The ECARE Taxonomy Tool

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This document presents the taxonomy which was developed within the ECARE project. In addition, the ECARE consortium has developed an Excel tool to identify and define the ECARE taxonomy topics. The topics can be linked to competences of companies and research institutions. The taxonomy topics can also be utilized to identify prioritized topics by funding authorities. The Excel tool is available in the appendix of this document.

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Methodology of Developing the ECARE Taxonomy

In the aerospace sector, many taxonomies have been adopted in the past years trying to define a commonly understood, shared, and recognized nomenclature of structured technological topics. It is important to note that no taxonomy can fully satisfy the needs of the current aerospace sector, as these needs are constantly evolving due to a variety of factors. Therefore, the ECARE Taxonomy was created by evaluating existing taxonomies and integrating insights from all stakeholders.

The ECARE consortium worked on a taxonomy specifically aligned with aircraft types and key technologies under development by Clean Aviation.

The prioritized aircraft classes within this taxonomy are:

🎯 **Regional Aircraft:** These commercially operated aircraft are designed for short-haul flights, typically reaching up to 1,000 nautical miles.

🎯 **Short-Medium Range Commercial Aircraft:** These commercial aircraft cater to short to medium-haul flights, typically with a range of 1,000 to 3,000 nautical miles.

🎯 **Long Range Commercial Aircraft & Business Aviation:** This category encompasses commercial aircraft designed for long-haul flights exceeding 3,000 nautical miles, alongside business jets used for private, corporate travel and future very high-speed systems.

🎯**General Aviation Commuter & Rotorcraft:** This diverse category includes various aircraft used for general aviation purposes, such as commuting, air taxi services, and recreational flying. Additionally, it incorporates helicopters used for diverse applications including transportation, search and rescue, and law enforcement.

As a first task, the consortium evaluated the existing taxonomies in Europe, which are different in nature and were updated at varying times over the last years. The ACARE Taxonomy [1], European Space Agency (ESA) Taxonomy [2], European Defence Agency (EDA) Taxonomy [3], WAND Aerospace Engineering Taxonomy [4], NASA Technology Taxonomy [5], EASN Thematic Structure [6] and the Taxonomy of Disruptive Technologies [7] were considered in this process.

Following the study of those taxonomies, it was evident that only certain parts had to be taken into consideration. This was specifically the case for the ACARE and EDA taxonomies which involve aeronautical technologies applicable to the Clean Aviation SRIA. **The ECARE consortium identified an initial list of relevant topics [8] and subtopics [9] from the ACARE and EDA taxonomies.** To create a concise ECARE Taxonomy, some topics and subtopics of the older taxonomies were not included, while others were newly introduced for improved homogeneity.

The three partners of the ECARE consortium representing the three pilot countries (France, Germany and Italy) evaluated this list on the basis of their expertise, taking into consideration the Clean Aviation targets.

As a result, various topics were removed, while new ones were introduced, e.g. the electric, hybrid-electric and hydrogen propulsion systems, which were not initially present in the ACARE and EDA Taxonomy.

[1] NLR-CR-2002-688 (daccampania.com)
[2] ESA Technology Tree v4.0
[3] OSRA Defence Technology Taxonomy (europa.eu)
[4] https://www.wandinc.com/taxonomies/wand-aerospace-engineering-taxonomy)
[5] https://www.nasa.gov/offices/oct/taxonomy/index.html
[6] https://www.easn.net/?q=thematic_structure&area=1
[7] Taxonomy of Disruptive Technologies (nydalengroup.com)
[8] Topic: Technical domain
[9] Subtopic: Technological brick
[10] clean-aviation.eu/sites/default/files/2022-01/CAJU-GB-2021-12-16-SRIA_en.pdf

As the last step, the partners performed a cross-correlation of the final topics and subtopics with their regional Smart Specialisation Strategy for Research & Innovation (RIS3) and the Clean Aviation Strategic Research and Innovation Agenda [10] (CA SRIA). **Finally, the consortium validated the taxonomy by presenting it to 58 interviewees. These interviewees represented a range of stakeholders, including regional SMEs, intermediate-sized enterprises, large companies, RTOs, and researchers working on aeronautics (see ECARE Deliverable D3.1). Their field and technical expertise proved invaluable in refining the list.** This part of the process enabled the consortium to adjust the list and thus finalize the definition of the main topics of the ECARE taxonomy. **Figure 1** presents the process followed by the ECARE consortium to validate the taxonomy.

To conclude the process of ECARE taxonomy building, the consortium structured a two-level taxonomy with a total of **24 main topics with 214 subtopics**. The information about the selection of the topics and subtopics is available in **ECARE Deliverable D2.1**.

*Research and Innovation Smart Specialisation Strategy

Figure 1: ECARE Taxonomy Building Process

The Resulting ECARE Taxonomy

The final version of the ECARE Taxonomy is characterized by 24 topics presented in Table 1. These topics represent the top-level technical domains in aircraft construction, enabling a first breakdown of aircraft technologies. The full ECARE Taxonomy is attached in Appendix 1 of D2.1.

