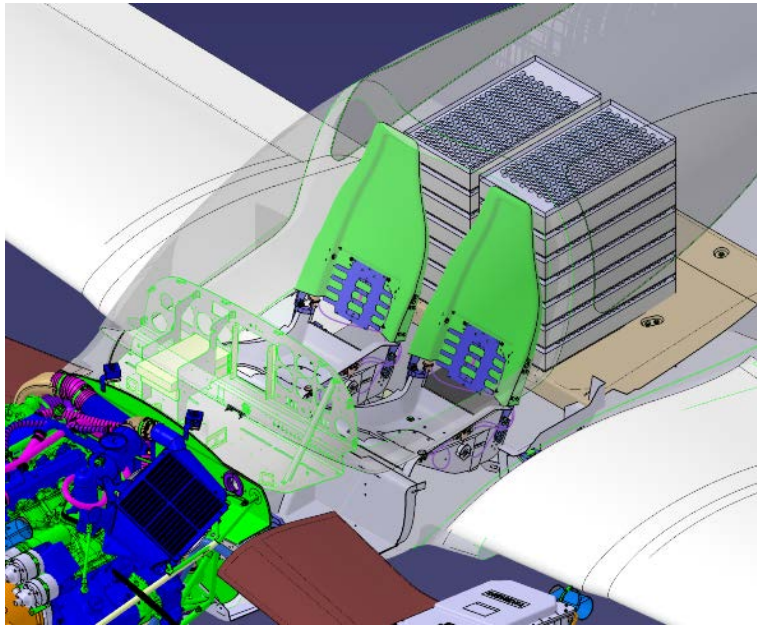


Component integration

Battery System

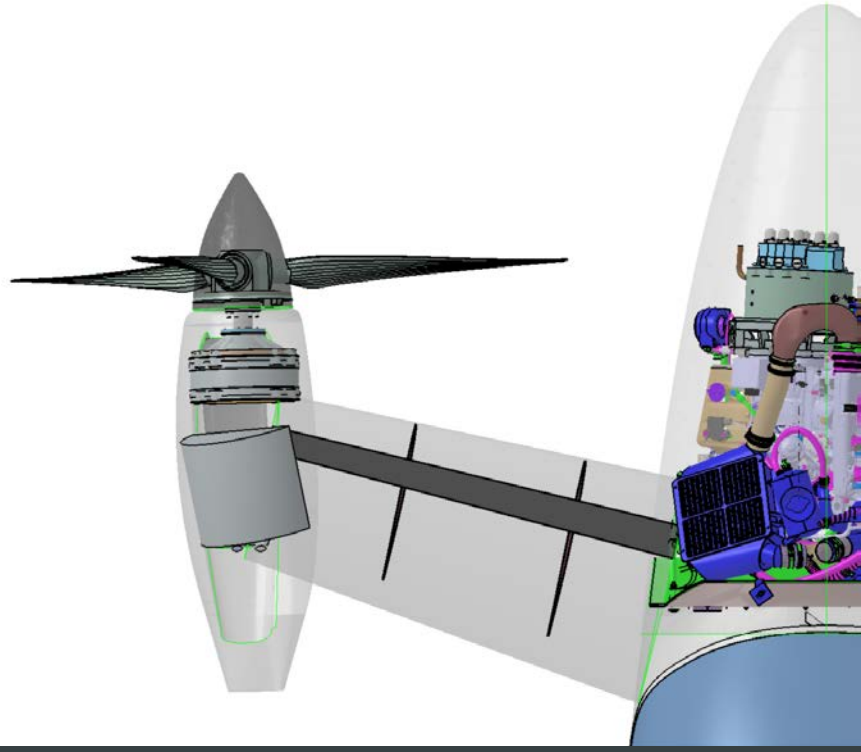
- Battery System located behind pilot seats
  - Current dimensions: 700 x 700 x 700 (mm)
  - Mass: ~220 kg
  - Capacity: ~28 kWh
  - Voltage: ~740 V

- Access through passenger door
- Temperature conditioning via passenger foot heating air
- Outgas of containment air/fumes through hole in aft fuselage (equivalent to A/C outlet)

