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Organizational activities in preparation of LCA and LCC estimation in the framework of HERA Project

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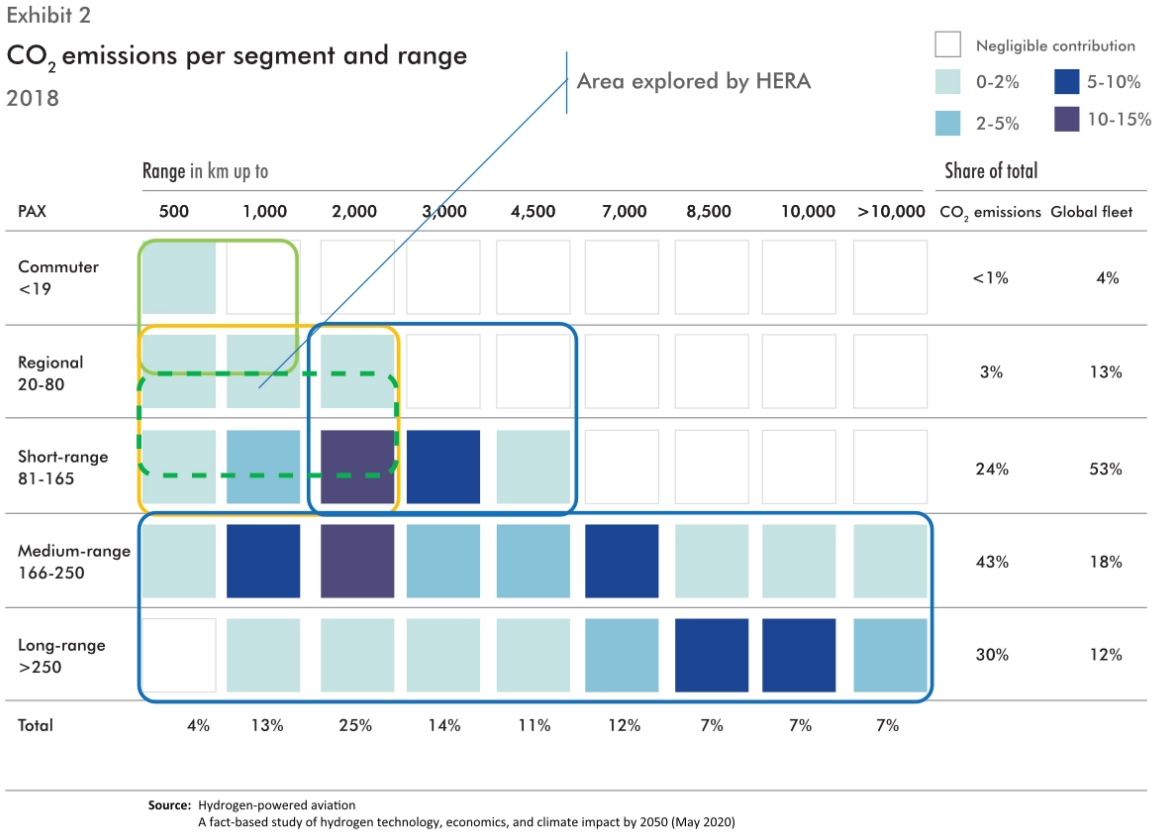
HERA project objectives

HERA Hybrid Electric Regional Architecture

Design a more efficient aircraft for regional / short range transportation

- 50 – 100 passengers
- 500 – 2000 km range
- Reduction by 90% of GHG
- Entry in service 2035
- Reach TRL6 (technology demonstration) during the Phase 2



Source
Hydrogen-powered aviation
A fact-based study of hydrogen technology, economics, and climate impact by 2050 (May 2020)