Table 1: ECARE Taxonomy Topics

ECARE TAXONOMY TOPICS
A. Flight physics - A1. Aerodynamics
A. Flight physics - A2. Thermal & Fluidynamics
B. Manufacturing Processes/Design Tools/Techniques
C. Materials Technology - C1. Electronics
C. Materials Technology - C2. Photonic/Optical
D. Device Technology
E. Design Technologies for Platforms
F. Aerostructures
G. Propulsion - G1. Endothermic Systems
G. Propulsion - G2. Propellant & Combustion
G. Propulsion - G3. Electric Systems
H. Avionics & On-board Systems - H1. General
H. Avionics & On-board Systems - H2. Communications
H. Avionics & On-board Systems - H3. Sensor systems
H. Avionics & On-board Systems - H4. Major subsystems
I. Flight Mechanics
J. Information and Signal Processing Technology
K. Intergrated Design & Validation
L. Integrated Systems Technology
M. Human Factors
N. Innovative concepts & scenarios
O. Operating Environment Technology
P. Simulators, Trainers and Synthetic Environments

The subtopics presented in Appendix 1 were defined by using and updating the definitions of the existing taxonomies. An example is presented in Figure 2 for the topic "A. Flight Physics - A2. Thermal & Fluid Dynamics" with the related subtopics and their definitions.
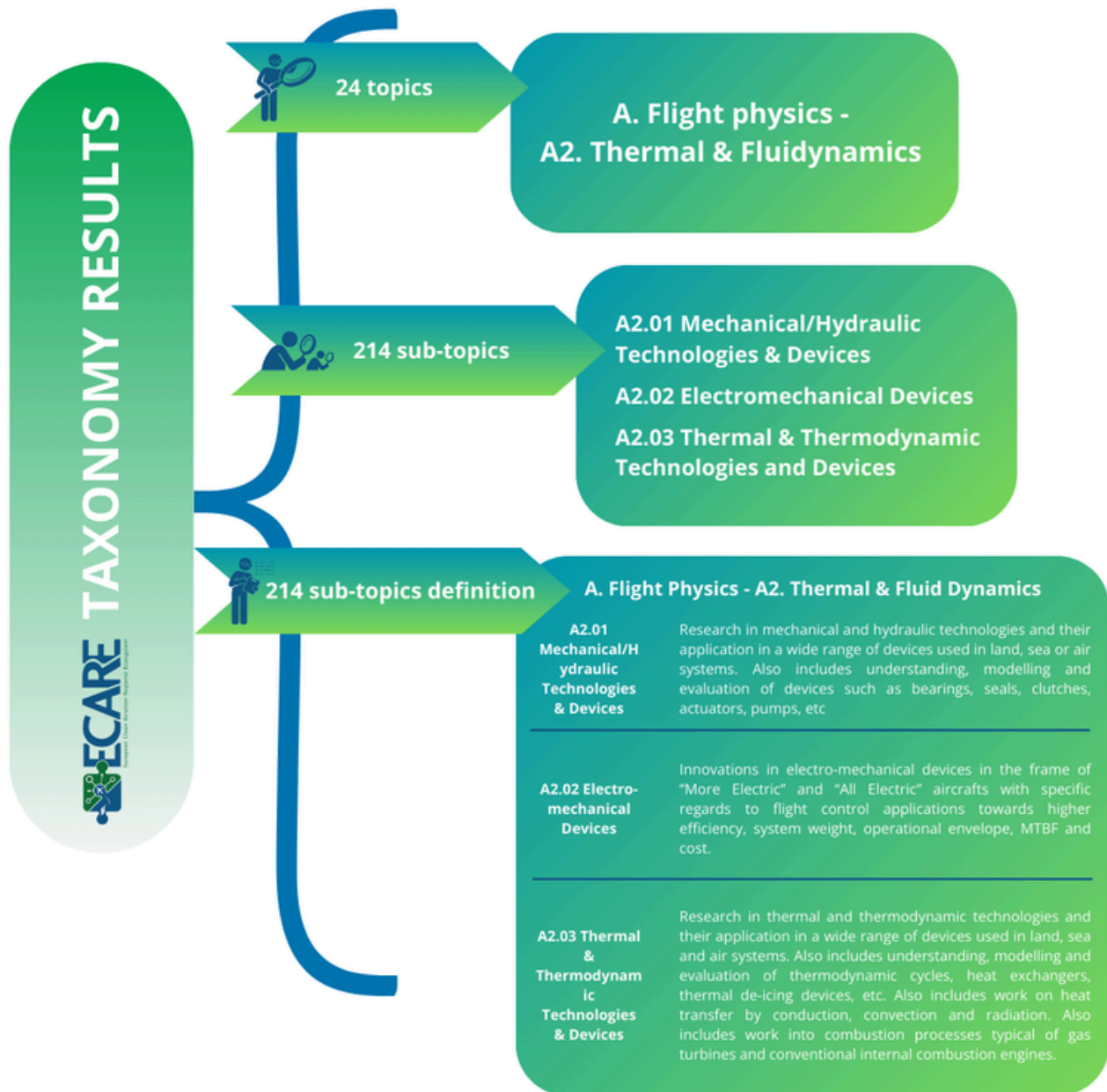

Figure 2: ECARE Taxonomy Results

Conclusion

The ECARE Taxonomy provides a common framework for understanding and discussing aeronautical technologies within the Clean Aviation framework. The following specifics contribute to the significance and usability of the ECARE Taxonomy:

- The taxonomy is based on extensive consultation and feedback from a wide range of stakeholders, ensuring relevance and applicability across diverse stakeholders.

- The taxonomy is divided into 24 main topics and 214 subtopics, providing a sufficient level of detail to cover a wide range of aeronautical technologies, with each subtopic having its own definition.

- **The ECARE taxonomy documentation and appendices are available in spreadsheet format HERE.**