1st Call for Proposals: List and description of topics

ANNEX to CAJU-GB-2022-03-16 Amended Work Programme and Budget 2022-2023

Revision History Table		
Version n°	Issue Date	Reason for change
P1	16/03/2022	Adopted by the Governing Board via decision on adoption of the Amended Work Programme and Budget 2022-2023.

Important notice on FAQ

Applicants are invited to submit their questions (technical and administrative) via the functional mailbox: CFP-2022-01@clean-aviation.eu

Questions will be analysed and, when appropriate, the Q&A will be published via the F&T Portal.

The FAQ session will open with the ***launch of the Call, foreseen on 23 March 2022****.*
Q&As are linked to the topics concerned. Applicants are therefore invited to check the topic documentation in the F&T Portal.

The closure date of the FAQ will be clearly stated on the F&T Portal.

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List of Topics for Calls for Proposals

Identification Code	Title	Type of Action	Ind. Value (Funding in M€)
Hydrogen-powered aircraft topics			
HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-01	Direct Combustion of Hydrogen in Aero-engines	IA	115
HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-02	Multi-MW Fuel Cell Propulsion System for Hydrogen-Powered Aircraft	IA	50
HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-03	Large Scale Lightweight Liquid Hydrogen Integral Storage Solutions	IA	10
HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-04	Near Term Disruptive Technologies for Hydrogen-Powered Aircraft	IA	7
Hybrid-electric powered regional aircraft topics			
HORIZON-JU-CLEAN-AVIATION-2022-01-HER-01	Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft	IA	75
HORIZON-JU-CLEAN-AVIATION-2022-01-HER-02	Thermal Management Solutions for Hybrid-Electric Regional Aircraft	IA	40
HORIZON-JU-CLEAN-AVIATION-2022-01-HER-03	Electrical Distribution Solutions for Hybrid-Electric Regional Aircraft	IA	40
HORIZON-JU-CLEAN-AVIATION-2022-01-HER-04	Innovative Wing Design for Hybrid-Electric Regional Aircraft	IA	20
Short/short-medium range aircraft topics			
HORIZON-JU-CLEAN-AVIATION-2022-01-SMR-01	Ultra Efficient Propulsion Systems for Short and Short-Medium Range Aircraft	IA	175
HORIZON-JU-CLEAN-AVIATION-2022-01-SMR-02	Ultra Performance Wing for Short and Short-medium Range Aircraft	IA	55
HORIZON-JU-CLEAN-AVIATION-2022-01-SMR-03	Advanced Low Weight Integrated Fuselage and Empennage for Short Range and Short-Medium Range Aircraft	IA	40
Transversal activity topics			
HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01	Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications	IA	90
HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-02	Novel Certification Methods and Means of Compliance for Disruptive Technologies	IA	18
TOTAL	**13 topics**		

Identification Code	Title	Type of Action	Ind. Value (Funding in M€)
Coordination and Support Actions			
HORIZON-JU-CLEAN-AVIATION-2022-01-CSA-01	Developing a European Clean Aviation Regional Ecosystem (ECARE)	CSA	0.72
TOTAL	**1 topic**		

1. Clean Aviation – Hydrogen-Powered Aircraft (HPA)

I. <u>HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-01: Direct Combustion of Hydrogen in Aero-engines</u>

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of up to EUR 115 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 115 million. The Clean Aviation Joint Undertaking may award up to two projects with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL5 at combustion system level, TRL4 at overall engine / propulsion system level at project completion. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with

	an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include propulsion system level integrators with a proven track record in developing and delivering globally competitive engines/propulsion systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs and demonstrate a track record of • Research and development in the field of aero-engine combustion technologies (numerical and experimental) • Research and development in the field of hydrogen combustion technologies (numerical and experimental) • Successful design, development, manufacturing and certification in the Aeronautical supply chain of regional and/or single aisle aero-engines at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional and short and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement

	a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure fulfilling the obligations for in-kind contributions by Members of the CAJU (i.e. "Founding Member", "Associated Member" and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[1], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. "Founding Member", "Associated Member" and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[2] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[3], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the

[1] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[2] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085.

[3] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014.

	proposal who are not a "Member" of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[4] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects (s - indicate in their proposal a list of topics published in this call, ,from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to the following expected outcomes:

- Demonstrate technology and industrial feasibility, i.e. sufficient maturity of hydrogen direct combustion in an aero-engine.

[4] Available on the F&T portal.

- De-risk, mature, integrate and perform first ground test of the propulsion system technologies (fuel injection and delivery system, combustion chamber adaptation, controls) in order to demonstrate the technology feasibility and obtain "key answers".
- Perform experimental and numerical validation of H2 direct combustion from single and sector burner tests up to full annular rig tests.
- Perform ground tests of a Donor Engine (TurboProp or TurboFan) based on Hydrogen Direct Combustion, in-line with the scope and performance targets.
- Perform modelling and full characterization of engine tailpipe emissions in relation to GHG emissions and climate impact (CO2, NOx, water, particulates, etc.) after ground tests.
- Achieve "Permit-to-Fly", following extended ground tests (engine, incl. nacelle, fire detection and prevention system, etc.).
- Engine-to-aircraft integration studies completed for enabling Flight Tests of H2 donor engine.
- Identification of gaps versus a new product development (optimized direct combustion hydrogen aero-engine).
- Identification of gaps in relation to certification of the H2 direct burn technology and focus on new means of compliance. Propose a qualification and certification plan linked to the proposed activities and relevant to both Hybrid-Electric Regional aircraft (HER) and Short and Short-Medium Range (SR/SMR) aircraft.
- Identification of gaps/needs in relation to aircraft integration and in relation to information exchange (inputs/outputs) with other relevant projects (see table above).
- Identify synergies with activities funded under research and innovation programmes at regional, national[5] and European[6] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

Hydrogen can be considered as a potential energy source for aviation as shown in a recent independent study[7], jointly commissioned by the Clean Sky 2 and Fuel Cells & Hydrogen 2 Joint Undertakings.

Hydrogen can be used as a fuel for aircraft when it is burned in an H2-fuelled engine or reacted in a fuel cell powering electric motors.

Hydrogen combustion allows for the complete elimination of CO2 and most of the non-volatile Particulate Matter (nvPM) at the exhaust, leaving water vapour and nitrogen oxides (NOx) as main combustion emissions.

In time, hydrogen fuel may also be generated carbon-free – resulting in absolute zero-CO2 emissions

5 Activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).
6 Activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.
7 "Hydrogen-powered aviation, a fact-based study of hydrogen technology, economics, and climate impact by 2050", McKinsey & Company, May 2020, ISBN 978-92-9246-342-7.

over the entire fuel life cycle. In time, NOx emissions from H2 direct combustion may be substantially reduced by novel combustion technologies (advanced lean-mixture concepts, “micromix” type combustors, etc.) without significant impact on combustion efficiency.

Why direct combustion? Roughly half of today’s kerosene consumption – which directly correlates with CO2 emissions – comes from flights operated in the 1000-3000 km range aircraft. Regional and short-medium range aircraft offer a unique introduction opportunity for hydrogen (given their typical mission against the aircraft size and capability), but they will need to rely on H2 “direct burn”, as the power density of fuel cell systems is still likely to be insufficient for such high-power applications.

The topic aims to demonstrate the technical feasibility of direct combustion of hydrogen in a gas turbine (donor engine). The following key issues are within the scope of the topics and should be taken into consideration:

- Safety: at least equivalent or even better safety levels must be achieved for an H2 Direct Combustion propulsion system versus the well-proven conventional jet-fuel technology.
- Technological challenges at system and sub-system level, in particular the fuel injection system and associated H2 combustion chamber sizing and design, and the fuel delivery systems.

Although not requested as a mandatory outcome of the topic, the following challenges, towards accelerating the introduction of H2 Direct Combustion Propulsion Systems, are also considered to be within the scope of this topic and may be covered in a proposal:

- H2 distribution and conditioning.
- H2 injection and combustion.
- The achievement of “Ultra-low” NOx emission levels with similar combustion efficiencies and satisfactory stability characteristics.
- The management of system packaging (volume, weight) and complexity.
- Improved overall efficiency at engine level to enable acceptable tank size for airframe integration.
- Exploration of dual-fuel operation

The H2 Direct Combustion early Demo Engine power/thrust class will be aligned to one of the two following target power/thrust class scenarios in relation with the HER and/or SR/SMR aircraft concepts:

a) Turboprop option: 5000 shp at MTO sea level static
b) Turbofan option: 20,000 lbf thrust at sea level static, Mn 0.25, ISA +15K

Phase 2 is expected to target a turboprop engine with more than 5,000 shp or a turbofan engine with at least 20,000 lbf (all sea level static) as a minimum requirement for future SMR integrated propulsion system. Final requirements, for the second phase, are expected to be defined during Phase 1, in accordance with the Airframer, to properly support the substantiation of H2 Direct Combustion Aircraft EIS by 2035.

The climate impact assessment of hydrogen direct combustion at altitude is not within the scope of this topic which is limited to ground tests, up to permit-to-fly. GHG emissions at altitude and climate impact assessment will be addressed in a subsequent dedicated topic in a later call for proposals for flight tests.

However, analytical or virtual flight test predictions (for a typical mission) are highly desirable.

Performance targets:

The performance targets shall be defined, developed and specified by the applicant consistently with all constraints pertaining to the design of hydrogen direct burn aero-engines. The applicant shall provide a clear analysis substantiating these targets and explaining how the project is developing solutions compliant with them, while providing effective means for monitoring progress and optimizing the work statements.
The applicant shall determine the above targets at system, sub-system, down to component level. The targets shall be accompanied by a maturity roadmap and a strategic development plan including performance improvements for critical components covering the time period until 2030.

Versus a state-of-the-art Aero-Engine Gas Turbine, the performance targets shall be compliant with the following aspects:

- engine and dispatch reliability, maintenance overall safety levels at least equivalent,
- power or thrust capability equivalent (depending if targeting Turboprop or Turbofan application),
- engine responsiveness equivalent,
- overall thrust-to-mass ratio equivalent at aircraft level,
- overall energy efficiency equivalent.
- NOx emissions level equivalent or comparable versus conventional fuels

All data required to characterize GHG emissions (especially non-CO2 effects such as but not limited to NOx, water, nvPM) shall be modelled and measured during ground tests. Proposals shall include a detailed project plan with key milestones and deliverables and a list of performance targets per critical technologies associated to this plan.

Projects are encouraged to exploit the involvement of EASA to de-risk and secure an adequate certification process of novel propulsion technologies, with a particular focus on the new means of compliance.

II. HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-02: Multi-MW Fuel Cell Propulsion System for Hydrogen-Powered Aircraft

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of up to EUR 50 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 50 million. The Clean Aviation Joint Undertaking may award up to two projects with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level at their minimum entry point. Activities are expected to achieve TRL4 or higher at propulsion system level at project completion. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include propulsion systems integrators and their supply chain with a proven track record in developing and delivering globally competitive propulsion systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route

	that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs demonstrating a track record of successful design, development, manufacturing and certification in the aeronautical supply chain of regional and/or single aisle aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional and short and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by

	the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure fulfilling the obligations for in-kind contributions by Members of the CAJU (i.e. “Founding Member”, “Associated Member” and affiliated entities to a Member) can be fullfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[8], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. “Founding Member”, “Associated Member” and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[9] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[10], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a “Member” of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[11] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects (s

[8] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[9] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[10] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[11] available on the F&T portal

	- indicate in their proposal a list of topics published in this call, ,from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. **During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation.** **The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.**

Expected Outcome:

Project results are expected to contribute to the following expected outcomes:

- Demonstrate the scalability up to multi-MW level of fuel cell usage as power source/electricity generation in a complete propulsion system (drive train) and for main future electrical systems, optimized for A/C application, designed consistently with qualification, certification and safety principles.
- Perform a detailed design optimization of a complete compact lightweight high efficiency full electric propulsion system based on Fuel Cells as energy source from LH2, associated sub-systems and auxiliary systems (Balance of Plant: BoP), sized for regional aircraft application
    - o at a power level of at least 2MW up to 4MW,
    - o up to FL250.
- Perform integrated research and development on components and demonstrate the validation of the following sub-systems up to TRL4 at multi-MWpower level, in 2025, at least up to sub-system ground demonstration.
    - o Hydrogen line (LH2 Tank including sensing and metering, valve system, LH2 controls, piping, pressure control for the fuel cell stack, anode recirculation, H2 purge)
    - o Air systems line (air inlet, filter, compressor, intercooler, humidification system, cathode recirculation, water separation, water management, air exhaust, piping and tubing, valves)
    - o Fuel cell stack with high efficiency (> 45%) and high gravimetric power density (>2kW/kg) – (endplates including sensors, bipolar plates, Membrane Electrolyte Assembly (MEA) including the membrane, catalyst, Gas Diffusion layers (GDL), internal cooling design, sealing, housing, attachment), including optimization of weight and size per stack, multi-stack architecture optimization.

    - Power line (electric distribution, motor control units, BoP inverters and BoP batteries, electric motors, gear box)
    - Cooling line (cooling fluids, pumps, filters, reservoirs, piping and tubing, sensors, Valves, Heat exchangers)
- Investigate system availability (>95%), reliability, durability (life time >20,000 h), ageing kinetics, acoustic and vibrations, thermal, multi-stack optimization aspects, in connection with size, weight, output power, energy efficiency, power densities (at stack and at system levels), in-line with the validation requirements of the previous outcome:
    - Identify main issues (including safety, reliability and certification concerns), constraints, limitations, major trade-offs required, proposed solutions / mitigations.
    - Identify concepts and architecture solutions to maximum utilization of residual process (dump) water.
    - Identify concepts and architecture solutions for FC gases (H2) exhaust management in the aircraft.
    - Anticipate further areas which may require particular attention/efforts in subsequent R&D, such as but not limited to e.g., technology maturity issues, heat dissipation issues, cooling requirements, thermal management; ways to satisfy various aircraft system needs: ECS, anti-ice, etc.; system integration; compatibility of technologies with aircraft environment; methodologies, tools, testing requirements, etc.; membrane robustness to contaminants and pollution; circular economy and recycling strategies, etc.
- Perform ground demonstration and tests of a generic system incorporating the TRL 4 (1st generation) technology bricks (i.e. allowing to reach TRL5) at a max power level allowing demonstration within the timeframe of the project.
- Identify gaps versus a new product development (Multi-MW Fuel Cell Propulsion System for full electric Regional Aircraft).
- Identify gaps in relation to certification of the Fuel Cell power train technology and focus on new means of compliance. Propose a qualification and certification plan linked to the proposed activities and relevant to both Hybrid-Electric Regional aircraft (HER) and Short and Short-Medium Range (SR/SMR) aircraft.
- Identify gaps/needs in relation to aircraft integration and in relation to information exchange (inputs/outputs) with other relevant projects (see table above).
- Identify synergies with activities funded under research and innovation programmes at regional, national[12] and European[13] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

Hydrogen can be considered as a potential source of energy for aviation as shown in a recent independent study14, jointly commissioned by the Clean Sky 2 and Fuel Cells & Hydrogen 2 Joint

[12] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[13] activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

[14] "Hydrogen-powered aviation, a fact-based study of hydrogen technology, economics, and climate impact by 2050", McKinsey & Company, May 2020, ISBN 978-92-9246-342-7.

Undertakings.

Hydrogen can be used as a “fuel” for aircraft when it is burnt in an H2 fuelled engine or reacted in a fuel cell, powering electric motors.

While Hydrogen combustion allows for the elimination of CO2 and most of the non-volatile Particulate Matter (nvPM) at the exhaust, its emissions leave an increased amount of water vapour, as well as nitrogen oxides (NOx), although there is longer term potential to reduce those by new combustor technologies.

Hydrogen Fuel Cells, on the other hand, are probably the cleanest power generation source that may be envisaged for aircraft propulsion, as they produce no CO2, no NOx, and no particulates; only water and heat as by-products of the reaction of Hydrogen with Oxygen.

The topic aims to demonstrate the technical feasibility of a multi-MW Fuel Cell Propulsion System for Hydrogen-Powered Aircraft. In terms of propulsion system or complete drive train, in principle, three different concepts have the potential to achieve the GHG emissions reduction objective of -30%(at aircraft level) for regional aircraft applications. All concepts will drive propellers to maximize propulsive efficiency as required for the given typical regional mission and range. The propulsion concepts are associated each to a reference aircraft configuration, size, scalability potential and limits:

1. Electric motors on wing + LH2 Fuel Cells (full electric) (~ 50 passengers range)
2. a) Electric motors on wing + Turbo-generator + Batteries or Fuel Cells (serial hybrid) (50<passengers< 85)

   b) Gas Turbines on wing + Motor/Generator + Batteries or Fuel Cells (parallel hybrid) (50<passengers< 85)
3. a) H2 burning Gas Turbines on wing (> 85 passengers<100)

   b) H2 burning Gas Turbines on wing + Motor/Generator + Batteries or H2 Fuel Cells (H2 parallel hybrid) (> 85 passengers<100)

The present topic focuses on concept no. 1, whereas concept no. 3a) is covered by the topic on “Direct Combustion of Hydrogen in Aero-engines”[15] and 3b) may be covered by a specific separate topic at a later stage.