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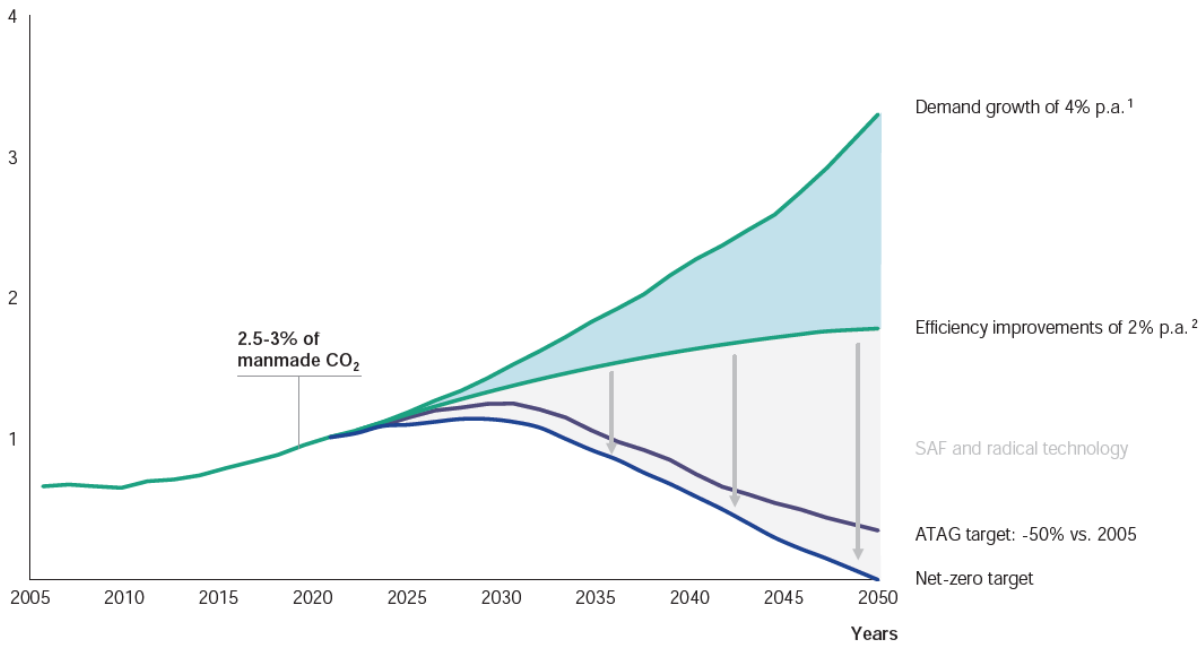
HERA project objectives

Exhibit 1

Projection of CO_2 emissions from aviation

Gt CO_2 emissions from aviation
Does not include compensation schemes



1. Assumption based on growth projections from ATAG, IATA, ICCT, WWF, UN
2. ICAO ambition incl. efficiency improvements in aircraft technology, operations and infrastructure

Source
Hydrogen-powered aviation
A fact-based study of hydrogen technology, economics, and climate impact by 2050 (May 2020)

By 2035:

- 50% reduction of fuel burnt by using new aircraft technologies
  - Hybrid electric propulsion
  - Systems electrification
  - More efficient aerodynamic
  - Others
- 90% reduction of GHG emissions including the use of new fuel
  - SAF
  - Hydrogen

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HERA project organization

WP8 Configuration results and analysis

- Main objective:

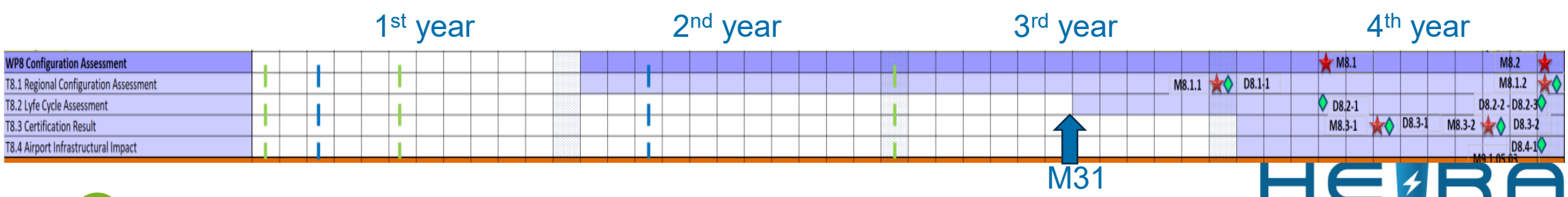
Elaborate final HERA results about aircraft, life cycle assessment, life cycle cost, certification and standards, infrastructures managing and integrating all data coming from HERA and linked projects.