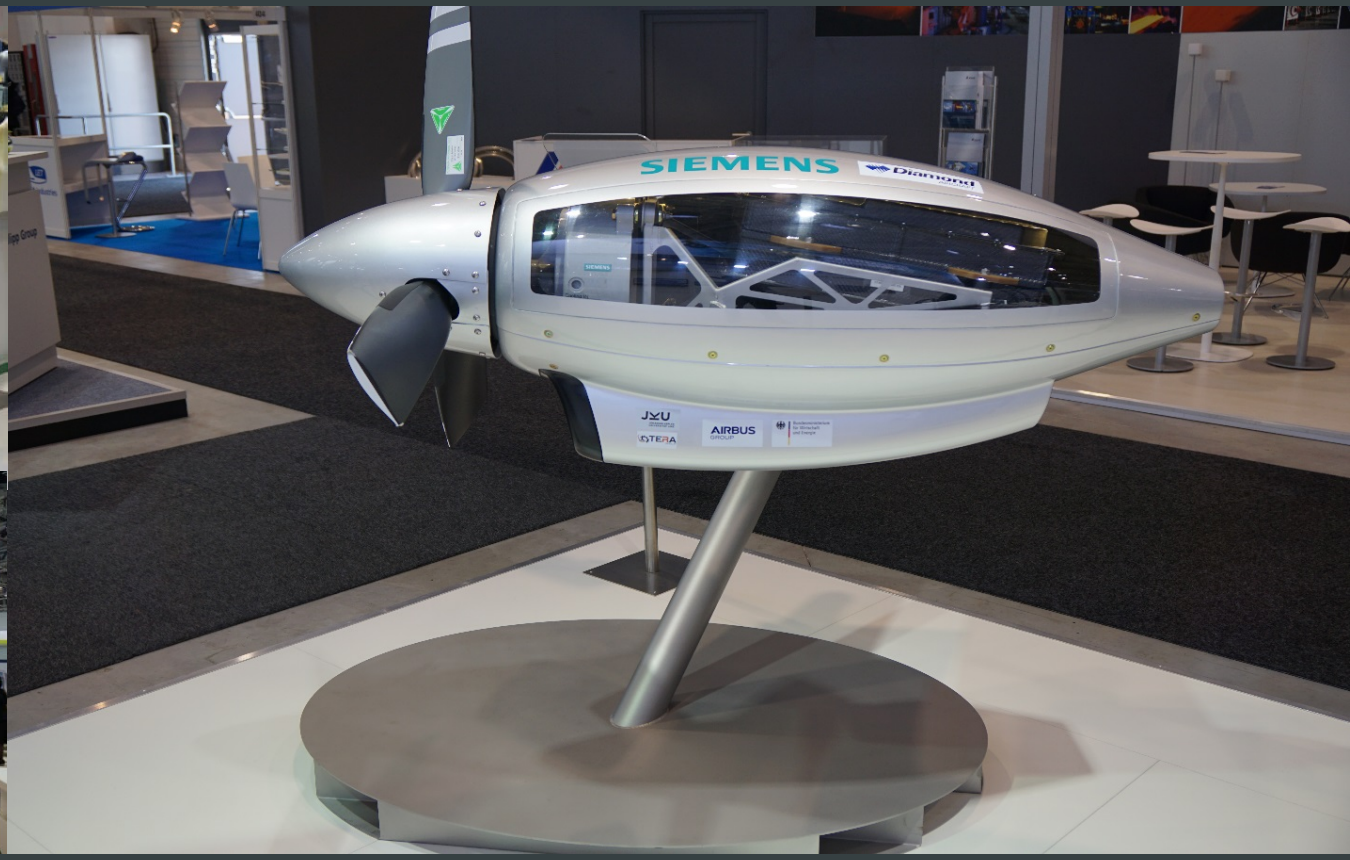


Structure concept

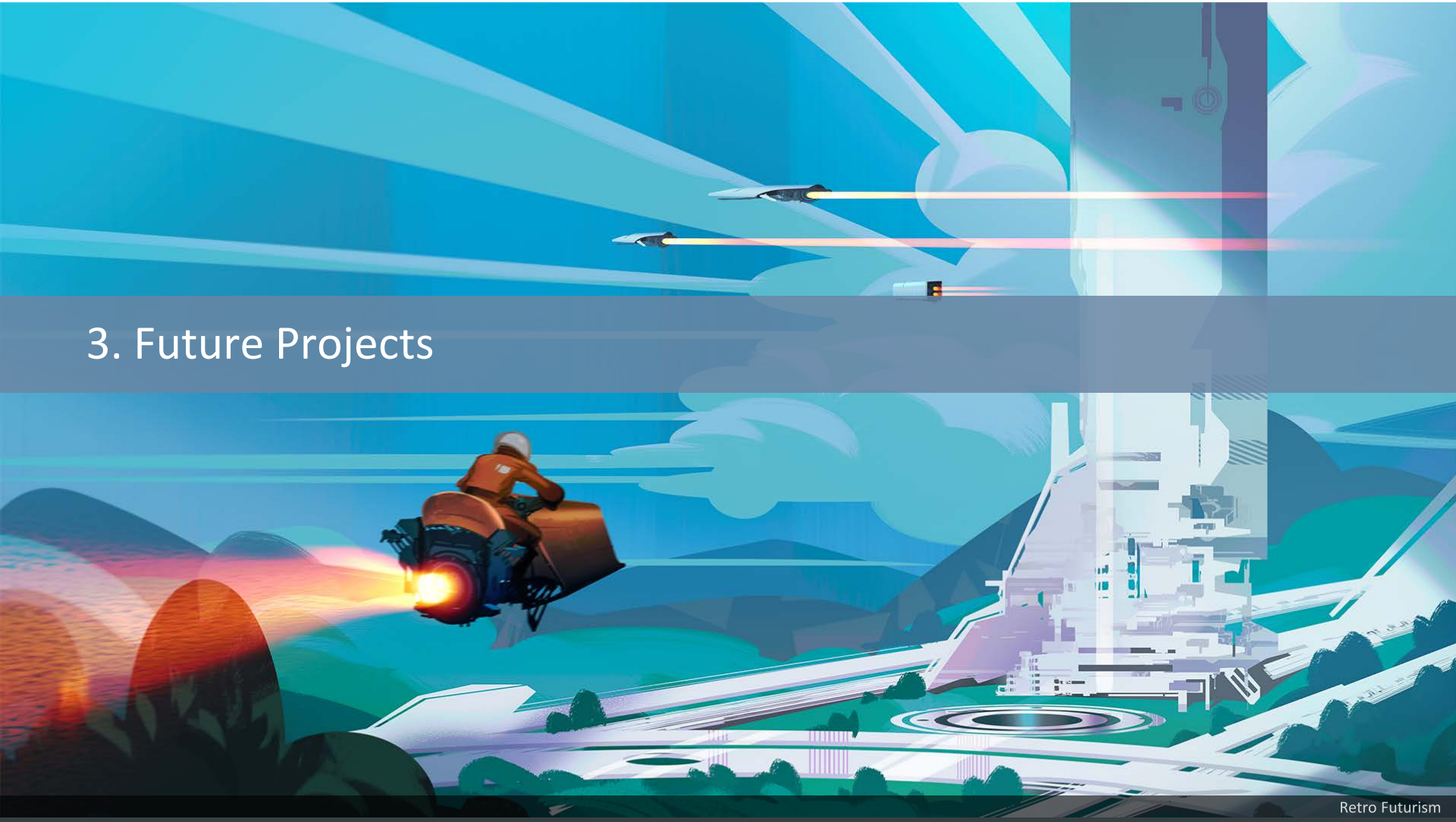
- Modified Engine Mount to support Engine/Generator Unit and cooling
- Canard wing produces lift to outbalance the weight of the Motor Unit
- Canard wing structure connected to Engine Mount and Firewall



Mock-up Motor Unit ILA 2016



3. Future Projects



Retro Futurism

AMP
AMP
AXA AUSTRALIA

Thank you for your attention!