While propulsion concepts no. 2a) and 2b) as well as technology bricks for electric motors, motor/generators, turbogenerators, batteries and hybrid turboprop engines will be developed in the HER thrust[16] of the Clean Aviation partnership, the benchmark and trade-off analyses to achieve a propulsion architecture suitable to HER will be performed under the HER architecture / platform project in close coordination with the H2 Thrust.

Technologies other than PEM (Polymer Electrolyte Membrane) Fuel Cells are considered not mature enough to have concrete application and/or demonstration within the Clean Aviation timeframe. Therefore, such technologies are not in-scope of this topic. Their maturation shall be performed in other dedicated research programmes.

The coordination with the HER aircraft architecture and propulsion systems related projects, as well as with relevant activities performed outside of Clean Aviation will be key to ensure consistency at all levels

[15] CLEAN-AVIATION-2022-01-HPA-01

[16] CLEAN-AVIATION-2022-01-HER-01: Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft

(concept, configuration, programmatic, timing, objectives, orientations, etc.) and overall work optimization/efficiency relative to the whole aircraft, systems, sub-systems and components, in anticipation of future work subsequent to this project.

Performance targets:

The performance targets shall be defined, developed and specified by the applicant consistently with all constraints pertaining to the design of hydrogen fuel cell power trains.
The applicant shall provide a clear analysis substantiating these targets and explaining how the project is developing solutions compliant with them, while providing effective means for monitoring progress and optimizing the work statements.
The applicant shall determine the above targets at system, sub-system, down to component level. The targets shall be accompanied by a maturity roadmap and a strategic development plan including performance improvements for critical components covering the time period until 2030, taking into account the overall HER goals defined in the Clean Aviation SRIA.
In the process of defining the above targets, appropriate parameters shall be used, which may comprise, but not limited to: total system power, fuel cell power per stack, fuel cell stack energy efficiency, overall power system energy efficiency, bulkiness/volume/weight related efficiencies and power densities, at stack, at packaging levels, at BoP level and at overall power system levels.

Projects are encouraged to exploit the involvement of EASA to de-risk and secure an adequate certification process of novel propulsion technologies, with a particular focus on the new means of compliance.

III. HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-03: Large Scale Lightweight Liquid Hydrogen Integral Storage Solutions

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of EUR 10 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 10 million. The Clean Aviation Joint Undertaking may award up to one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	**Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level at their minimum entry point.** **Activities are expected to achieve TRL4 or higher at tank system level at project completion, ready for an eventual flight test in Phase 2.** Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include **airframe/aerostructures** integrators with a proven track record in developing and delivering globally competitive engines/propulsion systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can

	ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs and demonstrate a track record of successful design, development, manufacturing and certification in the aeronautical supply chain of regional and/or single aisle aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional and short and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project

	plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure fulfilling the obligations for in-kind contributions by Members of the CAJU (i.e. "Founding Member", "Associated Member" and affiliated entities to a Member) can be fullfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[17], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. "Founding Member", "Associated Member" and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[18] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[19], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a "Member" of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[20] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023),

[17] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[18] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[19] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[20] available on the F&T portal

	and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects (s - indicate in their proposal a list of topics published in this call, ,from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to the following expected outcomes:

- Perform the design, development, optimization and manufacturing of large scale (150 kg LH2 content) integral and conformal/non-conformal LH2 storage solutions with the gravimetric index of the tank alone (i.e. without accessories/external systems) being no less than 35%.
- Perform ground test demonstration up to TRL 5 at end of Phase 1, of a large scale (150 kg LH2) integral LH2 tank, including boil-off management, gas leak detection system, venting, gauging, metering and health monitoring for characterisation of the LH2 storage system. TRL5 is considered to cover ground tests of the full scale prototype at ambient conditions (not comprising altitude tests in a test chamber or flight tests.
- Perform the full characterization of functional behaviour of an integral flight load bearing LH2 tank including metering, gauging, pressure and temperature controls, venting, boil-off, thermal cryogenic fatigue while filling up due to temperature gradients, insulation thermal conductivity, overpressure management and dynamic loads due to sloshing and internal pressure behaviour due to its interaction with the thermodynamic environment, mechanical resistance to operational loads, normal statics and failure fatigue load cases and thermal cycling loads, etc.
- Develop a detailed roadmap defining the key enablers and actions needed for a large scale (>>100 kg LH2) concept to allow the adoption of hydrogen as fuel / energy source and (e.g. in a H2 burning gas turbine or in fuel cells) meeting the abovementioned objective, including

compatibility with future hydrogen-powered aircraft concepts, the target tank capacity being 600kg for Phase 2.

- Deliver a roadmap towards full-scale demonstration of the LH2 storage system compatible with TRL6 at aircraft level before the end of the Clean Aviation programme compatible with an entry into service by 2035.
- Identification of gaps versus safe on-board refuelling operations.
- Identification of gaps versus a new product development.
- Identification of gaps in relation to certification of the LH2 storage technology and focus on new means of compliance. Propose a qualification and certification plan linked to the proposed activities and relevant to both Hybrid-Electric Regional aircraft (HER) and Short and Short-Medium Range (SR/SMR) aircraft.
- Identification of gaps/needs in relation to aircraft integration and in relation to information exchange (inputs/outputs) with other relevant projects (see table above).
- Identify synergies with activities funded under research and innovation programmes at regional, national[21] and European[22] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

The goal is to achieve is TRL 5 at storage system level at project completion duly supported by component and subsystem ground tests at appropriate scale at project completion, so that the selected LH2 storage concept can be further matured in the Clean Aviation Programme and embedded and integrated in a specified architecture for (flight) demonstration. Scalability to other applications is the main opportunity to be pursued.

Scope:

Liquid hydrogen storage in aircraft implies challenges in several disciplines due to:

- exceptionally low energy content per unit of volume. As an example, an integral fuselage tank for equivalent energy could mean increasing fuselage length as much as 10 m for current single aisle aircraft, and over 20m for wide bodies.
- the need to adapt LH2 storage solutions for a/c environment, particular challenges on:
    - Safety concerns for H2 management in a/c environment. Beyond the implicit associated with the storage conditions, safety is very relevant in relation to H2 leakage and materials behaviour at cryogenic conditions. This implies a specific development of certification means. The design should consider all critical safety requirements / analyses and certification requirements pertaining to the aircraft application targeted, including, but not limited to, potential critical structural cases, such as acceleration characteristics under crash landing and gust conditions.
    - Solve the non-integral tank issue. In principle, H2 tanks are considered independent from the functional aircraft structure which creates a high weight impact compared to

[21] Activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).
[22] Activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

current solutions in which the fuel tanks are integral.
 - Solve the non-conformal tank issue. Today, most of the gas or liquid storage tanks are spherical or cylindrical. Enabling the tank shape to be conformal to the volume shape where it is integrated would result in a much better optimization of the volume occupancy, hence storage capacity.

Performance Targets:

The performance targets shall be defined by the applicant consistently with constraints that are customary in the design of liquid hydrogen storage tanks for aircraft. The applicant shall provide a clear analysis of how this has been determined and how the project will develop solutions compliant with these targets, including effective means of monitoring progress and optimizing the work statements.
The applicant shall determine performance targets down to component level (inner shell, outer shell, metering, gauging and controls, etc.) including a maturity roadmap and a strategic development plan including performance improvements until 2030 for critical components in view of LH2 integral and conformal storage solutions in relevant aircraft integration configurations.

The following performance targets are provided for Phase 1 primarily.

- Gravimetric index of H2 selected storage solutions compared to current fuels (JET A-1, SAF; ultimate goal) and current ground/road transport H2 indexes (SoA); as a reference target is proposed 35% for a 150 kg LH2 tank.
- Tank LH2 storage capacity > 150 kg LH2, scalable to a target of 600kg LH2 capacity by 2025.
- Life Cycle Cost Analysis including KPIs targeting or dealing with:
  - Production, installation and assembly costs
  - Low maintenance impact: at all check types (A, B, C…)
  - End of life: durability, recyclability/overhaul and overall waste generation (i.e. % recovered material in weight, exergy losses during recycling)
  - Target between 50.000 and 100.000 hours of expected service life, aligned with a/c expected life
- Refueling conditions: making the refueling operations compatible with 45 min turnaround times.
- Boil-off < 2% in 24 hours (24 h defined as dormancy time reference)

Proposals shall include a detailed project plan with key milestones and deliverables and a list of performance targets per critical technologies associated to this plan.

Projects are encouraged to exploit the involvement of EASA to de-risk and secure an adequate certification process of novel liquid hydrogen storage technologies, with a particular focus on the new means of compliance.

IV. HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-04: Near Term Disruptive Technologies for Hydrogen-Powered Aircraft

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of EUR 4 and 3 million (respectively for each sub-topic of this call) would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 7 million, EUR 4 million for sub-topic 1 and EUR 3 million for sub-topic 2. The Clean Aviation Joint Undertaking may award up to one project per sub-topic with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level at their minimum entry point. Activities are expected to achieve TRL5 at project completion for both sub-topics. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include aircraft/propulsion system level integrators with a proven track record in developing and delivering globally competitive engines/propulsion systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial,

	economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs and demonstrate a track record of successful design, development, manufacturing and certification in the Aeronautical supply chain of regional and/or single aisle aero-engines at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to HER aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project

	plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure fulfilling the obligations for in-kind contributions by Members of the CAJU (i.e. "Founding Member", "Associated Member" and affiliated entities to a Member) can be fullfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[23], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. "Founding Member", "Associated Member" and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[24] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[25], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a "Member" of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[26] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant

[23] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[24] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[25] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[26] available on the F&T portal

	thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects (s - indicate in their proposal a list of topics published in this call, ,from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

This topic is composed of 2 distinct sub-topics:

1. Ground test demonstration of a scaled integrated flight ready Fuel Cell Power Train (~ 500 kW, based on SoA components).
2. Flight test demonstration of a small scale but relevant size (min 100 kg LH2) integral tank.

Applicants are encouraged to submit one proposal per sub-topic.

Project results are expected to contribute to the following expected outcomes:

Sub-topic 1:

- Perform ground test demonstration of a scaled integrated flight ready Fuel Cell Power Train (~ 500 kW, based on SoA components) up to TRL 5at project completion, for performance characterisation by virtual flight test with cryo-enabled integrated thermal management system and including the possibility to explore solutions for utilizing FC waste heat (e.g. in combination with Vapour Cycle System (VCS) for ECS.
- Understand how different architectures of a large FC system will behave in a relevant environment, by ground testing a complete drive train (including LH2 storage and distribution, electric motors and propellers, kilovolt-class electric distribution network, thermal

management system, and non-propulsive loads such as ECS or anti/de-icing system, LH2 warming, etc.).

- Understand the performance and handling of failure modes relating to a large distributed and modular airborne fuel cell drive train system powering kilovolt-class distributed propulsion architectures at relevant altitudes and start-up, shut-down characteristics with extreme temperatures. Identify gaps in technology with respect to failure modes.
- Further explore/identify the challenges related to system level observability, management, control and failure mitigations in lieu of safety and certification, as well as human factors.
- Deliver a roadmap towards full-scale demonstration of a FC propulsion system compatible with TRL6 at aircraft level before the end of the Clean Aviation programme compatible with an entry into service by 2035.
- Identify gaps in relation to certification of the LH2 FC power train technology and focus on new means of compliance. Propose a qualification and certification plan linked to the proposed activities and relevant to both Hybrid-Electric Regional aircraft (HER) and Short and Short-Medium Range (SR/SMR) aircraft.
- Identify gaps/needs in relation to aircraft integration and in relation to information exchange (inputs/outputs) with other relevant projects (see table above).
- Identify synergies with activities funded under research and innovation programmes at regional, national[27] and European[28] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Sub-topic 2:

- Perform flight test demonstration up to TRL 5[1] at project completion, exposing a small scale but relevant size (min 100 kg LH2) integral tank implemented in a small fuselage section to the airborne environment by flying this structure and associated cryogenic tank system on-board a cargo deck, including boil-off management, gas leak detection system, venting and health monitoring for characterisation of the LH2 storage system in representative flight conditions.
- Understand how an integral flight load bearing LH2 tank will behave during long term exposure to the relevant flight environment, i.e. aspects of boil-off, sloshing, thermal cryogenic fatigue while filling up due to temperature gradients, etc.
- Develop a detailed roadmap defining the key enablers and actions needed for a large scale (>>100 kg LH2) concept to allow the adoption of hydrogen as fuel / energy source and (e.g. in a H2 burning gas turbine or in fuel cells) meeting the abovementioned objective, including compatibility with future hydrogen-powered aircraft concepts;

[27] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[28] activities funded under Horizon Europe (outside the Clean Aviation Work Progr. 2022-2023) and/or other EU programmes.

- Deliver a roadmap towards full-scale demonstration of a LH2 integral storage system compatible with TRL6 at aircraft level before the end of the Clean Aviation programme compatible with an entry into service by 2035.
- Identify gaps in relation to certification of the LH2 storage technology and focus on new means of compliance. Propose a qualification and certification plan linked to the proposed activities and relevant to both Hybrid-Electric Regional aircraft (HER) and Short and Short-Medium Range (SR/SMR) aircraft.
- Identify gaps/needs in relation to aircraft integration and in relation to information exchange (inputs/outputs) with other relevant projects (see table above).
- Identify synergies with activities funded under research and innovation programmes at regional, national[29] and European[30] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

The primary objective of this topic is twofold:

- Ground Test (flight ready testbed) of a Small Scale Fuel Cell HIPS (Hydrogen Integrated Propulsion System) and
- Flight Test of a Small Scale LH2 Integral Tank.
-

For the HIPS Ground Test, the goal is to achieve TRL 5 at overall propulsion system level at project completion duly supported by component and subsystem ground tests at appropriate scale at project completion, so that the selected propulsion concept can be further matured in the Clean Aviation Programme and embedded and integrated in a specified architecture for (flight) demonstration. Scalability to other applications is the main opportunity to be pursued.

For the Tank Flight Tests, the goal is to achieve TRL 5 at storage system level at project completion duly supported by component and subsystem ground tests at appropriate scale at project completion, so that the selected storage concept can be further matured in the Clean Aviation Programme and embedded and integrated in a specified architecture. Scalability to other applications is the main opportunity to be pursued. Consideration should be given to aspects such as, but not limited to, refilling operations, considering the coupling and control interface, as well as the safety and reliability issues required to allow aircraft refuelling according to the performance targets in all the possible vessel state conditions (cold, warm, level, pressure) and according to a/c regulations.

The project shall also deliver digital twins of the components, subsystems and the full propulsion system compatible with the reference aircraft digital framework and requirements, in order to regularly assess the contribution to the overall aircraft performance in the context of the impact monitoring framework. These models shall be continuously validated and updated at each TRL loop.

The topic aims to:

[29] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European re covery fund (i.e. NextGenerationEU).

[30] activities funded under Horizon Europe (outside the Clean Aviation Work Progr. 2022-2023) and/or other EU programmes.

- de-risk the development of disruptive LH2 storage solutions and Fuel Cell based power train architectures;
- validate and verify these solutions on a smaller scale demonstrator with the opportunity for disruptive quick market implementation;
- facilitate their implementation in the HER and SR/SMR aircraft concepts.

Both SMR and HER thrusts in Clean Aviation are relying on technology development, maturation and validation of key technologies within the H2 pillar. Rapidly maturing these technologies with an agile and iterative approach on lower risk certification classes will enable Clean Aviation to follow the ambitious timeline and shorten the time to bring new products to market and into service while maintaining European leadership and competitiveness.

The Fuel Cell HIPS system to be ground tested is expected to be based on State-of-the-Art components simulating a complete drive train system: LH2 storage tank, fuel distribution system, FC including Balance of Plant and thermal management, high voltage electrical distribution network and power conversion (potentially including batteries or super-capacitors), and loads (propulsive and non-propulsive, i.e. electric motor(s) with propeller, ECS, etc.).

Aircraft level demonstrations of fuel delivery and boil-off management must showcase compatibility not only with aircraft energy storage function but also with the envisioned concepts of operation (considering also power and trajectory management during flight).

The storage structure to be flight-tested in the cargo deck (of a freight transport aircraft for example) is expected to be a state-of-the-art vacuum insulated integral tank (metallic/composite non-conformal/cylindrical inner tank with outer composite shell as external load bearing structural part) including boil-off management, gas leak detection system, venting, metering and health monitoring.