- **T8.1 Regional configuration assessment**: assess the impact of new technologies in HERA aircraft compared to standard configuration
- **T8.2 Life Cycle Assessment**: estimate environmental impact and cost of each phase of HERA aircraft life cycle
- **T8.3 Certification results**: assessment of new technologies and their integration in terms of safety and their acceptability for certification and identification of the means of compliance
- **T8.4 Airport infrastructural impact**: assessment of the impacts of HERA aircraft on airport infrastructure (e.g. use of LH2, batteries recharge etc.)

Task 8.2 scope

- Deliver a life cycle assessment on new aircraft with a dedicated methodology that includes new cost items such as:
  - SAF and hydrogen,
  - logistics of new energy sources,
  - future technologies production and maintenance (high power fuel cells, batteries, electronics, LH2 fuel systems, TMS etc.)
  - new operative use of the aircraft.
- Main results: GHG emissions and other environmental impact categories.

- T8.2 has the aim to connect LCA (lifecycle assessment) with LCC (lifecycle cost) and to provide a first cost estimation of the designed aircraft.



Task 8.2 Expected results

- LCC and LCA of the reference regional aircraft

- LCA of novel configurations

- LCC of novel configurations

HERA Aircraft

USC A and B configuration for trade-off will have different propulsive configurations but the same:

- Fuselage and tail-planes
- System architectures
- Total installed propulsive power with different propulsion distribution

New aircraft technologies

- Electric motor for propulsion
- High power electronics
- High power batteries
- Fuel cells
- Hydrogen fuel system
- Thermal Management
- High voltage and high power electric system
- Electrified ECS, IPS, FCS and Landing gear

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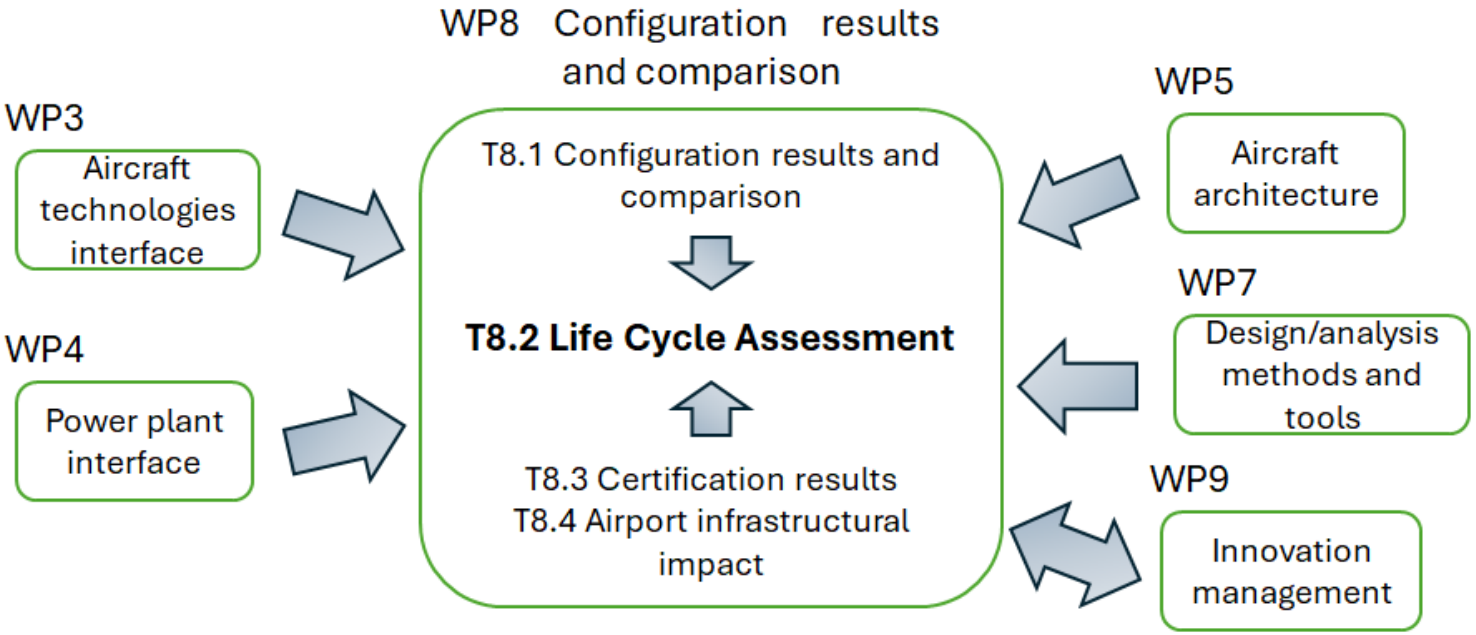
T8.2 Preliminary activities

