MAHEPA – EASA Webinar

03 July 2020
Aim of the webinar / panel discussion

- Inform about the MAHEPA project and its research results
- Inform about EASA's role in research and innovation in general and for the MAHEPA project in particular
- Facilitate a dialogue between webinar participants and the panellists
Some recommendations

→ Use your headset and keep your microphone muted when not speaking

→ If you would like to participate in the discussion:
  
  → Use the ‘raising hand’ button on the right top corner next to your name, or
  
  → Use the ‘chat tool’ and draft a comment or question to ‘everyone’
Panellists

Fabrizio Gaspari
Lorenzo Trainelli
Tine Tomazic

Alain Leroy
Gernot Kessler

Moderator: Willy Sigl
At the verge of a new era for aviation

Hybrid-electric propulsion
MAHEPA
Towards hybrid-electric flying

- **MAHEPA**: Modular Approach to Hybrid-Electric Propulsion Architecture

- 9 M€ project entirely funded by European Union Horizon 2020 research and innovation programme

- 8 Partners:
MAHEPA
Objectives of the project

Main objectives:

- To **advance** two variants of a low emission, highly efficient, **serial** hybrid-electric propulsion architecture to **TRL 6**

- **In-flight** demonstrations on **two different aircraft** to showcase flexibility and scalability of the powertrains

- Scalability studies towards **megawatt scale** hydrocarbon driven hybrids and zero-emission hydrogen-powered solutions
MAHEPA Project direct value propositions

Methods

- Modular Approach
- Cooling system design
- Flex FC hybrid architecture
- Emission measurements
- Market Demands Estimations
- Ground infrastructure assessments
MAHEPA Project direct value propositions

Components

- Electric Drive
- Power Generation Module
- Fuel Cell System
- Structure adaptations
- Liquid cooled battery
- Battery Management System
MAHEPA – Electric motor
Light and powerful

- **Dual motor** mechanically and electrically decoupled

- Free wheel to run only one motor in case of **failure**

- Peak power: **300 kW** (50% more **powerful** than previous generations)

- Weight (excl. gearbox and prop shaft): **30 kg** (25% **lighter** than previous generations)
MAHEPA – Power controller
As light as possible

- **Silicon-Carbide** technology
- Peak power: **180 kW**
- Power density: **25.7 kW/kg**
- Efficiency: **97.5 %**
- Weight: **7 kg** (each) (**29% lighter** than previous generation)
MAHEPA – Liquid cooled battery

- **Lithium-ion** technology
- Peak power: **75 kW** (each)
- Weight: **60 kg** (each)
- Fully **integrated** in the airframe
- Allowing **all-electric** take-off
MAHEPA – Fuel Cell System
An intrinsic redundant system

From a FC Module to FC-line

12kW FC-Module

FC-line: 4 modules

FC-power: 48 kW
MAHEPA – Fuel Cell hybrid-electric airframe

Airframe adaptations

- New structural **challenges** to integrate the fuel cell system
- **Ground tests** to thoroughly understand system behaviour
- **New** Cooling System design
MAHEPA – Next steps
Flight tests and consolidation of results

• **Flight test** campaigns of two HE aircraft

• Advanced **power management** methods validation

• Flight data analysis and **consolidation** of results

• **Scalability studies**: design freeze of DEP and classic architectures
MAHEPA – not only about flying aircraft

Scalability studies

Definition of **parametric models for the powertrain components** and system performance.

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\begin{align*}
\eta_{nom\ i} &= P_{nom}, Arch, ... \\
W_{nom\ i} &= P_{nom}, Arch, ...
\end{align*}
\]

A/C design with “concentrated” HEPS.
POLIMI tool: **HYPERION**

A/C design with “distributed” HEPS.
TUD tool: **INITIATOR**

Advanced power management concept to reduce energy consumption during the mission.
MAHEPA – not only about flying aircraft

19-seat microfeeder: a real business case for today’s hybrid-electric technology
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 723368.
Innovation and related activities

Alain LEROY - 03 July 2020

Your safety is our mission.

An Agency of the European Union
Innovation and related Activities

03 July 2020 – Alain LEROY

Your safety is our mission.

EASA is an agency of the European Union
Innovation & related activities

OBJECTIVES

Manage & coordinate changes necessary to adapt the Agency activities and processes to innovation.

Create a dynamic of innovation in the Agency and foster the sharing of innovation knowledge and information across domains.

Support the Industry on innovation through partnerships.

We need to be prepared for the FUTURE.
Establish a formal framework enabling....

- Cooperation in the early stages
- Identification of key risk areas linked to innovation projects
- Evaluate possible EASA support
- Adapt our processes, organisation, procedures, rules and staff competence plans to support innovative industry projects.

Possible related tasks & actions:
- Specific Innovation Partnership Contracts
- Workshops
- Research cooperation (PhD thesis, ...)
- Universities networking
- Exchanges of experts (limited period)
- Training
Innovation Partnership Contracts

Cover the supply of technical knowledge and support within an innovation project to encourage the development of:

- novel technologies
- new business models
- new services

Focus on the exchange of expertise on a multi-disciplinary scale (certification, operation, crew qualification, ATM, etc...)