The project should focus in a first step on manufacturing such an integral tank including relevant instrumentation for flight test, targeting a flight test campaign in a second step. Flight tests are expected to be completed within the 36 month project period.

<u>Performance Targets:</u>

The performance targets shall be defined, developed and specified by the applicant consistently with all constraints pertaining to the design of hydrogen fuel cell power trains and liquid hydrogen storage tanks.
The applicant shall provide a clear analysis substantiating these targets and explaining how the project is developing solutions compliant with them, while providing effective means for monitoring progress and optimizing the work statements.
The applicant shall determine the above targets at system, sub-system, down to component level. The targets shall be accompanied by a maturity roadmap and a strategic development plan including performance improvements for critical components covering the time period until 2030, taking into account the overall HER goals defined in the Clean Aviation SRIA.

In the process of defining the above targets, appropriate parameters shall be used, which may comprise, but not limited to: total system power, fuel cell power per stack, fuel cell stack energy efficiency, overall power system energy efficiency, bulkiness/volume/weight related efficiencies and power densities, at

stack, at packaging levels and at overall power systems levels.
The applicant shall determine performance targets down to component level (inner shell, outer shell, metering, gauging and controls, etc.) including a maturity roadmap and a strategic development plan including performance improvements until 2030 for critical components in view of LH2 integral and conformal storage solutions in relevant aircraft integration configurations.
Proposals shall include a detailed project plan with key milestones and deliverables and a list of performance targets for the critical technologies associated to this plan.

Projects are encouraged to exploit the involvement of EASA to de-risk and secure an adequate certification process of novel propulsion technologies, with a particular focus on the new means of compliance.

2. Clean Aviation – Hybrid-electric powered Regional Aircraft (HER)

I. HORIZON-JU-CLEAN-AVIATION-2022-01-HER-01: Multi-MW hybrid-electric propulsion system for Regional Aircraft

Description of the call topic and topic and specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of between EUR 30 and 40 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 75 million. The Clean Aviation Joint Undertaking may award up to two projects with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level at their minimum entry point. Activities are expected to achieve TRL4 or higher at overall engine / propulsion system level at project completion. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include propulsion systems integrators and their supply chain with a proven track record in developing and delivering globally competitive propulsion systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the

	appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs demonstrating a track record of successful design, development, manufacturing and certification in the aeronautical supply chain of regional and/or single aisle aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional and short and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal For a successful programmatic approach and implementation of the Clean Aviation programme, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with the other relevant JU projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under other relevant projects. A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the

	required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. "Founding Member", "Associated Member" and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[31], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. "Founding Member", "Associated Member" and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[32] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[33], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a "Member" of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[34] at large.

[31] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[32] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[33] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[34] available on the F&T portal

Other relevant projects	This project should run in close synchronization with other relevant projects selected stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023, and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects. - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to provide or contribute to the following expected outcomes:

- Deliver an in-depth analysis of the 2020 state of the art including feasibility, architecture viability and corresponding gates with regard to performance requirements for all relevant components of the systems and subsystems and the expected developments currently underway.
- Demonstrate at project completion a substantial step in overall architecture, energy efficiency and emissions of the propulsion system compared to a clearly identified 2020 state-of-the-art reference propulsion system that will support a 50%[35] fuel burn reduction on a typical mission and at overall aircraft level. The project's results should provide the foundation to progress

[35] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

the further research and demonstration that will enable the development of a hybrid-electric propulsion system for a Hybrid-Electric Regional (HER) aircraft with maximum efficiency and minimum weight and minimum drag penalty, and with a target EIS of no later than 2035:

  - Relevant energy efficiency and emissions improvement targets shall be identified and elaborated in appropriate metrics, such as but not limited to installed cruise Thrust Specific Fuel Consumption (TSFC) if applicable.
  - Quantified reduction potential in CO_2 and all other relevant GHG emissions (see performance targets section below) are expected to be derived from the project (both in terms of actual demonstrated and potential performance impact); further reduction potential beyond the target in one or several of the known GHG emissions related to aviation propulsion will receive strong consideration within the evaluation of proposals.

- Perform ground test(s) (full or scaled) to demonstrate the performance and technology maturity of the propulsion system.
- Deliver digital twins of the components, subsystems and the full propulsion system compatible with the reference aircraft digital framework and requirements, in order to regularly assess the contribution to the overall aircraft performance in the context of the impact monitoring framework. These models shall be continuously validated and updated at each step in the TRL progress loop. Solutions shall propose a Prognostics & Health Management approach together with an associated digital model.
- Propose a qualification and certification plan linked to the proposed activities and suitable to HER aircraft.
- Quantify the expected potential performance and the impact and features of the proposed concept(s) on operations and systems (e.g. ECS, anti-icing, fire detection / extinguishing) including maintenance, repair, availability, fault tolerance, reliability, safety (including rotating part failures, depressurization).
- Ensure the abovementioned concept will allow the adoption of 100% non-blended Sustainable Aviation Fuel (SAF);
- Demonstrate at project completion the propulsion concept performance and detail the demonstration plan, with inclusion of component/sub-system level, to meet the maturity of TRL 4 or higher at project completion, achieved by ground test(s) at propulsion system level or including the proper simulation of major items at relevant scale (i.e. propeller suitable to the selected power unit);
- Develop a detailed roadmap, including a state-of-the-art analysis defining the key enablers and actions needed for a hybrid-electric propulsion concept to allow the adoption of hydrogen as fuel / energy source and (e.g. in a H2 burning gas turbine or in fuel cells) meeting the abovementioned objective, including compatibility with future hydrogen-powered aircraft concepts;
- Deliver a roadmap towards full-scale demonstration of propulsion system compatible with TRL6 at aircraft level before the end of the Clean Aviation programme and compatible with an entry into service by 2035.

- Identify synergies with activities funded under research and innovation programmes at regional, national[36] and European[37] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

Greater attention to environmental aspects (even with stringent regulations) and higher market demand are changing the scenario of air mobility in the short range, centred on 500 km and up to 1000 km. Air vehicles (as defined in CS25/FAR25) operating in this range and operational environment (including regional aircraft with a capacity of up to 100 seats) are considered the first application in the scheduled air transport system that will adopt hybrid-electric propulsion technologies and associated complementary solutions for reducing the environmental footprint, toward climate-neutral aviation. Air vehicles operating at smaller distances or on thinner routes will also benefit from electric propulsion solutions tested on regional aircraft testbeds, by sharing the development of power modules and making use of different approaches to air vehicle integration.

Hybrid-electric propulsion is a significant challenge for the successful realization of the Hybrid-Electric Regional aircraft (HER) with a targeted fuel burn reduction of minimum 50% at aircraft level.
The reference HER aircraft shall have a seating capacity up to 100 passengers in a standard configuration, with a sizing mission of around 1000 km and a typical sector distance flown of around 400-500 km.

- Any deviation from these references as a result of different configuration effects (e.g. for technical feasibility, project viability reasons, or for optimizing the project outcome) should be identified and substantiated.
- The propulsion power requirements shall be dependent on the targeted HER aircraft architecture configuration(s)[38], which will be delivered by one or more separate projects launched under Clean Aviation.

The scope of this topic is to deliver a hybrid-electric propulsion system expected to meet TRL 4 or higher at overall engine level at project completion and compatible with HER aircraft concept(s) selected at the end of 2025.

The project shall explore configurations combining, in different arrangements, including serial, parallel or hybrid configurations, with associated technology bricks: electrical motors on wing, gas turbines on wing, turbogenerators, motors/generators, batteries, H2 fuel cells. (to be specified and described in detail by the applicant). The various configurations intended to be studied by the applicant shall be described in detail (justification, targeted advantages, anticipated drawbacks, anticipated challenges, possible adaptations, risks, etc.) and compared in terms of potential and the most promising option selected.

Propulsion concepts to be developed are expected to provide a total shaft power within a range of 4

[36] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).
[37] activities funded under Horizon Europe (outside the Clean Aviation Work Progr. 2022-2023) and/or other EU programmes.
[38] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01: Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

MW up to 10 MW, which would translate into a range of 2 MW up to 5 MW per wing assuming the proposed concept would be based on two main propulsion systems per aircraft. The minimum powertrain module shall be 1 MW with a growth potential towards the total power required of 10 MW and having a minimum of 50% hybridization for a 50 pax aircraft: the project shall confirm and adjust / precise, also substantiate these targets as required.

Today, three different propulsion system concepts have the potential to achieve the emissions reduction objective. All concepts will drive propellers to maximize propulsive efficiency as required in the given typical regional mission and range. The propulsion concepts are associated each to a reference aircraft configuration and size and scalability potential and limits shall be analyzed both quantitatively and qualitatively:

1. Electric motors on wing + LH2 fuel cells (full electric) (up to 50 passengers range)
2. a) Electric motors on wing + turbogenerator + batteries or fuel cells (serial hybrid) (50<passengers< 85)

   b) gas turbines on wing + motor/generator + batteries or fuel cells (parallel hybrid) (50<passengers< 85)
3. a) H2 burning gas turbines on wing (> 85 passengers)

   b) H2 burning gas turbines on wing + motor/generator + batteries or H2 fuel cells (H2 parallel hybrid) (> 85 passengers)

The present topic shall focus only on concepts #2 a) and #2 b). Applicants may submit proposal(s) addressing one or both concepts.

Concept #1, #3 a), and #3 b) as well as technology bricks for the hydrogen related subsystems such as H2 fuel cells, H2 burning gas turbines, H2 storage incl. distribution will be developed in the other relevant project(s) under the Hydrogen thrust of Clean Aviation[39,40].
The fuel cell subsystem for concept #2a and #2b may be delivered by a separate project under the Hydrogen thrust of Clean Aviation[41].
This project shall also use the other relevant project(s) to perform the benchmark and trade-off analyses to achieve a propulsion architecture suitable for HER in close coordination with project(s) on aircraft architecture investigating the overall aircraft concepts related to regional aircraft.

Proposed concepts will build on, adapt, complement and add to DO 160, DO 178, CS-25 and any other relevant regulations, to highlight any gaps and maximize the impact potential, and to enable new certification standards, while maintaining or enhancing safety levels. It shall support Clean Aviation initiatives to define new certification or qualification rules as well new standardisation efforts concerning the areas of the project and others related to them. Any specific safety or certification issue should be highlighted, and mitigation action should be proposed.

Scalability (down and up) to other applications is an opportunity to be pursued, in particular versus the Short and Short-Medium Range (SR/SMR) class, given the fact that the HER and SR/SMR classes are today adjacent, if not overlapping. This requires an effective coordination to establish collaboration with the other relevant projects.

[39] HORIZON-JU-CLEAN-AVIATION-2023-02-HPA-01: Liquid Hydrogen Fuel Distribution Technologies
[40] HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-01: Direct Combustion of Hydrogen in Aero-engines
[41] HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-02: Multi-MW Fuel Cell Propulsion System for Hydrogen-Powered Aircraft

Proposed solutions shall explore critical ground situations linked to sizing or off-design conditions such as little or no relative cooling flow in hot & high conditions during taxiing within HER typical operative range on ground and in flight.

The project shall provide relevant data to the other relevant project(s) on aircraft architecture[42] in order to estimate performance elements such as aircraft noise, cabin noise and comfort, acquisition and operating costs, and overall system maintenance and reliability. Results should be provided in a comparative way for different configurations that will be studied, highlighting the advantages and drawbacks, finally proposing / substantiating the optimal selection (s).

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification process of novel hybrid-electric propulsion technologies.

The project shall take into account:

- the specifications for propulsive and non-propulsive energy requirements at a/c level from the targeted a/c concept
- the potential engine architectures selected for the targeted a/c concept
- the targeted operating envelope / mission (profile), to be consistent with the one assumed in the corresponding HER aircraft architecture and configuration topic.
- The research and further development of components where relevant and validation of the following sub-systems up to TRL5 (ground demonstration) at the 2 to 5 MW power level, in 2025:
    - Development of electrical components such as but not limited to electric motors, motor/generators, turbogenerators, etc. The maturity target is TRL 5, to be achieved by subsystem tests
    - Propellers, including folding propellers, and its integration into the overall hybrid powerplant system, including pitch control system development and its integration into powerplant control system and monitoring.
    - Hybrid System enablers such as but not limited to batteries, fuel cells, power distribution. The maturity target is TRL 5, to be achieved by subsystem tests.
    - Advanced Thermal Engine optimization (including hybridization) and related integration with electrical system, nacelle systems cooling/ventilation etc. The maturity target is TRL 5, to be achieved by subsystem tests with appropriate sizing and performance, may be not at real scale and operating environment but assuring their scalability to the HER requirements.
- The propulsion system efficiency improvement targets shall be transformed into appropriate metrics, such as cruise specific fuel consumption (fuel to mechanical shaft power) for clarity and comparisons capability.
- Quantified reduction potential in CO_2 and all other relevant GHG emissions (see performance targets section below) are expected to be derived from the project (both in terms of actual demonstrated and potential performance impact); further reduction potential beyond the

[42] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01: Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

target in one or several of the known GHG emissions related to aviation propulsion will receive strong consideration within the evaluation of proposals.

Performance Targets:

A number of top-level goals will be the basis for performance targets, in particular:

- No less than 30% GHG emissions per Available Seat Kilometre (ASK) on a typical mission compared to a clearly identified 2020 state-of-the-art reference propulsion system (not considering other contributions or installation effects) available for order/delivery;
- Engine/propulsion system: installed performance contributing to the a/c performance target of 50% fuel burn reduction, to be extended as much as possible to a target of 50% GHG emissions reduction at aircraft level (possibly expressed, for instance, in terms of overall GHG emissions per passenger kilometre);
- All noise and emissions levels resulting from the project's outcomes shall be consistent with meeting all currently foreseen regulations and standards with sufficient margin to accommodate uncertainty in results at the TRL level achieved.
- Weight constraints of the overall propulsion system so as to minimize the propulsion weight ratio to the OEW and achieve the best possible power density.
- It is implicit that targets must be compatible with safety as an overarching requirement.

The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to systems, sub-systems and components level requirements, from where pertinent performance targets including key performance indicators shall be derived.

Those performance targets, including key performance indicators (KPIs), shall be defined and calibrated with the objective of maximizing the probability of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T. objectives[43];
- these performance targets shall be established, developed and actual corresponding quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of HER aircraft;
- KPIs and the corresponding quantified targets shall be defined according to the technologies involved within the propulsion system and depending on its integration in the aircraft, in a manner consistent with the overall GHG reduction targets.
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

The applicant shall determine and quantify the above targets at system, sub-system and down to

[43] SMART = Specific, Measurable, Achievable, Relevant, Timely

component level; they shall be adapted to the explored configurations, and, for each one, accompanied by a maturity roadmap and a strategic development plan including performance improvements by 2030 for critical components, taking into account:

- in terms of systems weight and volume, the whole packaging required to comply with cooling needs, with ground and flight envelope requirements (e.g. maximum high and low temperature) and with any applicable safety requirements. This applies in particular to battery packs and fuel cell stacks.
- thermal management aspects, which require a proper coordination with the other relevant projects, in particular with the Thermal Management project [see HORIZON-JU-CLEAN-AVIATION-2022-01-HER-02].
- power densities of electrical components, fuel cells and batteries, as well as the efficiencies at component, sub-system and overall levels, the cooling efficiencies. For instance, consideration could be given to: emissions / overall propulsion system weight; lost (cooling) / kW usable (energy supply); total volume impact / kW usable; total weight impact / volume impact; etc.

These metrics shall be flowed down in the proposal from HER propulsion system level down to component level with the aim of yielding an optimal overall configuration (or several configurations as applicable). The resulting objectives have to be demonstrated in ground tests of the whole propulsion system (full or scaled demonstrator) enabling the SRIA performance objectives to be met for the aircraft configuration(s) concerned.
All data required to characterize emissions (including non-CO_2 effects) shall be modelled and measured as required to feed aircraft performance assessment(s). Factors relative to non-CO_2 effects which are needed from other topics or other sources shall be identified, properly checked, adapted and incorporated where needed into the topic assessments.

Proposals shall include a detailed project plan with key milestones and deliverables, together with a list of performance targets per critical technologies associated to this plan.