- **WPs/Tasks connection**

Connection with HERA linked projects:
- HERWINGT
- HECATE
- HERFUSE
- NEWBORN
- ……



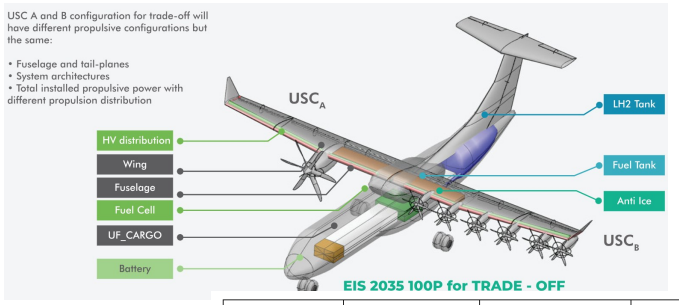
Information from other HERA WPs:
- aircraft design
- aircraft performance
- eco-design
- ……

Ensure consistency with linked projects and within HERA

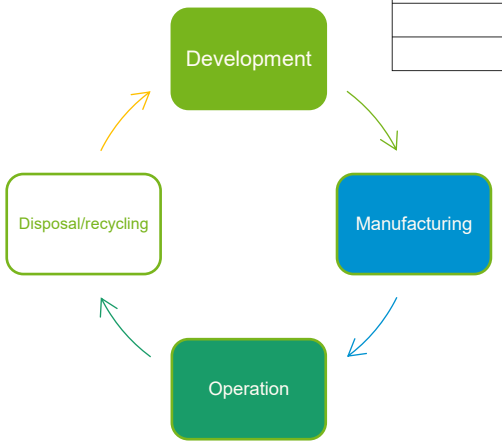
T8.2 Preliminary activities

- **Data collection**

  - General arrangement/Technical description of each aircraft
  - Aircraft Product Breakdown Structure (PBS)
  - Masses, performance and technologies at aircraft and component level
  - Material and production process at aircraft and component level
  - Information regarding program, operation and end-of-life
  - Economic environment



Aircraft level	Sub-system level	Component level	Part level
	airframe	Wing	- Skin panel n.1 - Skin panel n.2 - Spar - .....
		fuselage	
		Horizontal tail	
		Vertical tail	
	Landing gear	strut	
		Wheels	
		brakes	
	.....	...	