Address the concept development phase (feasibility)

⚠️ do not cover any pre-certification task (this is done via Technical Advice Contracts)
General concept of operations

MAHEPA consortium - 03 July 2020
Hybrid-electric short-haul air transportation scenarios

Lorenzo Trainelli, PhD
In the **MAHEPA** H2020 project, an important research effort is devoted to:
- Hybrid-electric powertrain technology and component *scalability*
- Hybrid-electric aircraft *design, performance and environmental impact analysis* methods
- Strategies for maximizing the impact of hybrid-electric aircraft in future commercial aviation

In the **UNIFIER19** Clean Sky project, a **near-zero emission** 19-pax *commuter* is conceptually designed
- Scenario studies are carried out to derive top-level aircraft requirements
Hybrid-electric short-haul air transport

Future European mobility

- Short-haul air transportation is a key for the enhancement of personal mobility in Europe

- **Flightpath 2050 vision**
  - **Four-hours door-to-door goal**: virtually all EU citizens shall reach any continental destination in less than four hours, door to door, by the year 2050

- Hybrid-electric aircraft are **ideal candidates** to contribute to this ambitious goal
  - Environmentally-sustainable operations
  - Technology maturity
    - Hybrid-electric propulsion shall enter the market starting with lower-weight aircraft categories
    - Scalability to commuter aircraft is **feasible**
Hybrid-electric short-haul air transport

General concept

- Scenario studies specifically address the **short-haul regional** air transportation system
  - **Miniliner market** (point-to-point)
    A miniliner provides a commuting service connecting small towns, substituting less-effective ground transportation means
  - **Microfeeder market** (hub-and-spoke)
    A microfeeder service brings passengers from small towns and open-country to hubs, feeding medium-range and long-range flights
- Exploiting the European **smaller airports** and even airstrips is a crucial enabler
Hybrid-electric short-haul air transport
European aerodromes

Type of Surface

Concrete: 37%
Asphalt: 6%
Grass: 7%
Gravel: 1%
Soil: 0%
Sand: 1%
Unknown: 1%

Map showing distribution of airports by surface type across Europe.
Hybrid-electric short-haul air transport

European aerodromes

Runway length distribution
- 50% of the aerodromes feature a length over 800 m

Aerodrome mutual distance
- 88% of the aerodromes have another one closer than 100 km
Hybrid-electric short-haul air transport
Potential demand estimation

- Potential demand is assessed based on the advantage of using a miniliner/microfeeder service when compared to ground transportation means
  - Multiple elements may contribute: cost, comfort, time
  - The time advantage is crucial

Miniliner case
SA: secondary aerodrome
Hybrid-electric short-haul air transport

Potential demand estimation

- Based on the time (possibly other parameters) advantage, a **catchment area** can be attributed to each candidate route
- The potential traveller demand can be estimated

**Microfeeder case**

Catchment area for the Lamezia Terme - Naples International Airport route
Hybrid-electric short-haul air transport
Miniliner scenario studies

MAHEPA-EASA Webinar
03/07/2020

Italian scenario example
• Trip distance 200 km
• Cruising speed 200 KTAS
• Runway length 800 m or longer

Potential demand estimation
Hybrid-electric short-haul air transport
Microfeeder scenario studies

Venice International Airport example: distribution of towns and secondary aerodromes involved

- Case of 800 m or longer runways and a cruising speed of 200 KTAS

Maximum trip distance: 150 km
Maximum trip distance: 200 km
Maximum trip distance: 250 km
Hybrid-electric short-haul air transport

Optimal transportation network

- Potential demand assessment allows to derive effective top-level **aircraft design requirements**
  - These drive the **conceptual design** of innovative, near-zero emission commuter aircraft
- It also provides the input for a **location and routing algorithm** that defines the **optimal route network**
  - Maximizes the total demand satisfied while minimizing the number of active secondary airports
  - Provides the complete time-scheduling of flights operated with the miniliner/microfeeder

**Multi-hub microfeeder case**

Optimal network between 8-9 a.m., using a fleet of 80 aircraft
Thank you for your attention!
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 723368.

Check out www.mahepa.eu

Check out www.unifier19.eu

MODULAR APPROACH TO HYBRID-ELECTRIC PROPULSION ARCHITECTURE
Innovation integration into the regulatory framework

Gernot KESSLER - 03 July 2020

Your safety is our mission.

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Regulatory Concept: How to best accommodate New Technologies

The rules we need will be:

→ Timely available
→ Clear and robust
→ Easy to adjust
→ Outlooking
→ Technologically neutral
→ Enforcable

The art of regulation is to combine these aspects!
Regulatory Concept:
How to best accommodate New Technologies

To master challenges:
→ Find proper balance
→ Do NOT ‘All New’
→ Subsidiarity
  → What for EU?
  → What for local bodies?
  → Formal borders?
→ Mind recognition: ICAO, FAA, ...
→ Involve upfront:
  → Closest involvement by all
  → Research
  → EASA TACs, IPCs, ...

HARD law vs. SOFT law
All New vs. Patches
Harmonisation vs. Local Solutions

Clear and robust
Easy to adjust
Outlooking
Technologically neutral
Enforcable