II. HORIZON-JU-CLEAN-AVIATION-2022-01-HER-02: Thermal Management Solutions for Hybrid-Electric Regional Aircraft

Description of the call topic and topic and specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of up to EUR 40 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 40 million. The Clean Aviation Joint Undertaking may award one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level as minimum at their entry point. Activities are expected to achieve TRL 5 at each sub-/system level at project completion. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include systems integrators and their supply chain with a proven track record in developing and delivering globally competitive systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market

	deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs demonstrating a track record of successful design, development, manufacturing and certification in the aeronautical supply chain of regional and/or single aisle aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional and short and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of the Clean Aviation programme, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with the other relevant JU projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under other relevant projects. A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this

	key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. “Founding Member”, “Associated Member” and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[44], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. “Founding Member”, “Associated Member” and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[45] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[46], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a “Member” of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[47] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023, and duly considers interfaces and interdependencies therein, in order to ensure a

[44] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[45] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[46] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[47] available on the F&T portal

	consistent and coordinated approach with the selected other relevant projects. - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to the following expected outcomes:

- Develop a thermal management concept for a Hybrid Electric Regional Aircraft (HER) with an improved efficiency and minimum weight compared to 2020 state of the art with conventional technologies, contributing to the targeted fuel burn reduction of minimum 50%[48] at aircraft level. The concept shall identify and address all relevant heat loads expected to arise as a consequence of the novel architecture for a regional aircraft with hybrid-electric propulsion. This project shall focus on thermal management solutions at aircraft level, expected to be at 1 MW and beyond, excluding the thermal loads from the powerplant:
    - Heat loads of new electrical energy sources (batteries and APU/ fuel cells) or other relevant aircraft systems impacted by the novel architecture from 300 to 1000 kW;
    - "conventional" heat loads such as (but not limited to) from the cockpit, cabin, the ECS or non-propulsive power electronics from 20 to 50 kW;
    - Non-propulsive power electronics from 20 to 50 kW (share between pressurized, temperature controlled, non-pressurized, non-temperature-controlled areas to be addressed);
    - Proposed solutions shall seek a minimum aerodynamic drag penalty at aircraft level;
- Demonstrate at project completion the thermal management performance and detail the demonstration plan, with inclusion of component/sub-system level, to meet the maturity of TRL 5 at project completion.

[48] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission.

- Determine and substantiate the main criteria and the key parameters / KPIs of the thermal management such as but not limited to heat generation, energy and cooling efficiencies, safety, maintainability and durability criteria, in close cooperation with the identified other relevant projects related to the aircraft concepts under investigation.
- Identify and develop the key cooling technologies and sub-systems including potential cooling possibilities needed for the above-mentioned hybrid-electric aircraft concept while taking into account the typical aeronautical usage / flight profile / ground operations, in terms of weight and reliability and meeting the new aircraft and thermal management requirements. This includes appropriate cooling systems for power systems / components located in the aircraft fuselage (for power electronics cooling, APU/fuel cell cooling and battery cooling), aiming at maximum cooling efficiency, minimum weight and bulkiness penalties.
- Identify and develop the key enabling technologies needed to allow the adoption of hydrogen as fuel / energy source while meeting the above-mentioned objective, including compatibility with future hydrogen-powered aircraft concepts.
- Identify and deliver advanced air supply system concept(s) able to match the key features and issues of the hybrid-electric propulsion with high efficiency and reduced impact on engine operations (e.g. bleed vs less-bleed vs no bleed, waste heat and energy recuperation and reuse), also without impact on cabin air quality.
- Deliver a roadmap towards full-scale demonstration of the thermal management system compatible with TRL6 at aircraft level before the end of the Clean Aviation programme and compatible with an entry into service by 2035.
- Propose a qualification and certification plan linked to the proposed activities and suitable to HER aircraft.
- Identify the components and sub-/systems including the requirements, criteria, functionalities, and issues (such as but not limited to power, energy efficiency, cooling efficiency, systems sizing and optimization or thermal and energy management), which can be potential “stepping stones” from the HER to the SMR activity in Clean Aviation, allowing to leverage potential synergies between these two targeted aircraft categories, implying a tight coordination need.
- Implement and test the concept in an Iron Bird ground demonstrator and perform scaled tests enabling integration of all subsystems of the Thermal Management System.
- Deliver digital twins of the components, subsystems and the thermal management system compatible with the reference aircraft digital framework and requirements, in order to regularly assess the contribution to the overall aircraft performance in the context of the impact monitoring framework. These models shall be continuously validated and updated at each step in the TRL progress loop. Solutions shall propose a Prognostics & Health Management approach together with an associated digital model.

- Identify synergies with activities funded under research and innovation programmes at regional, national[49] and European[50] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

Greater attention to environmental aspects (even with stringent regulations) and higher market demand are changing the scenario of air mobility in the short range, centred on 500 km and up to 1000 km. Air vehicles (as defined in CS25/FAR25) operating in this range and operational environment (including regional aircraft with a capacity of up to 100 seats) are considered the first application in the scheduled air transport system that will adopt hybrid-electric propulsion technologies and associated complementary solutions for reducing the environmental footprint, toward climate-neutral aviation. Air vehicles operating at smaller distances or on thinner routes will also benefit from electric propulsion solutions tested on regional aircraft testbeds, by sharing the development of power modules and making use of different approaches to air vehicle integration.

Thermal management is one of the key challenges for the successful realization of the Hybrid-Electric Regional aircraft (HER) with a targeted fuel burn reduction of minimum 50% at aircraft level. The reference HER aircraft shall have a seating capacity up to 100 passengers in a standard configuration, with a sizing mission of around 1000 km and a typical sector distance flown of around 400-500 km.

- Any deviation from these references as a result of different configuration effects (e.g., for technical feasibility, project viability reasons, or for optimizing the project outcome) should be identified and substantiated.
- The thermal management performance requirements shall be dependent on the targeted HER aircraft architecture configuration(s)[51] also considering the thermal management of the hybrid-electric propulsion system[52], which both will be delivered by one or more separate projects launched under Clean Aviation.

The scope of this topic is to deliver a thermal management concept including all relevant key enabling technologies matured to TRL 5 at system level at project completion, compatible with HER aircraft concept(s) selected at the end of 2025.

The project may explore different configurations, which shall be described in detail (justification, targeted advantages, anticipated drawbacks, anticipated challenges, possible adaptations, risks, etc.) and compared in terms of potential and the most promising option selected.

The hybrid-electric architecture will be challenging in terms of thermal management to match the systems architecture cooling requirements. Therefore, a suitable thermal management concept at

[49] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[50] activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

[51] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01: Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

aircraft level needs to be developed and validated in close connection with solutions at component and system levels which take this interrelationship into account.

Regarding the future potential use of liquid hydrogen tanks for fuel cells or direct burn in a gas turbine engine, this will have an impact on the thermal management architecture and may provide novel cooling solution opportunities. Inputs from relevant H2 technology developments (e.g. Liquid Hydrogen (LH2) heat exchangers or LH2 fuel systems) will be delivered by another relevant project[53] launched under the Clean Aviation programme.

Proposed concepts will build on, adapt, complement and add to DO 160, DO 178, CS-25 and any other relevant regulations, to highlight any gaps and maximize the impact potential, and to enable new certification standards, while maintaining or enhancing safety levels. The project shall propose a qualification and certification plan suitable to HER aircraft. It shall support Clean Aviation initiatives to define new certification or qualification rules as well new standardisation efforts, as necessary, concerning the areas of the project and others related to them.

Proposed solutions shall explore critical ground situations linked to sizing or off-design conditions such as little or no relative cooling flow in hot & high conditions during taxiing within HER typical operative range on ground and in flight.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification process of novel hybrid-electric propulsion technologies.

Scalability (down and up) to other applications is an opportunity to be pursued, in particular versus the Short and Short-Medium Range (SR/SMR) class, given the fact that the HER and SR/SMR classes are today adjacent, if not overlapping. This requires an effective coordination to establish collaboration with the other relevant projects.

Performance Targets:

A number of top-level goals will be the basis for performance targets, in particular:

- Minimum overall weight of the thermal management system (weight penalty <30% compared to 2020 SoA with conventional technologies)
- High thermal/energy efficiency (Coefficient of Performance ≥ 2 at the design point, using non-flammable refrigerant with GWP <= 1);
- Minimum surface-area-to-volume-ratio or any relevant size-related parameter target: consistent with aircraft and systems requirements and constraints (including architecture / installation / thermal aspects);
- It is implicit that all targets must be compatible with safety as an overarching requirement.

The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to systems, sub-systems and components level requirements, from where pertinent performance targets including key performance indicators shall be derived.

[53] HORIZON-JU-CLEAN-AVIATION-2023-02-HPA-01: Liquid Hydrogen Fuel Distribution Technologies

Those performance targets (such as but not limited to overall weight impact, thermal / energy efficiency or size/volume), including key performance indicators (KPIs), shall be defined and calibrated with the objective of maximizing the probability of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T. objectives[54];
- these performance targets shall be established, developed and actual corresponding metrics and quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of HER aircraft (including operational, certification, safety and reliability requirements, technical standards and all applicable regulations, manufacturing, life-cycle costs);
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

The applicant shall determine and quantify the above targets at system, sub-system and down to component level; they shall be adapted to the explored configurations, and, for each one, accompanied by a maturity roadmap and a strategic development plan including performance improvements by 2030 for critical components, taking into account:

- in terms of systems weight and volume, the whole packaging of the thermal management system required to comply with cooling needs, with ground and flight envelope requirements (e.g., maximum high and low temperature) and with any applicable safety requirements. This applies in particular to battery packs and fuel cell stacks.
- The performance benchmarking, targets, ratios and KPIs, either existing or to be developed as required, shall cover the thermal management of all concerned electrical components, fuel cells and batteries, including the efficiency of the cooling systems for the components. For instance, consideration could be given to ratios such as: kW lost (cooling) / kW usable.

These metrics shall be flowed down in the proposal from HER thermal management system level down to component level with the aim of yielding an optimal overall configuration. The resulting objectives have to be demonstrated in ground tests of the whole thermal management system enabling the SRIA performance objectives to be met for the aircraft concerned.

Proposals shall include a detailed project plan with key milestones and deliverables and a list of performance targets per critical technologies associated to this plan.

[54] SMART = Specific, Measurable, Achievable, Relevant, Timely

III. HORIZON-JU-CLEAN-AVIATION-2022-01-HER-03: Electrical Distribution Solutions for Hybrid-Electric Regional Aircraft

Description of the call topic and topic and specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of up to EUR 40 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 40 million. The Clean Aviation Joint Undertaking may award one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level at their minimum entry point. Activities are expected to achieve TRL 5 at each sub-/system level at project completion. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include systems integrators and their supply chain with a proven track record in developing and delivering globally competitive systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation

	and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs demonstrating a track record of successful design, development, manufacturing and certification in the aeronautical supply chain of regional and/or single aisle aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional and short and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of the Clean Aviation programme, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with the other relevant JU projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under other relevant projects. A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the

	project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. “Founding Member”, “Associated Member” and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[55], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. “Founding Member”, “Associated Member” and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[56] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[57], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a “Member” of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[58] at large.

[55] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[56] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[57] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[58] available on the F&T portal

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects. - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to the following expected outcomes:

- Demonstrate at project completion the performance of the advanced electrical distribution system and detail the demonstration plan, with inclusion of component/sub-system level, to meet the maturity of TRL 5 at project completion.
- Demonstrate that the proposed electrical distribution system(s) is (are) reliable and safe at the voltages as required for a hybrid-electric architecture that delivers the targeted performance at typical operating conditions, considering 800 V or beyond for the distribution, while meeting the requirements of maximum efficiency, minimum weight penalty, maintainability and durability, taking into account the various components and electrical energy sources under investigation such as but not limited to:
    - Batteries (development not part of this topic)
    - Fuel cells (covered in a separate project in Clean Aviation[59])

[59] HORIZON-JU-CLEAN-AVIATION-2022-01-HPA-02: Multi-MW Fuel Cell Propulsion System for Hydrogen-Powered Aircraft

- Turbo generators and AC/DC converters (covered in a separate project in Clean Aviation[60])
- Electric motors (covered in a separate project in Clean Aviation[61])
- Cables, wiring and various components / devices (such as but not limited to protection and control)

- Identify and deliver an advanced electrical distribution concept for a Hybrid Electric Regional Aircraft (HER) with minimum weight, contributing to the targeted fuel burn reduction of minimum 50%[62] at aircraft level, considering modular approaches and in close cooperation with the identified other relevant project(s) related to the aircraft concepts under investigation.
- Determine and substantiate the main criteria and the key parameters / KPIs of the electrical distribution system i.e. voltage, power capacity, heat generation, energy and cooling efficiencies, safety robustness such as but not limited to arcing, fire and lightning strike impact, maintainability and durability criteria, in close cooperation with the identified other relevant project(s) related to the aircraft concepts under investigation.
- Identify and develop all key enabling technologies and components (e.g. the power management, power electronics, switches, control systems, protection devices, etc) needed to allow the adoption of increased electrical power for a hybridization of the propulsion system of minimum 50% for a 50 pax HER.
- Deliver digital twins and a life cycle assessment of the components, subsystems and the full advanced electric distribution system compatible with the reference aircraft digital framework and requirements, in order to regularly assess the contribution to the overall aircraft performance in the context of the impact monitoring framework. These models shall be continuously validated and updated at each step in the TRL progress loop. Solutions shall propose a Prognostics & Health Management approach together with an associated digital model.
- Propose a qualification and certification plan linked to the proposed activities and suitable to HER aircraft.
- Deliver a roadmap towards full-scale demonstration of the advanced electrical distribution system(s) compatible with TRL6 at aircraft level before the end of the Clean Aviation programme and compatible with an entry into service by 2035.
- Identify the components and sub-/systems including the requirements, criteria, functionalities, and issues (such as but not limited to power, energy efficiency, grounding, electromagnetic compatibility, cooling efficiency, systems sizing and optimization or thermal and energy management), which can be potential “stepping stones” from the HER to the SMR activity in Clean Aviation, allowing to leverage potential synergies between these two targeted aircraft categories, implying a tight coordination need.

[60] HORIZON-JU-CLEAN-AVIATION-2022-01-HER-01: Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft

[61] HORIZON-JU-CLEAN-AVIATION-2022-01-HER-01: Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft

[62] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

- Identify synergies with activities funded under research and innovation programmes at regional, national[63] and European[64] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

Greater attention to environmental aspects (even with stringent regulations) and higher market demand are changing the scenario of air mobility in the short range, centred on 500 km and up to 1000 km. Air vehicles (as defined in CS25/FAR25) operating in this range and operational environment (including regional aircraft with a capacity of up to 100 seats) are considered the first application in the scheduled air transport system that will adopt hybrid-electric propulsion technologies and associated complementary solutions for reducing the environmental footprint, toward climate-neutral aviation. Air vehicles operating at smaller distances or on thinner routes will also benefit from electric propulsion solutions tested on regional aircraft testbeds, by sharing the development of power modules and making use of different approaches to air vehicle integration.

The Advanced Electrical Distribution network is one of the key enablers for the successful realization of the Hybrid-Electric Regional aircraft (HER) with a targeted fuel burn reduction of minimum 50%[65] at aircraft level.

The reference HER aircraft shall have a seating capacity up to 100 passengers in a standard configuration, with a sizing mission of around 1000 km and a typical sector distance flown of around 400-500 km.

- Any deviation from these references as a result of different configuration effects (e.g., for technical feasibility, project viability reasons, or for optimizing the project outcome) should be identified and substantiated.
- The electrical distribution performance requirements shall be dependent on the targeted HER aircraft architecture configuration(s)[66] including the selected hybrid-electric propulsion system[67], which both will be delivered by one or more separate projects launched under Clean Aviation.

The scope of this topic is to deliver an advanced electrical distribution concept including all relevant key enabling technologies at TRL 5 at system level at project completion, compatible with HER aircraft concept(s) selected at the end of 2025.

The project may explore different configurations, which shall be described in detail (justification, targeted advantages, anticipated drawbacks, anticipated challenges, possible adaptations, risks, etc.) and compared in terms of potential and the most promising option selected.

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[63] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[64] activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

[65] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission.

[66] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01: Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

[67] HORIZON-JU-CLEAN-AVIATION-2022-01-HER-01: Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft

New hybrid-electric propulsion concepts and the associated introduction of their electrical architecture and technologies require innovative and disruptive solutions to reduce the electrical distribution network weight and volume while complying with functional and safety requirements. Depending on the sizing and degree of hybridization, total power of the hybrid-electric propulsion concept is expected to range from 4 to 10 MW. Any single electrical channel shall manage an electric power (for propulsive system and other systems) of 500 kW – 1 MW minimum with a specific power management to address safety and certification requirements. All these conditions have important implications at the aircraft level:

- The electrical distribution system must be robust with respect to the different adverse physical phenomena associated with severe environmental conditions (such as partial discharges, arcing and lightning effects at high voltages and low pressures or in non-pressurized areas).
- New electrical energy storage devices (batteries and/or fuel cells) will raise new challenges to the aircraft electrical systems in terms of networking, safety and performance. Transitioning to high voltage electrical network will require in particular new solutions and approaches.
- The electrical control system must be able to respond to the aircraft mission profile needs and performance, including power-up and down of systems and propulsion. The aggregated energy management system must be optimized in terms of sizing and operation in order to achieve reduced weight and fuel consumption in regard of the defined flight mission, while addressing situations involving power reduction / shedding, requiring system flexibility, reconfiguration capability and proper handling of any failure modes.