T8.2 Preliminary activities

- **Definition of the needed activities**

	What we have		*What is needed*
LCC estimation →	Parametric model developed within Clean Sky 2 already available	→	Adaptation/calibration for new technologies
LCA estimation →	Parametric model developed as preparatory activity • Sensible to mass/power/technologies • Based on EcoInvent database	→	Parametric model enhancement for new components / technologies • Working groups • Localized detailed LCA

Models Requirements

- Capable to assess different aircraft
- Capable to assess new technologies
- Quick response for trade-off analysis

T8.2 Preliminary activities

- **Simplified LCA model**

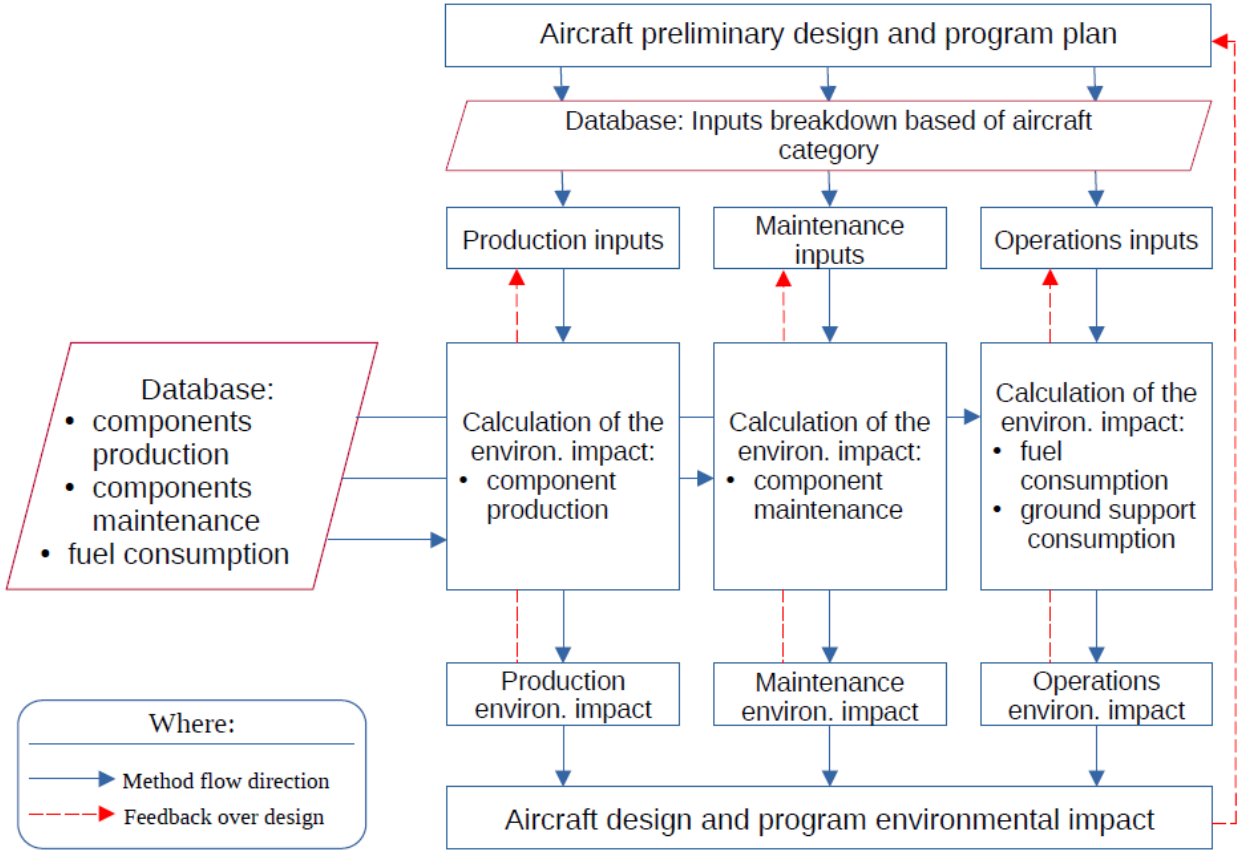
Cradle-to-cradle

Parametric equations

EcoInvent database

Sensible to mass, technologies

Calibrated with known aircraft



Vivalda, P., & Fioriti, M. (2024). Stream Life Cycle Assessment Model for Aircraft Preliminary Design. *Aerospace*, *11*(2), 113. https://www.mdpi.com/2226-4310/11/2/113/pdf