Martin Volck

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Division Development

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E-FAN

THE NEW WAY TO FLY

AIRBUS
GROUP

Low emissions for futur aircrafts

Fligth Path 2050

Europe's Vision for Aviation

Emissions in 2050 = 50% of 2005, with 5% traffic growth per year

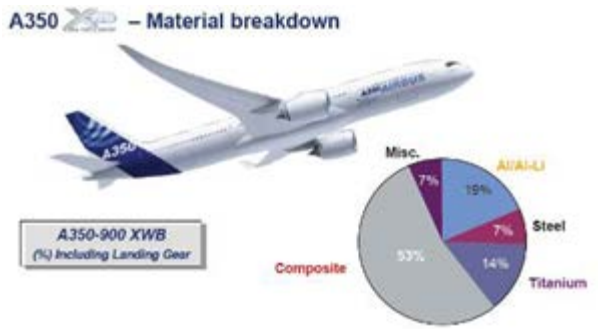
- 75 % CO2
- 90% NOx
- 65% Noise

Vs typical new aircraft in 2000

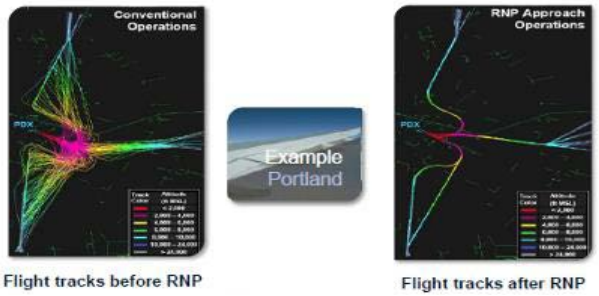
Voluntary commitment

Traditional solutions reach their limit

CO2 potential reduction:



Efficient airframe - 20 to - 25%



Air Trafic Management - 5 to - 10%

Efficient engine - 15 to - 20%

Alternative fuel CA. - 15%

⇒ Still missing between 10 and 25 %

Disruptive propulsion required

Enabler :

electrical power

Prerequisities :

High efficiency generators/energy storage

High voltage distribution network

High efficiency motors and power electronics

A Long Term road-map of electrical propulsion development

E-Fan
Fully Electrical
Training Aircraft

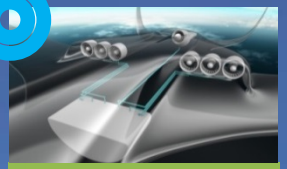
Fully Electrical
Experimental
Aircraft

Helicopter
Hybrid-
Propulsion

E-Star2
Hybrid-Propulsion

Big Transport
Aircraft

E-Thrust
Hybrid-Propulsion



Challenges:

Energy storage (> 350 Wh/Kg)

E-motors/Power electronics (> 15kW/kg)

Control, thermal mngt, ECM

New configuration

Certification

Road-map first step:E-FAN Family concept

CriCri

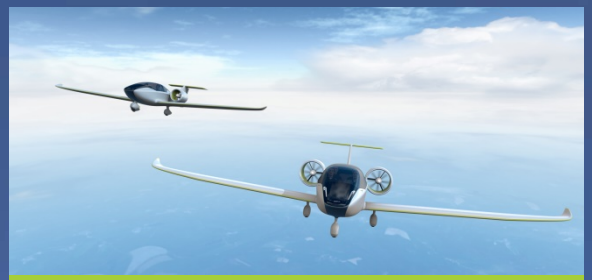
Master
Technologies,
Architecture
& Components

2009

F-Fan 1.0

Learn
E-A/C Design
Principles

2012



E-Fan 2.0 / E-Fan 4.0

Design to market

Further evolutions thru

Family concept

2014

AIRBUS GROUP

The Electrical Cricri

CRICRI technical data:

Wing span	4,9 m
Length	3,9 m
MTOW	185 kg
Empty weight	78 kg
Battery weight	26 kg
Maximal power	4 x 5,5 kW
Stall speed	75 km/h
Maximal speed	260 km/h

July 27, 2010, first flight of the world's first fully-electric four-engine aerobatic aircraft. Until 2012 july 20, 85 tests and demonstration flights

E-Fan 1

E-Fan 1 technical data:

Wing span	9,44 m
Wing area	10,7 m²
Lenght	6,67 m
Height	2,50 m
Empty weight	510kg
Maximum takeoff weight	600 kg
Maximum takeoff power	62 kW
Total battery weight	167 kg

E-Fan 2.0

E-Fan 2.0 Preliminary Specification:

Maximum takeoff weight	Under 600 kg (CS-LSA certification)
Endurance	1 hour, plus a 30 minute reserve
Availability	5 flying hours per day (300h/year)
Wingspan	11 m
Length	5.6 m
Height	1.98 m
Maximum takeoff power	2 x 22kW
Evolutivity	Compatible with the next battery generation

First certified all-electrical aircraft

Target: Develop and certify an attractive Product

- Full system two-seater
- All electric certified aircraft designed for the initial training role
- Environment friendly

Target: Achieve business objectives

- Competitive hourly rate (TCO -20%)
- Develop efficient ground support tools
- Deliver the expected training services