Life cycle aspects should be considered in the overall environmental impact.

Proposed concepts will build on, adapt, complement and add to DO 160, DO 178, CS-25 and any other relevant regulations, to highlight any gaps and maximize the impact potential, and to enable new certification standards, while maintaining or enhancing safety levels. The project shall propose a qualification and certification plan suitable to HER aircraft. It shall support Clean Aviation initiatives to define new certification or qualification rules as well as new standardisation efforts concerning the areas of the project and others related to them.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification process of novel electrical distribution technologies.

Scalability (down and up) to other applications is an opportunity to be pursued, in particular versus the Short and Short-Medium Range (SR/SMR) class, given the fact that the HER and SR/SMR classes are today adjacent, if not overlapping. This requires an effective coordination to establish collaboration with the other relevant projects.

<u>Performance Targets:</u>

A number of top-level goals at system level will be the basis for performance targets, in particular:

- Minimum overall weight of the advanced electrical distribution system (weight penalty <20% compared to 2020 SoA with conventional technology);
- High thermal/energy efficiency (>95%);

- Minimum surface-area-to-volume-ratio or any relevant size-related parameter target: consistent with aircraft and systems requirements and constraints (including architecture / installation / thermal aspects);
- It is implicit that all targets must be compatible with safety as an overarching requirement.

The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to systems, sub-systems and components level requirements, from where pertinent performance targets including key performance indicators shall be derived.

Those performance targets (such as but not limited to power capacity, energy density, energy/thermal efficiency, cooling efficiency, weight, volume, safety and reliability criteria including system MTBF[68], MTBR[69], etc.), as well as the key performance indicators (KPIs), shall be defined and calibrated with the objective of maximizing the probability of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T. objectives[70];
- these performance targets shall be established, developed and actual corresponding metrics together with quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of HER aircraft (including operational, certification safety and reliability requirements, technical standards and all applicable regulations, manufacturing, life-cycle costs);
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

The applicant shall determine and quantify the above targets at system, sub-system and down to component level; they shall be adapted to the explored configurations, and, for each one, accompanied by a maturity roadmap and a strategic development plan including performance improvements by 2030 for critical components taking into account:

- in terms of systems weight and volume, the whole packaging required to comply with cooling needs, with ground and flight envelope requirements (e.g., maximum high and low temperature) and with any applicable safety requirements. This applies in particular to battery packs and fuel cell stacks.
- thermal management aspects, which require a proper coordination with the other relevant Project(s), in particular with the Thermal Management project[71] in Clean Aviation.
- power densities of electrical components, fuel cells and batteries, as well as the efficiencies at component, sub-system and overall levels, the cooling efficiencies. For instance, consideration

[68] MTBF: Mean Time Between Failures
[69] MTBR: Mean Time Between Repairs
[70] SMART = Specific, Measurable, Achievable, Relevant, Timely
[71] HORIZON-JU-CLEAN-AVIATION-2022-01-HER-02: Thermal Management Solutions for Hybrid Electric Regional Aircraft

could be given to: overall propulsion system weight; kW lost (cooling) / kW usable (energy supply); total volume impact / kW usable ; total weight impact per unit of volume; etc.

These metrics shall be flowed down in the proposal from HER advanced electrical distribution system level down to component level with the aim of yielding an optimal overall configuration (or several configurations as applicable). The resulting objectives have to be demonstrated in ground tests of the whole electrical distribution system enabling the SRIA performance objectives to be met for the aircraft configuration(s) concerned.

All data required to characterize environmental impact over the life cycle shall be modelled and measured as required to feed aircraft performance assessment(s).
Proposals shall include a detailed project plan with key milestones and deliverables and a list of performance targets per critical technologies associated to this plan.

IV. HORIZON-JU-CLEAN-AVIATION-2022-01-HER-04: Innovative Wing Design for Hybrid-Electric Regional Aircraft

Description of the call topic and topic and specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of up to EUR 20 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 20 million. The Clean Aviation Joint Undertaking may award one project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level at their minimum entry point. Activities are expected to achieve TRL5 at overall wing system level at project completion. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft

	with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking (CAJU) expects proposals to be submitted by consortia that include airframe/aerostructures integrators and their supply chain with a proven track record in developing and delivering globally competitive airframe/aerostructures to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programs demonstrating a track record of successful design, development, manufacturing and certification in the aeronautical supply chain of regional and/or single aisle aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional and short and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of the Clean Aviation programme, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with the other relevant JU projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant

	JU topics: see further under other relevant projects. A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. “Founding Member”, “Associated Member” and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[72], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. “Founding Member”, “Associated Member” and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[73] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[74], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants

[72] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[73] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[74] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

	in the proposal who are not a "Member" of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme/Strategic Research and Innovation Agenda[75] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023, and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects. - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to the following expected outcomes:

- Identify and deliver an innovative wing design for the targeted concept for a hybrid-electric regional (HER) aircraft with maximum aerodynamic efficiency and minimum weight,

[75] available on the F&T portal

contributing to the targeted fuel burn reduction of minimum 50%[76] at A/C level, while taking into account:

- the integration of the hybrid-electric propulsion system plus subsystems into wing (depending on aircraft architecture)
- the installation of other aircraft system typically positioned in/mounted on the wing

- Demonstrate a minimum fuel burn reduction of no less than 15%[77] at integrated wing level, compared to a clearly identified 2020 SoA reference wing, supporting a fuel burn reduction of 50% at aircraft level, taking into account the wing-fuselage effects but excluding the engine installation effects.
- Demonstrate at project completion the targeted overall structure weight reduction of 20% at full wing level (excluding propulsion system) depending on the A/C architecture compared to a clearly identified 2020 SoA wing. Quantified reduction potential in CO_2 and all other relevant GHG emissions (see performance targets section below) are expected to be derived from the project (both in terms of actual demonstrated and potential performance impact).
- Develop and demonstrate novel approaches to increase structural, aero-elastic and aerodynamic performances, and boost emission reduction potential beyond the targeted level of aerodynamic and structural efficiency and potential fuel burn reduction;
- Demonstrate the wing design performance and maturity at TRL 5 at full wing system level at project completion via relevant tests and ground demonstration. The applicant shall detail the demonstration plan, with inclusion of component/sub-system level, and develop, propose and execute an appropriate simulation and testing programme to ensure confidence that the required maturity levels and performance targets are met.
- Deliver a roadmap towards wing full-scale demonstration at TRL 6 at aircraft level with a first flight not later than 2030 following new certification rules for novel technologies and compatible with an entry into service by 2035.
- Propose a qualification and certification plan linked to the proposed activities and suitable to HER aircraft.
- Deliver modules and systems designs compatible with more electrical functions (such as but not limited to electric actuators for flaps/slats/spoilers or electric-thermal ice protection systems) and alternate energy sources such as hydrogen and SAF, enabling for disruptive concepts.
- Deliver digital twins and a life cycle assessment of the components, subsystems and full wing system compatible with the reference aircraft digital framework and requirements, in order to regularly assess the contribution to the overall aircraft performance in the context of the impact monitoring framework. These models shall be continuously validated and updated at each step in the TRL progress loop. Solutions shall propose a Prognostics & Health Management approach together with an associated digital model.

[76] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission.
[77] measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

- Identify synergies with activities funded under research and innovation programmes at regional, national[78] and European[79] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

Greater attention to environmental aspects (even with stringent regulations) and higher market demand are changing the scenario of air mobility in the short range, centred on 500 km and up to 1000 km. Air vehicles (as defined in CS25/FAR25) operating in this range and operational environment (including regional aircraft with a capacity of up to 100 seats) are considered the first application in the scheduled air transport system that will adopt hybrid-electric propulsion technologies and associated complementary solutions for reducing the environmental footprint, toward climate-neutral aviation. Air vehicles operating at smaller distances or on thinner routes will also benefit from electric propulsion solutions tested on regional aircraft testbeds, by sharing the development of power modules and making use of different approaches to air vehicle integration.

A novel wing design is one of the key enablers for the successful realization of the Hybrid-Electric Regional aircraft (HER) with a targeted fuel burn reduction of minimum 50%[2] at aircraft level. The reference HER aircraft shall have a seat capacity up to 100 passengers in a standard configuration, with a sizing mission of around 1000 km and a typical sector distance flown of around 400-500 km. The necessary overall aircraft power shall be in the range of 4 to 10 MW.

- Any deviation from these references as a result of different configuration effects (e.g. for project viability reasons, or for optimizing the project outcome) should be identified and substantiated.
- The wing performance requirements shall be dependent on the targeted HER aircraft architecture configuration(s)[80] including the selected hybrid-electric propulsion system[81], which both will be delivered by one or more separate projects launched under Clean Aviation.

The scope of this topic is to deliver an innovative wing design including the relevant technology bricks expected to meet TRL 5 at wing system level at project completion and compatible with HER aircraft concept(s) selected at the end of 2025.

The hybrid-electric propulsion system will come with challenges in system integration (e.g. wing-engine, controls, energy distribution) and in aircraft integration. Therefore, a wing design and the enabling technologies need to be developed and validated in close connection with solutions and choices at aircraft, system and component level, and taking into account interdependencies. The future potential use of hydrogen as energy source requires the development and demonstration of compatible technologies and sub-systems that will have an impact on the wing system, as well as on

[78] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[79] activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

[80] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01: Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

[81] HORIZON-JU-CLEAN-AVIATION-2022-01-HER-01: Multi-MW Hybrid-Electric Propulsion System for Regional Aircraft

the aircraft architecture. Inputs from relevant hydrogen technology developments (e.g. H2 distribution system), as well as from the propulsion system and fuselage will be delivered by separated projects launched under Clean Aviation.

The project shall also investigate the impact and features of the proposed concept(s) on operations and systems (e.g. flight control systems, anti-icing, etc.). Life cycle aspects should be considered in the overall environmental impact. A quantitative and qualitative estimation of future potential performance, identifying issues and potential solutions should be provided.

Proposed designs will build on, adapt, complement and add to DO 160, DO 178, CS-25 and any other relevant regulations, to highlight any gaps and maximize the impact potential, and to enable new certification standards, while maintaining or enhancing safety levels. It shall support Clean Aviation initiatives to define new certification or qualification rules as well new standardisation efforts concerning the areas of the project and others related to them. Any specific safety or certification issue should be highlighted.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification process of novel wing technologies.

Scalability (down and up) to other applications is an opportunity to be pursued, in particular versus the Short and Short-Medium Range (SR/SMR) class, given the fact that the HER and SR/SMR classes are today adjacent, if not overlapping. This requires an effective coordination to establish collaboration with the other relevant projects.

Performance Targets:

A number of top-level goals will be the basis for performance targets, in particular:

- No less than 15% fuel burn reduction target at integrated wing level (taking into account the wing-fuselage effects but excluding the engine installation effects);
- Targeting 20% structure weight reduction at full wing level (excluding propulsion system)
- Maximum aerodynamic efficiency
- wing system: installed performance contributing to the a/c performance target of 50% fuel burn reduction, to be extended as much as possible to a target of 50% GHG emissions reduction at aircraft level (possibly expressed, for instance, in terms of overall GHG emissions per passenger kilometre);
- It is implicit that targets must be compatible with safety (compliant with certification aspects) as an overarching requirement.

The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to systems, sub-systems and components level requirements, from where pertinent performance targets including key performance indicators shall be derived.

The performance targets, including key performance indicators (KPIs), shall be defined and calibrated with the objective of maximizing the probability of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T. objectives[82];
- these performance targets shall be established, developed and actual corresponding metrics and quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of HER aircraft (e.g. static and dynamic loads, noise, operation on ground);
- KPIs and the corresponding quantified targets shall be defined according to the technologies involved within the wing system, in a manner consistent with the overall GHG reduction targets
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

The applicant shall determine performance targets down to component level (e.g. weight reduction, improved aerodynamic performance, etc), including a maturity roadmap and a strategic development plan including performance improvements by 2030 for critical components and considering the potential implication of the design on aircraft noise as well as taking into account:

- Propulsion system (distributed propulsion or not)
- Flight control systems (FCS)
- Energy storage
- Energy distribution system
- High voltage electrical Network
- Noise requirements
- Regulation

The metrics shall be flowed down in the proposal from wing system level down to component level with the aim of yielding an optimal overall configuration (or several configurations as applicable). The resulting objectives have to be demonstrated in ground tests of the whole wing system enabling the SRIA performance objectives to be met for the aircraft configuration(s) concerned.

All data required to characterize the aircraft emissions and environmental impact over the life cycle shall be modelled and measured as required to feed aircraft performance assessment(s).

Proposals shall include a detailed project plan with key milestones and deliverables together with a list of performance targets per critical technologies associated to this plan.

[82] SMART = Specific, Measurable, Achievable, Relevant, Timely

3. Clean Aviation – Short/short-medium range Aircraft (SMR)

I. HORIZON-JU-CLEAN-AVIATION-2022-01-SMR-01: Ultra Efficient Propulsion Systems for Short and Short-Medium Range Aircraft

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of between EUR 25 and 100 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 175 million. The Clean Aviation Joint Undertaking may award up to 3 projects with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and technologies are expected to have TRL 3 at subsystem or component level as minimum entry point. Activities are expected to achieve TRL 4 or TRL 5 at system level at project completion depending on the concept developed, as indicated in section 'Expected Outcome'. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking expects proposals to be submitted by consortia that include propulsion system integrators and their supply chain with a proven track record in developing and delivering globally competitive

	propulsion systems to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programmes demonstrating a track record of successful design, development and certification in the aeronautical supply chain of short and short-medium range aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to short range and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity

	towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. “Founding Member”, “Associated Member” and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[83], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. “Founding Member”, “Associated Member” and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[84] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[85], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a “Member” of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme Strategic Research and Innovation Agenda[86] at large.

[83] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[84] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[85] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[86] available on the F&T portal

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects; - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to provide or contribute to the following expected outcomes:

- Demonstrate at project completion a substantial step in the energy efficiency and emissions of the overall propulsion system compared to a clearly identified 2020 state-of-the-art reference engine that will contribute to the target of at least 30%[87] fuel burn reduction on a typical mission and at overall aircraft level. The project's results should provide the foundation to progress the further research and demonstration that will enable the development of an ultra-efficient propulsion system for a Short and Short-Medium (SR/SMR) aircraft with maximum efficiency, minimum weight and minimum drag penalty, and with a target EIS of no later than 2035.

[87] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

- Relevant energy efficiency and emissions improvement targets shall be identified and elaborated in appropriate metrics, such as but not limited to installed cruise Thrust Specific Fuel Consumption (TSFC) if applicable.
- Quantified reduction potential in CO2 and all other relevant GHG emissions (see performance targets section below) are expected to be derived from the project (both in terms of actual demonstrated and potential performance impact); further reduction potential beyond the target in one or several of the known GHG emissions related to aviation propulsion will receive strong consideration within the evaluation of proposals.

- Demonstrate one or more engine architecture(s) compatible with the SR/SMR aircraft architecture[88], and that may be a novel ultra-efficient ducted or unducted geared architecture with fuel-efficiency no less than the above mentioned 20% at engine level, with quantified reduction in installed TSFC (if applicable), CO_2 and all other relevant GHG emissions, and full adaptability to 100% (non-blended) SAF.
  - The project shall maximize propulsive efficiency and/or thermal efficiency, and address one or more of the three following *Configurations* (applicants may submit more than one proposal), including potential hybridization technologies to boost the emission reduction potential:
    - *Configuration 1*: integrated propulsion system based on an unducted engine architecture;
    - *Configuration 2:* integrated propulsion system based on ducted engine architecture;
    - *Configuration 3:* core engine and combustion technologies, including advanced thermodynamic cycles, to boost the emission reduction potential, and to reduce CO_2 and/or other relevant GHG emissions such as NOx.
- Develop a detailed roadmap defining the key enablers and actions needed for the engine architecture to allow the adoption of hydrogen as fuel / energy source and meeting the above mentioned objective, including compatibility with future hydrogen-powered aircraft concepts;
- Detail the demonstration plan, with inclusion of component/sub-system level, to meet the following maturity levels at project completion:
  - *Configuration 1* and *2*: TRL5 at engine system level;
  - *Configuration 3*: TRL4 at engine system level.