T8.2 Preliminary activities

- **Working groups**

Batteries (aircraft use)
- Production process
- Maintenance / replacement

Fuel cells (aircraft use)
- Maintenance / replacement

Hydrogen tank (aircraft use)
- Check / replacement

Electric motors and power electronics (aircraft use)
- Production process
- Materials

LCA
Bottom-up approach
(using commercial software and/or databases)

Parametric models based on:
- main performance driver
- different technologies/materials
- Different manufacturing process

Parametric LCA model enhancement

T8.2 Preliminary activities

- **LCA from linked project**

High level results for aircraft main components/subsystems:

- **Wing**
- **Fuselage**
- **Electric Power Generation and Distribution System**
- **Fuel cells**
- **Hydrogen tanks**
- **etc**

New data base point for parametric model development

- Data normalization
- Comparison with HERA main components/subsystems

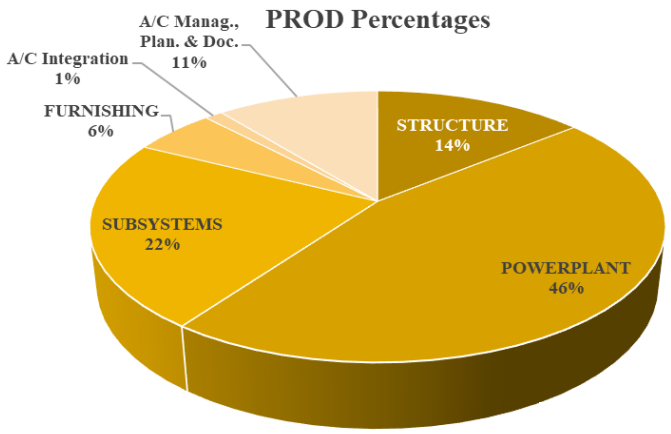
Parametric models based on:

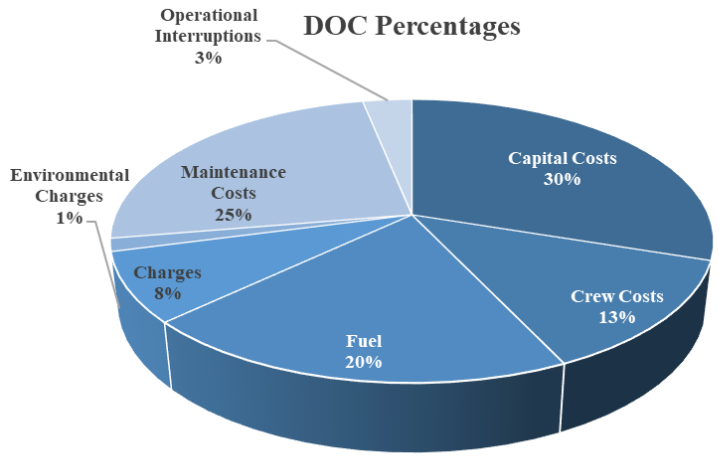
- main performance driver
- different technologies/materials
- Different manufacturing process