Target: Develop an Industrial set-up

- Develop a supply chain & FAL
- Dedicated company and team

Target: Prepare the future of Airbus

- Development of key competencies
- Buid-up experience on electrical propulsion integration
- Patents on key technologies

Introduction

- New techologies in GA:
  - Solar panels
  - Electric motors (hybrid and full)
  - Fuel cell technology
  - On-demand Mobility (ODM)
  - Aerodynamics (new propulsion)

What we already have

- **Certified Glider**
  - **Lange E1 Antares, 14-Jul-2006**
  - **Lange EA 42 (electric motor), CS-22, Subpart H**

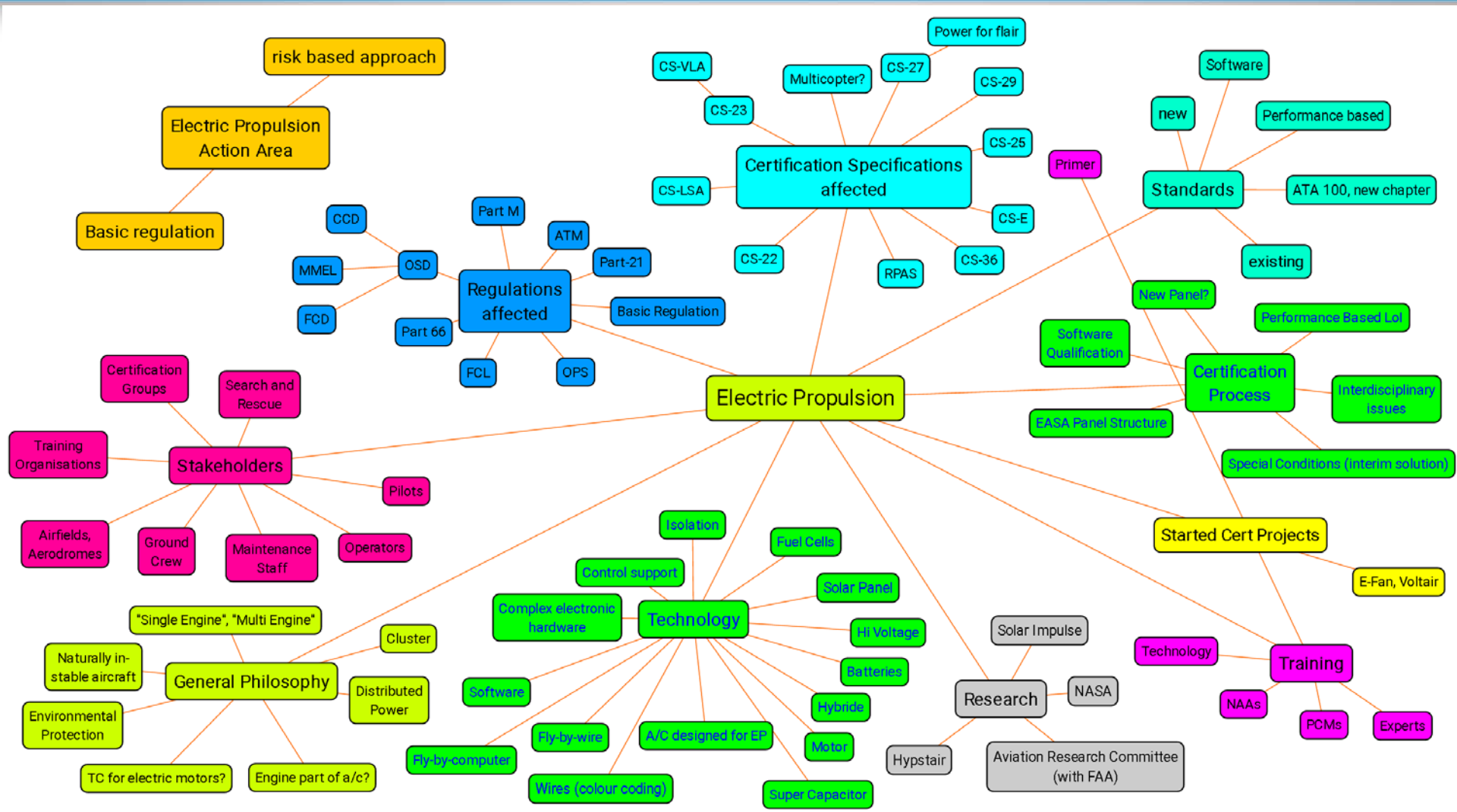
  - **Sportine Aviacija LAK-17B FES, 31-Oct-2014**
  - **FES-LAK-100M (part of the aircraft)**