  The performance and the technology maturity of the propulsion system at project completion shall be verified via full-scale engine ground demonstration testing for *Configurations 1* and *2*, and up to system/sub-system level for *Configuration 3*.
- Deliver a roadmap towards full-scale demonstration of the propulsion system compatible with TRL6 at aircraft level before the end of the Clean Aviation programme and compatible with an EIS by 2035. Propose a qualification and certification plan linked to the proposed activities and suitable to SR/SMR aircraft.
- Consider concepts addressing propulsive and non-propulsive loads, compatible with more electrical functions and in relation to alternate energy sources such as hydrogen. Trade-offs aspects between electrical solutions, non-electrical solutions, and hybrid solutions if

[88] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

applicable, shall be analysed in sufficient depth to propose and substantiate optimized solutions.

- Deliver digital twins of the components, subsystems and the full propulsion system compatible with the reference aircraft digital framework and requirements, as required to feed aircraft performance assessment(s) in the context of the impact monitoring framework.
- Identify synergies with activities funded under research and innovation programmes at regional[89], national[90] and European[91] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

With the greater attention to environmental aspects (even with stringent regulations) and higher market demand, the mid-2030s are expected to see the entry of a new generation of SR/SMR aircraft (with a capacity of up to 250 seats) aiming towards sustainable climate-neutral flight. While hybrid/electric energy architectures are considered to pave the way towards climate-neutral aviation on routes shorter than 1000 km, aircraft for classical short and medium-range distances, i.e. from 1000 km up to 3700 km, will rely on ultra-efficient aircraft designs and ultra-efficient thermal energy-based propulsion technologies using sustainable drop-in and non-drop-in fuels.

Propulsion represents a major challenge for the successful realization of the SR/SMR aircraft with a targeted fuel burn reduction of minimum 20%[92] at overall engine / propulsion system level, supporting a fuel burn reduction of 30%[93] at aircraft level.

- The assumptions relative to the aircraft operating envelope, to the flight mission profile, to the aircraft range, to the aircraft cruise speed, to the aircraft seating capacities and to the main aircraft sizing parameters in general, shall be fully consistent with those applicable in the SR/SMR aircraft architectures[94].
- Consistent propulsion power requirements shall be derived accordingly from the SR/SMR aircraft architectures[95]. Any deviation from these references as a result of different configuration effects (e.g., for technical feasibility, project viability reasons, or for optimizing the project outcome) should be identified and substantiated.

This topic is intended to deliver a novel engine architecture expected to meet, by project completion, a technology maturity levels at TRL5 for *Configurations 1* and *2*, and TRL4 for *Configuration 3*, and to

[89] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[90] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[91] activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

[92] compared to 2020 state-of-the-art engine / propulsion system available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

[93] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

[94] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

[95] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

be compatible with the SR/SMR aircraft concepts selected at that time. Engine integration activities are addressed within a separate topic dedicated to aircraft architecture concepts[96].

Novel propulsion technologies will bring challenges in system integration as well as in aircraft integration. Therefore, they need to be developed and validated in close connection with solutions and choices at aircraft, system and component level, while taking into account interdependencies.

The future potential use of hydrogen as energy source requires the development and demonstration of compatible technologies (e.g. hydrogen burning engines) and sub-systems that will have an impact on the propulsion system architecture, as well as on the aircraft architecture. Inputs from relevant hydrogen technology developments (e.g. hydrogen-burn technologies) will be delivered by a separate project launched under the hydrogen dedicated part of Clean Aviation programmes.

Proposed concepts will build on, adapt, complement and add to DO 160, DO 178 and CS-25 and other regulations to highlight any gaps and maximize the impact potential, and to enable new certification standards, while maintaining or enhancing safety levels. The project shall propose a qualification and certification plan suitable to SR/SMR aircraft. It shall support Clean Aviation initiatives to define new certification or qualification rules as well new standardisation efforts concerning the areas of the project and others related to them. Any specific safety or certification issue should be highlighted, and mitigation action should be proposed.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification of novel engine technologies.

Performance Targets:

A number of top level goals will be the basis for performance targets, in particular:

- No less than a 20%[97] reduction in fuel burn and related emissions on a typical mission at overall propulsion system level compared to a clearly identified 2020 state-of-the-art reference engine (not considering other contributions or installation effects);
- Engine/installed performance compliant with the aircraft performance target of 30%[98] fuel burn reduction, to be extended as much as possible to a target of 30% GHG emissions reduction at aircraft level (possibly expressed, for instance, in terms of overall GHG emissions per passenger kilometre);
- All noise and emissions levels resulting from the project's outcomes shall be consistent with meeting all currently foreseen regulations and standards with sufficient margin to accommodate uncertainty in results at the TRL level achieved;
- Weight constraints of the overall propulsion system so as to minimize the propulsion weight ratio to the Operating Empty Weight;
- It is implicit that targets must be compatible with safety as overarching requirement.

[96] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

[97] compared to 2020 state-of-the-art engine / propulsion system available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

[98] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) on a typical mission

The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to systems, sub-systems and components level requirements, from where pertinent performance targets including key performance indicators shall be derived.

The performance targets, including key performance indicators (KPIs), shall be defined and calibrated with the objective of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T.[99] objectives;
- these performance targets shall be established, developed and actual corresponding quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of SR/SMR aircraft;
- KPIs and the corresponding quantified targets shall be defined according to the technologies involved within the propulsion system and depending on its integration in the aircraft, in a manner consistent with the overall GHG reduction targets.
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

Parameters expected to be specified by the applicant shall include (but not limited to) thrust (SLS), Fan Pressure Ratio, Overall Pressure Ratio and By-Pass Ratio, compatible with the aircraft and Maximum Take-Off Weight (MTOW), and including potential aircraft and engine growth capabilities.

The applicant shall also determine and quantify the targets at system, sub-system and down to component level, showing for example the Low Pressure system targets and/or core engine and combustion technologies targets; they shall be adapted to the explored configuration(s), and associated with the above-mentioned maturity roadmaps and development plans, which shall include performance improvements expected by 2030 for critical components.

Each configuration shall target an optimum product, consistent with overall requirements (e.g. technical and operational feasibility/efficiency, safety, industrial, maintainability, reliability, costs). Consideration shall be given to defining optimal solution through methodologies such as multi-objective optimization[100].

All data required to characterize the emissions (including non-CO_2 effects) shall be modelled and measured as required to feed aircraft performance assessment(s).

Proposals shall include a detailed project plan with key milestones and deliverables, together with a list of performance targets per critical technologies associated with this plan.

[99] S.M.A.R.T.: Specific, Measurable, Achievable, Relevant, Timely

[100] Refer to the method used in Independent Expert Integrated Technology Goals Assessment and Review for Engines and Aircraft (ICAO Doc 10127 – 2019)

II. HORIZON-JU-CLEAN-AVIATION-2022-01-SMR-02: Ultra Performance Wing for Short and Short-medium Range Aircraft

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of between EUR 25 and 55 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 55 million. The Clean Aviation Joint Undertaking may award up to 2 projects with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 4 or higher at wing system level at project completion depending on the configuration developed, as indicated in section 'Expected Outcome'. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking expects proposals to be submitted by consortia that include airframe/aerostructures integrators and their supply chain with a proven track record in developing and delivering globally competitive airframe/aerostructures to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market

	deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should also be able to manage large and complex international aeronautical programmes demonstrating a track record of successful design, development and certification in the aeronautical supply chain of short and short-medium range aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to short range and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this

	key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. “Founding Member”, “Associated Member” and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[101], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. “Founding Member”, “Associated Member” and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[102] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[103], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a “Member” of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme Strategic Research and Innovation Agenda[104] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in

[101] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[102] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[103] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[104] available on the F&T portal

	order to ensure a consistent and coordinated approach with the selected other relevant projects; - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to all the following expected outcomes:

- Identify and deliver an ultra-high performance wing design for the targeted concepts for a Short and/or Short-Medium Range (SR/SMR) aircraft[105] with maximum aerodynamic efficiency and minimum weight, in order to contribute to the targeted fuel burn reduction of minimum 30%[106] at aircraft level. The project shall develop one or both of the following wing configurations (applicants may submit more than one proposal to cover both configurations):
  - *Configuration 1*: a novel ultra-high performance wing design for the targeted concept for a highly efficient SR/SMR aircraft using SAF as fuel, with an increased energy efficiency of 10-13%[107] at integrated wing system level (including in particular flight control systems, high-lift devices and anti-icing), demonstrating an equivalent energy efficiency / GHG reduction benefit at aircraft level, while taking into account the wing-fuselage effects and the engine installation effects;
  - *Configuration 2*: a novel ultra-high performance wing design for the targeted concept for a ultra-efficient SR/SMR aircraft exploiting non-drop-in fuels such as hydrogen,

[105] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

[106] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (megajoules) per ASK as applicable, on a typical mission

[107] compared to a clearly identified 2020 SoA reference wing available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (MJ) per ASK as applicable, on a typical mission

with an increased energy efficiency of 15-17%[108] at integrated wing system level (including in particular flight control systems, high-lift devices and anti-icing), demonstrating an equivalent energy efficiency / GHG reduction benefit at aircraft level, while taking into account the wing-fuselage effects and the engine installation effects.

- Develop and demonstrate novel approaches to increase structural, aero-elastic and aerodynamic performances, and boost emission reduction potential beyond the targeted level of aerodynamic and structural efficiency and fuel burn reduction potential.
- Demonstrate at project completion the wing design performance and detail the demonstration plan, with inclusion of component/sub-system level, to meet TRL4 or higher at full wing system level at project completion via relevant ground wind-tunnel and scaled-flight tests demonstration. The applicant shall develop and propose an appropriate simulation and testing programme to ensure confidence that the required maturity levels and performance targets are met.
- Deliver a roadmap towards full-scale demonstration of the wing system compatible with TRL6 at aircraft level before the end of the Clean Aviation programme and compatible with an EIS by 2035. The applicant shall develop and propose an appropriate simulation and testing programme to ensure confidence that the required maturity levels and performance targets are met.
- Propose a qualification and certification plan linked to the proposed activities and suitable to SR/SMR aircraft.
- Deliver modules and systems designs compatible with more electrical functions and alternate energy sources such as hydrogen and SAF, enabling for disruptive concepts.
- Deliver digital twins and a life cycle assessment of the components, subsystems and full wing system compatible with the reference aircraft digital framework and requirements, in order to regularly assess the contribution to the overall aircraft performance in the context of the impact monitoring framework. These models shall be continuously validated and updated at each step in the TRL progress loop.
- Identify synergies with activities funded under research and innovation programmes at regional[109], national[110] and European[111] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

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[108] compared to a clearly identified 2020 SoA reference wing available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (megajoules) per ASK as applicable, on a typical mission

[109] Activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[110] Activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[111] Activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

With the greater attention to environmental aspects (even with stringent regulations) and higher market demand, the mid-2030s are expected to see the entry of a new generation of SR/SMR aircraft (with a capacity of up to 250 seats) aiming towards sustainable climate-neutral flight. While hybrid/electric energy architectures are considered to pave the way towards climate-neutral aviation on routes shorter than 1000 km, aircraft for classical short and medium-range distances, i.e. from 1000 km up to 3700 km, will rely on ultra-efficient aircraft designs and ultra-efficient thermal energy-based propulsion technologies using sustainable drop-in and non-drop-in fuels.

With its large impact on aircraft's total drag and weight, developing an ultra-high performance wing is a key element for the successful realization of the SR/SMR aircraft with a targeted fuel burn reduction of minimum 30%[112] at aircraft level.

- The assumptions relative to the aircraft operating envelope, to the flight mission profile, to the aircraft range, to the aircraft cruise speed, to the aircraft seating capacities and to the main aircraft sizing parameters in general, shall be fully consistent with those applicable in the SR/SMR aircraft architectures[113].
- Consistent wing system requirements shall be derived accordingly from the SR/SMR aircraft architectures[114]. Any deviation from these references as a result of different configuration effects (e.g., for technical feasibility, project viability reasons, or for optimizing the project outcome) should be identified and substantiated.

Novel ultra-performing technologies will bring challenges and opportunities to minimize drag, optimize flight control devices, high lift and control surfaces, and reduce weight and noise, as well as in system integration (e.g. wing-pylon-engine and wing-fuselage integration) and the overall aircraft integration. Therefore, these technologies need to be developed and validated in close connection with solutions and choices adopted at aircraft, system and component level, taking into account constraints, requirements and interdependencies.

The future potential use of hydrogen as energy source requires the development and demonstration of compatible technologies and sub-systems that will have an impact on the wing system, as well as on the aircraft architecture. Inputs from relevant hydrogen technology developments (e.g. H2 distribution system), as well as from the propulsion system and fuselage characteristics will be delivered by separate projects launched under the Clean Aviation programme.

The project shall also investigate the impact and features of the proposed concept(s) on operations and systems (e.g. Flight Control Systems, anti-icing) including maintenance, repair, availability, fault tolerance, reliability, and safety. Life cycle aspects should be considered in the overall environmental impact. A quantitative and qualitative estimation of future potential performance, identifying issues and potential solutions should be provided.

Proposed designs will build on, adapt, complement and add to CS-25 and any other relevant regulations to highlight any gaps and maximize the impact potential, and to enable new certification

[112] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (megajoules) per ASK as applicable, on a typical mission

[113] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

[114] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

standards, while maintaining or enhancing safety levels. The project shall propose a qualification and certification plan suitable to SR/SMR aircraft and it shall support to Clean Aviation initiatives to define new certification or qualification rules as well as new standardisation efforts concerning the areas of the project and others related to them. Any specific safety or certification issue should be highlighted.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification of novel wing technologies.

Performance Targets:

A number of top level goals will be the basis for performance targets, in particular:

- increased efficiency of no less than 10-13%[115] for *Configuration 1* and no less than 15-17%[116] for *Configuration 2* at integrated wing system level;
- maximum aerodynamic efficiency and minimum weight;
- wing system: installed performance contributing to the a/c performance target of 30% fuel burn reduction, to be extended as much as possible to a target of 30% GHG emissions reduction at aircraft level (possibly expressed, for instance, in terms of overall GHG emissions per passenger kilometre);
- it is implicit that all targets must be compatible with safety as an overarching requirement.

The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to systems, sub-systems and components level requirements, from where pertinent performance targets including key performance indicators shall be derived.

The performance targets, including key performance indicators (KPIs), shall be defined and calibrated with the objective of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T.[117] objectives;
- these performance targets shall be established, developed and actual corresponding quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of SR/SMR aircraft;
- KPIs and the corresponding quantified targets shall be defined according to the technologies involved within the wing system and depending on its integration in the aircraft, in a manner consistent with the overall GHG reduction targets.
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

[115] compared to a clearly identified 2020 SoA reference wing available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (MJ) per ASK as applicable, on a typical mission

[116] compared to a clearly identified 2020 SoA reference wing available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (MJ) per ASK as applicable, on a typical mission

[117] S.M.A.R.T.: Specific, Measurable, Achievable, Relevant, Timely

The applicant shall also determine and quantify the targets at system, sub-system and down to component level; they shall be adapted to the explored configuration(s), and accompanied by maturity roadmaps and development plans, including performance improvements expected by 2030 for critical components, and considering the potential implication of the design on aircraft noise.

All data required to characterize the aircraft emissions and environmental impact over the life cycle shall be modelled and measured as required to feed aircraft performance assessment(s).

Proposals shall include a detailed project plan with key milestones and deliverables and a list of performance targets per critical technologies associated to this plan.

III. HORIZON-JU-CLEAN-AVIATION-2022-01-SMR-03: Advanced Low Weight Integrated Fuselage and Empennage for Short Range and Short-Medium Range Aircraft

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution up to 40 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 40 million. The Clean Aviation Joint Undertaking may award 1 project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	36 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 48 months.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve TRL 4 at system level at project completion, as indicated in section 'Expected Outcome'. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking expects proposals to be submitted by consortia that include airframe/aerostructures integrators and their supply chain with a proven track record in developing and delivering globally competitive airframe/aerostructures to aircraft programmes, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to

	product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicant(s) should be able to manage large and complex international aeronautical programmes demonstrating a track record of successful design, development and certification in the aeronautical supply chain of short and short-medium range aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to short range and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to deliver all necessary data to the JU and the other relevant project[s] on aircraft architecture (selected from the topic TRA-01) on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data.

	The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. "Founding Member", "Associated Member" and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[118], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. "Founding Member", "Associated Member" and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[119] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[120], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a "Member" of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme Strategic Research and Innovation Agenda[121] at large.

Other relevant projects	This project should run in close synchronization with other relevant projects stemming from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme.