Parametric LCA model enhancement

T8.2 Preliminary activities

- **Preliminary results to drive the activities - LCC**





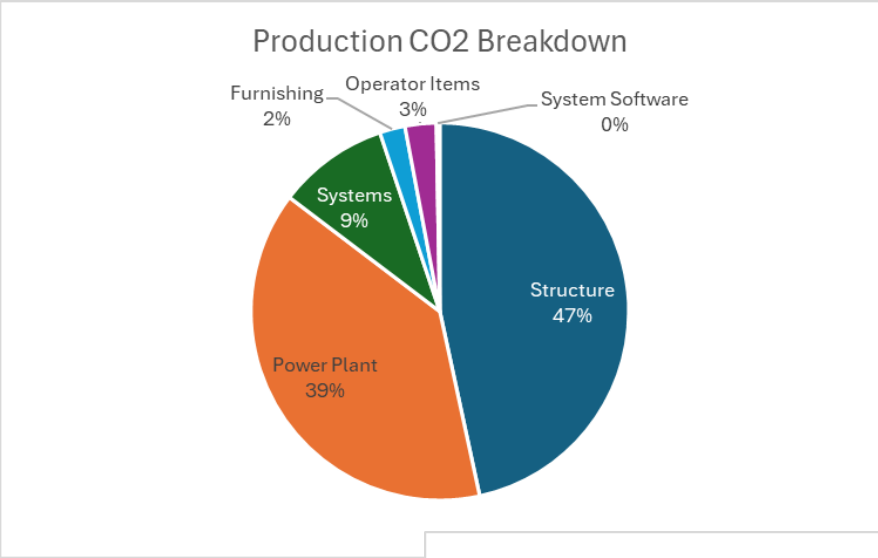
- Greater LCC cost compared to traditional aircraft in all phases
- High development and production cost due to new technologies
- Power plant cost increase (fuel cells, batteries, LH2 tank, TMS)

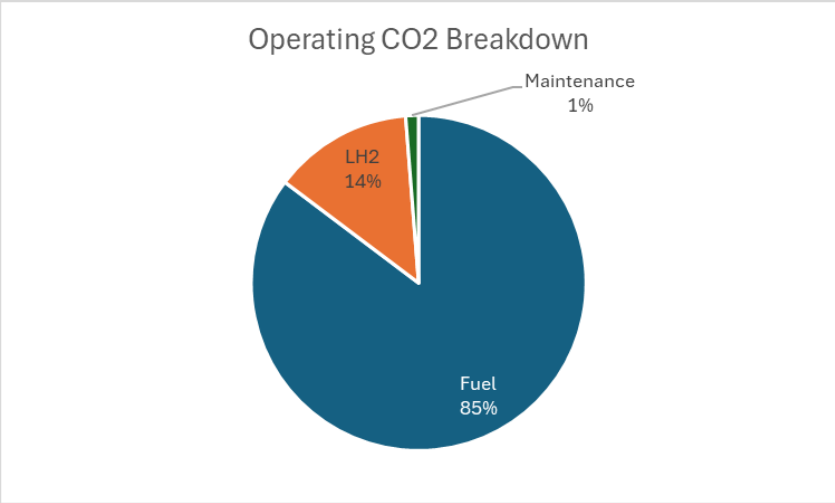
The operating cost is 20-40% higher due to:

- Small reduction in fuel cost
- Higher maintenance and capital cost

T8.2 Preliminary activities

- **Preliminary results to drive the activities - LCA**





- Structure and power plant are the two main items for manufacturing
- The GHG emission is mainly driven by operating phase if no SAF is used
- All technologies able to reduce operating impact (fuel consumption) should be used
- Pay attention on the increase of maintenance effort due to new technologies

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Conclusions

- After a preliminary organizational analysis, the main steps are:
  - Clear definition of the **input needed** (shared with all partners)
  - Use of **simplified approach** to help trade-off analysis and face LCC and LCA estimation of multiple aircraft
  - Formation of dedicated **working teams** to cover new technologies
  - Use of data from **linked project** to ensure consistency and save time
  - Provide **preliminary estimation** to drive the technologies selection
    - Importance of the operating phase of the aircraft for both LCC/LCA

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Acknowledgments

The project is supported by the Clean Aviation Joint Undertaking and its members.

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Funded by the European Union, under Grant Agreement No 101102007. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or Clean Aviation Joint Undertaking. Neither the European Union nor Clean Aviation JU can be held responsible for them.