Arrived and on the radar

- **Airbus (Voltair) E-FAN 2.0**
  - CS-LSA, 2-Seater, applied early 2015

- **On the radar**
  - Hybrid Aeroplanes
  - Other Electric Aircraft
  - ODM
  - …

Electric Propulsion -- Impact on Aviation



Flexibility in Certification

EU aviation safety regulations

Basic Regulation

(EC) No 216/2008

Replacing
(EC) No 1592/2002

EU Parliament
EU Council

Replaced by
(EC) No 748/2012

Implementing rules

Regulation No 1702/2003

For the airworthiness and environmental certification of aircraft and related products, parts and appliances, as well as for the certification of design and production organisations.

Implementing rules

Regulation No 2042/2003

On the continuing airworthiness of aircraft and aeronautical products, parts and appliances, and on the approval of organisations and personnel involved in these tasks.

EU Commission

Part 21

- Acceptable means of compliance (AMC)
- Guidance material (GM)

Certification specifications

- Airworthiness codes

Acceptable means of compliance (AMC) Guidance Material (GM)

- Part M – Continuing Airworthiness
- Part-145 – Maintenance Organisations Approvals
- Part-66 – Certifying staff
- Part-147 – Training organisations requirements

EASA

Binding

Non-Binding

Flexibility in Certification

Tools we have today:

- Special Conditions (e.g. Electric engines and installation in powered sailplanes)
- Restricted Type Certification

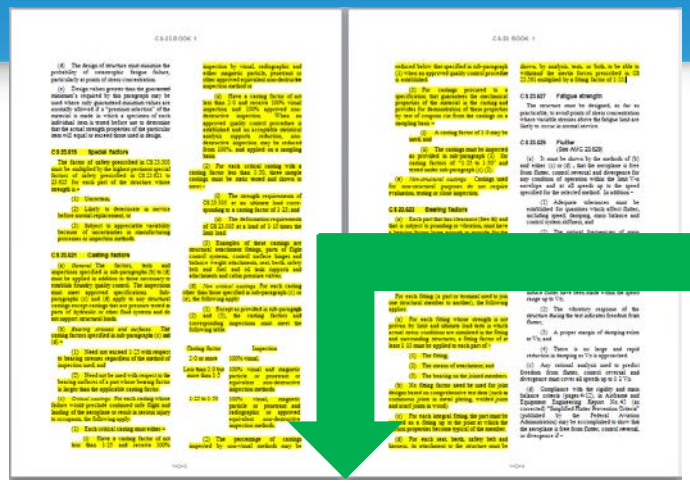
Option outside EASA:

- Annex II (Microlight, Experimental, Research)

The new approach: Performance based CS-23

1. **Part 23/CS-23 rule**
   - Safety objectives, not design specific
   - Future design solutions are already covered
   - Easier to harmonize & less need for amendments
2. **Airworthiness Design Standards (ADS)**
   - Technical details covered by standards developed via a consensus process
   - Easier to develop revisions or new standards
3. **AMC List of accepted ADS in CS-23**
   - Acceptance of Standards remains EASA RMP
   - Revision of the accepted ADS list can follow a shortened rulemaking process

CS-23 (& CS-VLA) New Concept



Consensus Standard
(ASTMF44)
(All design details)

23.619 Special Factors of Safety (v4)

(a) Special factors of safety must be established and applied in the design for each part of the structure whose critical design value is:

(1) Uncertain;

(2) Likely to deteriorate in service before normal replacement; or

(3) Subject to appreciable variability because of uncertainties in manufacturing processes or inspection methods.

(b) Special factors of safety must be determined using quality controls and specifications, suitable to the risk exposure, accounting for (as applicable) —

(1) Inspection methods;

(2) Structural test requirements;

(3) Sampling percentages; and

(4) Process and material controls.

(c) The factor of safety in 23.301(a) of this part must be multiplied by the highest pertinent special factors of safety.

The new approach: Part 21 Proportionality

Objective:

- Introduce flexibility and simplification in Part-21 certification for GA that is proportionate to the risks profile and meets an acceptable initial airworthiness safety level

Scope:

- Small organisations building simple products (Gliders, LSA, small CS23…)
- Doing design, production, maintenance and perhaps even training activities

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Questions?

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