[118] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

[119] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[120] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[121] available on the F&T portal

	The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects; - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to all the following expected outcomes:

- Develop the design for a fuselage and empennage with minimum environmental impact for the targeted concepts for Short and/or Short-Medium Range Aircraft (SR/SMR) architectures[122] using hydrogen as a fuel with maximum aerodynamic efficiency and minimum weight, contributing to the targeted energy consumption reduction of minimum 15%[123] at aircraft level, while taking into account the new aircraft design enabling:
    - the integration of the hydrogen-propulsion system and subsystems;
    - the hydrogen storage including the distribution system and subsystems;
    - the integration of sustainable cabin and cargo solutions;

  the integration of systems such as electrical power generation and distribution.For the full fuselage and empennage system, quantified reduction potential in CO_2 and all other relevant

[122] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'
[123] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as energy (megajoules) per Available Seat Kilometre (ASK) on a typical mission

GHG emissions (see performance targets section below) are expected to be derived from the project (both in terms of actual demonstrated and potential performance impact).

- Demonstrate an overall equivalent reduction of the structural weight of no less than 20% at fuselage level (excluding penalties due to hydrogen technologies) compared to clearly identified 2020 state-of-the-art fuselage available for order/delivery.
- Detail the demonstration plan, with inclusion of component/sub-system level, to meet the following maturity levels at project completion:
  - no less than TRL 4 at integrated fuselage level;
  - no less than TRL 4 at integrated empennage level.

  The performance and the technology maturity of the fuselage and empennage system at project completion shall be verified via numerical simulation, wind-tunnel test, and relevant ground demonstration. The applicant shall develop and propose an appropriate simulation and testing programme to ensure confidence that the required maturity levels and performance targets are met.
- Deliver a roadmap towards full-scale demonstration of fuselage (including cabin and cargo) and empennage at TRL6 at aircraft level before the end of the Clean Aviation programme compatible with an entry into service by 2035.
- Propose a qualification and certification plan linked to the proposed activities and suitable to SR/SMR aircraft.
- Deliver modules and systems designs compatible with more electrical functions and alternate energy sources such as hydrogen, enabling for disruptive concepts.
- Deliver digital twins and a life cycle assessment of the components, subsystems and the full fuselage and empennage system compatible with the reference aircraft digital framework and requirements in order to regularly assess the contribution to the overall aircraft performance in the context of the impact monitoring framework. These models shall be continuously validated and updated during the overall technology / TRL maturation phase.
- Identify synergies with activities funded under research and innovation programmes at regional[124], national[125] and European[126] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

With the greater attention to environmental aspects (even with stringent regulations) and higher market demand, the mid-2030s are expected to see the entry of a new generation of SR/SMR aircraft (with a capacity of up to 250 seats) aiming towards sustainable climate-neutral flight. While

[124] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[125] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[126] activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

hybrid/electric energy architectures are considered to pave the way towards climate-neutral aviation on routes shorter than 1000 km, aircraft for classical short and medium-range distances, i.e. from 1000 km up to 3700 km, will rely on ultra-efficient aircraft designs and ultra-efficient thermal energy-based propulsion technologies using sustainable drop-in and non-drop-in fuels.

A novel fuselage and empennage design is one of the key enablers for the successful realization of hydrogen-powered SR/SMR aircraft with a targeted energy consumption reduction of minimum 15%[127].

- The assumptions relative to the aircraft operating envelope, to the flight mission profile, to the aircraft range, to the aircraft cruise speed, to the aircraft seating capacities and to the main aircraft sizing parameters in general, shall be fully consistent with those applicable in the SR/SMR aircraft architectures[128].
- Consistent fuselage and empennage requirements shall be derived accordingly from the SR/SMR aircraft architectures[129]. Any deviation from these references as a result of different configuration effects (e.g., for technical feasibility, project viability reasons, or for optimizing the project outcome) should be identified and substantiated.

The scope of this topic is to deliver a design of a minimum environmental impact fuselage and empennage including the relevant technology bricks expected to meet TRL 4 at integrated fuselage level and TRL 4 at integrated empennage level at project completion and compatible with SR/SMR hydrogen-powered aircraft concept(s) selected at the end of 2025 as well.

The hydrogen-powered propulsion system will come with challenges in system integration and in aircraft integration. Therefore, a fuselage and empennage design and the enabling technologies need to be developed and validated in close connection with solutions and choices at aircraft, system and component level, and taking into account interdependencies.

The future potential use of hydrogen as energy source requires the development and demonstration of compatible technologies and sub-systems that will have an impact on the fuselage and empennage, as well as on the aircraft architecture. Inputs from relevant hydrogen technology developments (e.g. H2 distribution system), as well as from the propulsion system will be delivered by separated projects launched under Clean Aviation.

The goal is to achieve is TRL 4 at integrated fuselage level and TRL 4 at integrated empennage level at project completion duly supported by component and subsystem ground tests at appropriate scale at project completion, so that the selected fuselage and empennage designs can be further matured in the Clean Aviation Programme and embedded and integrated in a specified architecture for (flight) demonstration. Scalability to other applications is an opportunity to be pursued. Life cycle aspects should be considered in the overall environmental impact.

Proposed designs will depart from DO 160, DO 178 and CS-25 and other regulations to highlight any gaps and maximize the impact potential, and to enable new certification standards. The project shall

[127] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as energy (megajoules) per Available Seat Kilometre (ASK) on a typical mission

[128] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

[129] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

propose a qualification and certification plan suitable to SR/SMR aircraft plus support to Clean Aviation initiatives to define new certification or qualification rules as well new standardisation efforts concerning the areas of the project and others related to them. Any specific safety or certification issue should be highlighted, and mitigation action should be proposed.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification of novel fuselage and empennage technologies.

Performance Targets:

A number of top-level goals will be the basis for performance targets, in particular:

- Fuselage (including cabin and cargo) and empennage system: installed performance contributing to the aircraft performance target of minimum 15%[130] reduction in energy consumption, to be extended as much as possible to a target of 30% GHG emissions reduction at aircraft level (possibly expressed, for instance, in terms of overall GHG emissions per passenger kilometre);
- Equivalent reduction of the structural weight of no less than 20%[131] at fuselage level (excluding penalties due to hydrogen technologies);
- Targets must be compatible with safety as an overarching requirement.

The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to systems, sub-systems and components level requirements, from where pertinent performance targets including key performance indicators shall be derived.

The performance targets, including key performance indicators (KPIs), shall be defined and calibrated with the objective of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T.[132] objectives;
- these performance targets shall be established, developed and actual corresponding quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of SR/SMR aircraft;
- KPIs and the corresponding quantified targets shall be defined according to the technologies involved within the fuselage system and empennage system, and depending on its integration in the aircraft, in a manner consistent with the overall GHG reduction targets.
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

[130] compared to 2020 state-of-the-art aircraft available for order/delivery and measured as energy (megajoules) per Available Seat Kilometre (ASK) on a typical mission

[131] compared to 2020 state-of-the-art fuselage available for order/delivery

[132] S.M.A.R.T.: Specific, Measurable, Achievable, Relevant, Timely

The project shall also investigate the impact, effect, and features of the proposed concept(s) on operations and systems (e.g. propulsion, cabin) including maintenance, repair, availability, fault tolerance, reliability, and safety. A quantitative and qualitative estimation of future potential performance, identifying issues and potential solutions should be provided.

The applicant shall determine performance targets down to component level (e.g. weight reduction, improved aerodynamic performance, safety, system efficiency), including maturity roadmap and a strategic development plan including performance improvements until 2030 for critical components, taking into account:

- Rear-fuselage and empennage architectures (e.g. conventional, T-tail without engines, T-tail with engines)
- Flight control systems (FCS)
- Energy storage
- Energy distribution system
- Effects of sloshing and boil-off on structures and integration
- High voltage electrical Network
- Aeroelastic and dynamic requirements
- Impact and crashworthiness requirements
- The potential implication of the design on aircraft noise
- Regulation.

The metrics shall be flowed down in the proposal from fuselage and empennage system level down to component level to deliver optimal overall configuration. The resulting objectives have to be demonstrated in ground tests of the whole fuselage/aircraft system enabling the performance objectives of the respective aircraft delivering targeted performance gains defined in the SRIA.

All data required to characterize the aircraft emissions and environmental impact over the life cycle shall be modelled and measured as required to feed aircraft performance assessment(s).

Proposals shall include a detailed project plan with key milestones and deliverables together with a list of performance targets per critical technologies associated to this plan.

4. Clean Aviation – Transversal activities (TRA)

I. HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01: Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of EUR 30 million up to 60 million, depending on the scope of the aircraft architectures and market segment to be targeted, would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding for the topic is EUR 90 million. Depending on the outcome of the evaluation and funding available, the Clean Aviation Joint Undertaking may award up to 3 projects with funding. In the selection of projects to be retained for funding, strong consideration will be given to the comprehensiveness and complementarity of the proposed actions, ensuring the broadest coverage of aircraft types and their payload/range capability across the domains of regional, short range and short-medium range market segments. The project may address one or more aircraft concepts for a given market segment (i.e. regional, short range and/or short-medium range). Applicants may submit multiple proposals covering different aircraft concepts and market segments.
Indicative project duration	48 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 60 months.
Type of Action	Innovation Actions
Technology Readiness Level	Proposed solutions and architectures are expected to be based on technologies at TRL 3 or higher at subsystem or component level as minimum entry point. Applicants must provide a clear elaboration of the TRL steps and a roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can deliver the technology maturity needed by the end of

	Clean Aviation for the results of their project to be included in new aircraft with an entry into service no later than 2035. See General Annex B of Horizon Europe for a guide to the TRL definitions and criteria to be used.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking expects proposals to be submitted by consortia that include aircraft manufacturers/integrators that can demonstrate a track record of successful design, development and certification of regional, short and/or short-medium range aircraft. The consortium configuration should ensure the appropriate, industrial, technological and economic interests are represented in the project in order to allow an effective transition from research to product innovation. The proposal should demonstrate a clear commitment to achieve the Clean Aviation Strategic Research and Innovation Agenda (SRIA)[133] objectives in terms of next generation aircraft in the regional, short or short/medium range segments, and towards a potential market deployment no later than 2035, with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new / disruptive technologies. In particular, applicants are encouraged to include key contributors from the domain of academic/scientific research and technology development, as well as, where appropriate, potential newcomers to the field of aeronautics (in particular SMEs, start-ups and/or knowledge centres) that can support innovative approaches to design optimisation such as multi-variable and/or multi-disciplinary optimisation, and artificial intelligence based design and high-performance computing.
Membership agreement and other model agreements	As the Clean Aviation programme will be established through open calls, i.e. via individual integrated demonstrator projects aiming to develop distinct contributing key technologies in separate projects and through consortia established for these, the projects resulting from this topic should provide the common aircraft integration platform establishing and providing all required information on appropriate design methods and tools to enable all interdependent R&I activities linked to the targeted aircraft concept to work on a common aircraft development plan. The projects selected should establish effective links with all the technology development and demonstration projects related to the relevant aircraft concept and integrate them virtually [cfr Rules for Submission and Clean Aviation Work Programme 2022-2023].

[133] available on the F&T portal

	The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to collect all necessary data from the other relevant project[s] contributing to the aircraft architecture on a yearly or biennial basis and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion including a TRL assessment, in order to enable the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance at overall aircraft level. Applicants should also provide the results of such assessment to the JU and other relevant projects. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. "Founding Member", "Associated Member" and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[134], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. "Founding Member", "Associated Member" and affiliated entities) must describe in the proposal the planned in

[134] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

	kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[135] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[136], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a "Member" of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme Strategic Research and Innovation Agenda[137] at large.

Other relevant projects	This project should run in close synchronization with the other relevant projects from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects; - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with

[135] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085

[136] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014

[137] available on the F&T portal

	interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to provide or contribute to the following outcomes:

- Develop and deliver up to a typical Preliminary Design Review (PDR) one (1) high-potential disruptive aircraft concept for the market segment addressed fby assessing a broad set of potentially relevant configurations and performing a trade-study based down-selection, taking into consideration all contributing technologies with the appropriate level of detail. This shall include all validated requirements, design processes, methods, tools, models, digital twins and all associated validation and verification evidence tracing the complete informed decision making process. The targeted level of technical maturity at aircraft level shall be no less than TRL4 for all key technologies critical to the aircraft concept, to be progressed forward into a potential future project in Phase 2 of the Clean Aviation Programme.
- Conduct and describe the conceptual/architectural design trade studies involved, which shall include due consideration for aspects pertaining to all disciplines concerned, such as but not limited to aerodynamics, structure, loads, weight, propulsion, systems, overall performance, operational and flight handling qualities, maintainability, taking into account all relevant existing requirements, reliability, certification and safety, while highlighting potential needs of updated or new requirements or guidance. The most appropriate methodologies and tools shall be used, including numerical modelling and simulations, multi-factor optimization, scaled (wind tunnel or other) testing, etc., with proper identification and substantiation of the tools used and of the associated uncertainty ranges, limits and constraints involved.
- Deliver a detailed development plan for the proposed aircraft architecture, including systems and subsystems developed by the other relevant projects, as well as a detailed demonstration strategy towards demonstration of such systems and subsystems at aircraft level compatible with the targeted technological and industrial maturity as stated in the Regulation establishing the Clean Aviation JU (Council Regulation (EU) 2021/2085[138]) and an entry into service of new aircraft by 2035.
- Deliver, for each aircraft concept, an integrated aircraft systems architecture, functional/performance specification and inventorisation of critical technologies required to optimise the generation, storage, conversion and distribution of non-propulsive on-board energy (e.g. electrical, hydraulic, pneumatic). The system architecture shall consider advanced integrated energy management and thermal management strategies and set the requirements

[138] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)

for these. Hybridisation shall be considered where appropriate to reduce overall energy consumption and support the targeted reduction of GHG emissions.

- Establish a systematic co-design life cycle assessment for the concept(s) by considering an end-to-end Life Cycle Assessment (LCA). The results of the LCA will allow to identify gaps and opportunities with regard to the total life-cycle based environmental footprint of future technologies and to quantify key priorities to ensure the end-to-end sustainability for the relevant aircraft concept(s) selected. A design for sustainable manufacturing methodology will be developed as part of this Eco-design LCA.
- Develop and demonstrate an integrated methodology to support the design of a sustainable industrial system enabling successful market deployment of the aircraft concept(s), including key technologies. This methodology shall be integrated in the digital environment of the overall aircraft design and the individual demonstrator project digital framework.
- Develop a collaborative information system (digital backbone) to document the end-to-end decision making process with full data continuity and fully digitalised processes. This will include the efficient management of all functional and physical interfaces shared with all contributing demonstrators using an up to date configured digital mock-up supported by a Model-Based System Engineering approach.
- Develop the integrated plan and dynamic roadmap including the supporting other relevant projects, and the identification, assessment and mitigation of project risk and the identification and specification of collaborative development activities with and in supporting other relevant projects as well as from other activities that may be initiated outside the Clean Aviation programme (synergies).
- Establish an effective framework for the technology assessment and impact monitoring of the overall aircraft design and all contributing other relevant projects. This framework shall be harmonised with and across the Clean Aviation aircraft concept projects and contributing other relevant projects in order to report in line with the obligation of the Impact Monitoring methodology and ensure consistent approaches and comparability of outcomes for the programme's overall impact assessment as required in the Council Regulation (EU) 2021/2085[139].
- Support a step-change in the state-of-art computational design and analysis methods, enabling a significant reduction in time and cost to the aircraft design and development cycles, and establish clear links with the transversal topic on certification[140].
- Investigate and highlight the potential scalability of concept(s), design methodologies and the key technologies incorporated in the aircraft concept(s) towards other aircraft segments so as to maximise the potential impact of the research performed.

[139] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119.

[140] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-02: 'Novel and Efficient Certification Methods and Means of Compliance for Disruptive Technologies'.

- Identify synergies with activities funded under research and innovation programmes at regional[141], national[142] and European[143] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

With the greater attention to environmental aspects (even with stringent regulations) and higher market demand, the mid-2030s are expected to see a change of scenario of air mobility in the regional range, i.e. with a sizing mission of around 1000 km and a typical sector distance flown of around 400-500 km, and the entry of a new generation aircraft for the short and short-medium-range, i.e. with typical mission range from 1000 km and up to 3700 km, aiming towards sustainable climate-neutral flight. Hence mission profiles that minimize greenhouse gas emissions at aircraft level should be considered. While hybrid/electric energy architectures are considered to pave the way towards climate-neutral regional aircraft (with a capacity of up to 100 seats), SR/SMR aircraft (with a capacity of up to 250 seats) are expected to rely on ultra-efficient aircraft designs and ultra-efficient thermal energy-based propulsion technologies using sustainable drop-in and non-drop-in fuels.

Proposals are requested to cover the spectrum of payload/capacity and design range of regional, short-haul and short/medium range aircraft that collectively represent at least 90% of the air transport system operations typically flown with these aircraft types. While not limitative and prescriptive, applicants are expected to focus on aircraft ranging from a ‘regional’ capacity of around 50 seats up to a maximum ‘single aisle’ capacity of 250 seats, and with design range (at full payload) from no less than 900 km for disruptive zero emissions regional concepts up to 3700 km for an ultra-advanced short/medium range aircraft.

A successful development of the Ultra-Efficient regional, short and short/medium range aircraft described in the ambition of the Clean Aviation SRIA[144] requires that R&I activities for all contributing key technologies follow a coherent approach based on an aircraft concept and (digital) development platform providing the required top level aircraft requirements. This will include certification aspects, eco design and sustainability requirements. The aircraft concept projects resulting from this topic will provide a common virtual (digital) platform to integrate the contributing technologies under investigation and development across the various projects to which these projects will be linked (see Special Conditions). In order to work within a common aircraft development plan, projects selected will therefore provide through a collaborative framework all required information, tools, design methods and digital platforms enabling a continuous link between all Research and Technology activities relevant to the aircraft concepts in question, in order to deliver solutions meeting the high level goals as stated in the SRIA.

[141] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).
[142] activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).
[143] activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.
[144] available on the F&T portal.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification of novel designs and architectures.

Performance Targets:

A number of top level goals will be the basis for performance targets to be considered in the execution of the projects, and in the evaluation of proposals submitted and considered for funding. In particular:

- For concepts based on use of drop-in SAF:
    - o No less than 50%[145] fuel burn reduction target at overall aircraft/concept level for projects focused on the regional aircraft segment, which shall be considered here as all concepts with a payload of up to 100 passengers;
    - o No less than 30%[146] fuel burn reduction target at overall aircraft/concept level for projects focused on the short and short/medium range aircraft segment, which shall be considered here as all concepts with a payload of more than 100 passengers.
- For concepts based on the use of hydrogen as fuel or energy source:
    - o No less than 15%[147] reduction in aircraft energy demand taking into account all weight and drag penalties after integration of hydrogen storage, distribution, propulsion system, and aerodynamics at overall aircraft design level.

The targets must be achievable while assuring compatibility with safety, reliability, cost-effectiveness and sustainability as commensurate with regulatory requirements as well as market demands. The top level goals shall be broken down in a consistent manner at the different levels: from aircraft top level requirements to key parameters such as aerodynamic, structural, weight, flight physics, acoustics and propulsion system performance-related targets, and down to the other major systems and sub-systems. Their performance targets shall be identified in the proposal (as preliminary requirements). For projects retained for funding this 'flow-down' shall be provided to and agreed with the contributing other relevant projects.

The performance targets, including key performance indicators (KPIs), shall be defined and calibrated with the objective of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T. objectives;
- these performance targets shall be established, and actual, quantifiable values shall be specified by the applicant, consistently with all constraints pertaining to the design of regional/SR/SMR aircraft;
- KPIs and the corresponding quantified targets shall be defined according to the types of configurations and the technologies involved within the systems, in particular within the

[145] compared to 2020 state-of-the-art aircraft available in service and measured as fuel kg per Available Seat Kilometre (ASK), or energy (MJ) per ASK as applicable, on a typical mission
[146] compared to 2020 state-of-the-art aircraft available in service and measured as fuel kg per Available Seat Kilometre (ASK), or energy (MJ) per ASK as applicable, on a typical mission
[147] compared to 2020 state-of-the-art aircraft available in service and measured as energy (megajoules) per Available Seat Kilometre (ASK) on a typical mission

propulsion system, and depending on their integration in the aircraft, in a manner consistent with the overall GHG reduction targets;

- the envisaged emissions and noise performance targets and project improvements shall be expressed in the context of the associated environmental protection certification requirements and regulatory limits in order to put the outcome of the project in an appropriate context and to inform discussions on future standards.
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

Each project shall investigate a number of concepts to identify and down-select an optimum configuration for the market segment addressed, consistently with overall requirements (e.g. technical and operational feasibility/efficiency, safety, industrial, maintainability, reliability, costs). Consideration shall be given to achieving optimal solutions through methodologies such as multi-objective and/or multi-disciplinary design optimisation[148].

All data required to characterize GHG emissions (including non-CO_2 effects) shall be assessed and modelled to simulate the engine performance and assess the aircraft performance in terms of total GHG emissions.

Proposals shall include a detailed project plan with key milestones and deliverables, together with a list of performance targets per critical technologies associated with this plan.

[148] Refer to the method used in Independent Expert Integrated Technology Goals Assessment and Review for Engines and Aircraft (ICAO Doc 10127 – 2019).

II. HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-02: Novel Certification Methods and Means of Compliance for Disruptive Technologies

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution up to 18 million would allow these outcomes to be addressed appropriately. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative funding budget for the topic is EUR 18 million. The Clean Aviation Joint Undertaking may award 1 project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	48 months. This does not preclude submission and selection of a proposal with a different project duration, which however must not exceed 60 months.
Type of Action	Innovation Actions
Technology Readiness Level	Activities are expected to achieve a certification methodology at a maturity level deemed sufficient to support the down selection of system/subsystem and aircraft concepts proposed at the end of phase 1, as indicated in section 'Expected Outcome'. Applicants must provide a clear roadmap (aligned with the SRIA and with the objectives as defined in the Work Programme) that can support certification of new aircraft with an entry into service no later than 2035.
Special skills and/or capabilities expected from the Applicant(s)	The Clean Aviation Joint Undertaking expects proposals to be submitted by consortia that include aircraft manufacturers and engine system integrators and their supply chain with a proven track record in developing and delivering globally competitive aircraft and propulsion systems, as well as key contributors from the domain of academic/scientific research and technology development. The consortium configuration should ensure the appropriate industrial, economic and supply chain interests are represented in the project and can ensure the transition from research to product innovation and market deployment no later than 2035, and with a clearly articulated route that supports the aim of replacing 75% of the operating fleet by 2050.

	Applicant(s) should be able to manage large and complex international aeronautical programmes demonstrating a track record of successful design, development and certification in the aeronautical supply chain of regional, short and short-medium range aircraft at the level relevant to the topic's scope as described. Applicants should ensure their proposal and consortium reflect all necessary expertise and capabilities. Applicants should identify and include the additional expertise needed to complement the traditional aeronautical domain, in order to effectively address the incorporation of new/disruptive technologies. Where appropriate, the consortium should include newcomers to the field of aeronautics and in particular SMEs, start-ups and/or knowledge centres that can bring disruptive innovation to the project as proposed.
Membership agreement and other model agreements	The topic is identified as a key contributor to the overall aircraft concepts related to regional range, short range and short-medium range aircraft. The JU Members participating in the topic must ensure compliance with the existing Membership Agreement and must conclude with the participants to the project, a suitable Consortium Agreement [CA] governing the project and its consortium. A model of the Consortium Agreement is available on the F&T portal. For a successful programmatic approach and implementation of Clean Aviation, project(s) launched under this topic should share/exchange, as appropriate, relevant results generated in the project with other relevant projects. For this purpose, the participants in the projects selected under this topic must conclude within six (6) months of signature of the Grant Agreement a Cooperation Agreement with the participants implementing the projects selected under the other relevant JU topics: see further under "other relevant projects". A model of the Cooperation Agreement will be made available.
Project and Impact Monitoring	Applicants are expected to collect all necessary data from the other relevant project[s] on a yearly or biennial basis, and ensure relevant exchanges of information, as well as a final impact/performance assessment at project completion, in order to allow the Clean Aviation Impact Monitoring Framework to monitor and assess the progress of the activity towards the targeted impact and performance. Applicants should also provide the results of such assessment to the JU and other relevant projects. Applicants must ensure that their Consortium Agreement includes the necessary conditions to allow the required exchanges of data. The JU will perform a number of gate reviews with a key review @M24 (or fixed date to be determined) to assess the overall progress against the project plan and against the performance targets. Depending on the outcome of this

	key gate review, the scope of the project may be revised and/or funding reduced in case of significant issues. Mitigation actions may be requested by the JU as condition for continued funding.
In-kind contributions (IKOP/IKAA by JU Members; co-funding by other applicants)	In order to ensure the obligations for in-kind contributions by Members of the CAJU (i.e. “Founding Member”, “Associated Member” and affiliated entities to a Member) can be fulfilled as set in Article 61 of the Council Regulation (EU) 2021/2085[149], annual deliverables on in-kind contributions will be set in the grant agreements for the projects selected under this topic, as well as appropriate reporting requirements. The Members responding to this topic (i.e. “Founding Member”, “Associated Member” and affiliated entities) must describe in the proposal the planned in kind contributions to be provided in the course of the project implementation and indicate their level and the nature. In-kind contributions to additional activities should be declared via the template model available on the F&T portal. The amount of the total in-kind contributions (i.e. in-kind contribution to operation activities and in-kind contribution to additional activities) should be no less than 1.5[150] times the funding request in aggregate for the proposal. Considering that in accordance with Article 61 of the Council Regulation (EU) 2021/2085[151], only the Members of the CAJU are able to provide and report on the required minimum level of in-kind contributions, participants in the proposal who are not a “Member” of the CAJU should explain in the proposal which resources, key competences, technical and financial contributions they will be able to provide to the project and to the programme Strategic Research and Innovation Agenda[152] at large.

[149] Council Regulation (EU) 2021/2085 of 19 November 2021. Official Journal: OJ L 427, 30.11.2021, p. 17–119. (https://data.consilium.europa.eu/doc/document/ST-12156-2021-INIT/en/pdf)
[150] In order to support a leverage factor of no less than the ratio between the contribution from members other than the Union (EUR 2 400 000 000) and the Union financial contribution (EUR 1 700 000 000), which are defined in the Council Regulation (EU) 2021/2085
[151] Council Regulation (EU) 2021/2085 of 19 November 2021 establishing the Joint Undertakings under Horizon Europe and repealing Regulations (EC) No 219/2007, (EU) No 557/2014, (EU) No 558/2014, (EU) No 559/2014, (EU) No 560/2014, (EU) No 561/2014 and (EU) No 642/2014
[152] available on the F&T portal

Other relevant projects	This project should run in close synchronization with the other relevant projects from the topics published in this call. For further information, please also consult the Rules for Submission and the dedicated part in the Clean Aviation Work Programme. The applicants should: - ensure their proposal is aligned with the Gantt chart(s) of the relevant thrust(s) as published in the Clean Aviation Work Programme 2022-2023), and duly considers interfaces and interdependencies therein, in order to ensure a consistent and coordinated approach with the selected other relevant projects; - indicate in their proposal a list of topics published in this call, from which other relevant projects may be selected and with which cooperation and an exchange of information will be needed in order to achieve the proposal's objectives. They should also indicate the nature of interfaces and exchanges of information that will be needed with the other relevant projects. - Define a deliverable which will provide the specific technical requirements, the necessary data/information exchanges and the delivery schedule thereof with respect to the other relevant projects, in order to support an integrated programme planning across the projects with interfaces, including a list of milestones and deliverables across the contributing projects. This deliverable must be issued by the applicants at M6. During grant preparation, the JU may propose amendments or additions to the list of other relevant projects on the basis of the evaluation. The cooperation agreements to be concluded should leave open for future inclusion additional other relevant projects that may result from future calls.

Expected Outcome:

Project results are expected to contribute to all the following expected outcomes:

- Define, with EASA, the targeted safety objectives and the operational environment (concept of operation) to develop the applicable regulations and the boundaries of the project.
- Deliver a risk analysis based on existing regulations, such as but not limited to CS23/FAR23, CS25/FAR25 and CS-E, in order to identify the critical areas and regulatory gaps;
- Identify and deliver a comprehensive set of inputs for future international regulations applicable to the targeted concepts for Hybrid-Electric Regional (HER) and Short/Short-Medium- Range (SR/SMR) aircraft[153] (including hydrogen-powered aircraft[154]) regarding

[153] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

[154] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'

  - draft performance based special conditions (e.g. technology/system requirements, qualification testing, permit to fly), including safety objectives, to prepare the future framework, structured by technical disciplines, and to be implemented on a set of critical challenges that are representative of the disruptive new technologies and architectures;
  - draft associated means of compliance set up and optimisation.
- Propose an efficient interface between the project and the three main thrusts[155] at the level of both architecture projects[156] and technical projects[157] to set the requirements and define the objectives and framework.
- Define and organize the proof of concepts on new principles and certification processes for a set of emblematic and representative disruptive technologies (minimum one per thrust), including expected results and metrics.
- Deliver concrete and timely key inputs/dispositions on process and methods for draft performance based special conditions as a preliminary step to future certification basis and the implementation of new regulations and potential new rulemaking. In particular, the project shall focus on generic framework applied to proof of concepts, new draft regulations and rules, and key inputs/dispositions for draft certification conditions.
- Show the capability of developing transformational digital means and the full range of virtual tools enabling digital design and manufacturing of disruptive technologies and architectures as a potential improvement of the development of new processes and methods towards the compliance with certification requirements of disruptive technologies and architectures. In particular, the project shall focus on investigating and developing new methods of compliance for aviation safety, security and environmental protection, by using digital platform and preliminary description of methods of compliance.
- Set-up the preliminary performance and design of a life cycle digital platform for integration and demonstration assembling and structuring the pyramid of processes and models, and the associated behavioural digital aircraft dataset.
- Deliver a set of proposed technical specification addressing the regulatory gaps and risks identified in other relevant projects as a basis for future certification compatible with the start of aircraft development. Propose a modularised and stepped transversal approach, with representative proof of concepts and demonstration, to tackle the challenges for streamlining the certification of disruptive technologies, in order to closely monitor the progress made and the risks identified. By project completion, the project shall demonstrate a proposed certification methodology at a maturity level deemed sufficient to support the down selection of system/subsystem and aircraft concepts proposed at the end of phase 1.
- Deliver a roadmap towards demonstration of certification approach demonstrating a Time To Market Reduction (TTMR) of 30%[158] and a cost reduction of certification compliance

[155] as defined in the Clean Aviation SRIA the three thrusts are: Hybrid-Electric Regional (HER) aircraft architectures, Ultra-efficient Short Medium Range (SMR) aircraft architectures, disruptive technologies to enable hydrogen-powered aircraft
[156] HORIZON-JU-CLEAN-AVIATION-2022-01-TRA-01 'Aircraft architectures & technology integration for aircraft concepts ranging from regional to short-medium range applications'
[157] cfr. table of other relevant projects
[158] Compared to 2020 state of the art certification processes

demonstration of 30%[159], compatible with TRL6 at aircraft level before the end of the Clean Aviation programme and compatible with an EIS by 2035, while keeping safety as an overarching requirement.

- Identify synergies with activities funded under research and innovation programmes at regional[160], national[161] and European[162] level, and demonstrate how the project will benefit from these by detailing the specific contributions to the expected outcome(s).

Scope:

With the greater attention to environmental aspects (even with stringent regulations) and higher market demand, the mid-2030s are expected to see a change of scenario of air mobility in the regional range, i.e. with a sizing mission of around 1000 km and a typical sector distance flown of around 400-500 km, and the entry of a new generation aircraft for the short and short-medium-range, i.e. with typical mission range from 1000 Km and up to 3700 km, aiming towards sustainable climate-neutral flight. While hybrid/electric energy architectures are considered to pave the way towards climate-neutral regional aircraft (with a capacity of up to 100 seats), SR/SMR aircraft (with a capacity of up to 250 seats) are expected to rely on ultra-efficient aircraft designs and ultra-efficient thermal energy-based propulsion technologies using sustainable drop-in and non-drop-in fuels.

Certification is a major challenge for the successful realization of the HER and SR/SMR aircraft[163] with a targeted fuel burn reduction of minimum 50%[164] and 30%[165], respectively, and compatible with Entry into Service (EIS) 2035. In order to identify the critical areas and regulatory gaps linked to the disruptive technologies and concepts of operation, it is essential to analyse the risks of existing regulations, such as but not limited to CS23/FAR23, CS25/FAR25 and CS-E.

This topic is intended to deliver a novel framework for certification enabling the compliance of innovative and disruptive technologies, systems and architectures with certification requirements and a safe integration of these new sustainable concepts, and compatible with the HER and SR/SMR aircraft concepts and systems selected at the end of phase 1. The project should be built on two main streams of activities (closely connected with all the projects of the three main thrusts[166]) focusing on process and methods development and means of compliance set up and optimisation.

[159] Compared to 2020 state of the art certification processes

[160] Activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[161] Activities funded in Member States and Associated Countries and/or funded through EU funds administrated by regional or national authorities such as the European Regional Development Fund (ERDF) and the European recovery fund (i.e. NextGenerationEU).

[162] Activities funded under Horizon Europe (outside the Clean Aviation Work Programme 2022-2023) and/or other EU programmes.

[163] the assumptions relative to the aircraft operating envelope, to the flight mission profile, to the aircraft range, to the aircraft cruise speed, to the aircraft seating capacities and to the main aircraft sizing parameters in general, shall be fully consistent with those applicable in the HER and SR/SMR aircraft architectures

[164] compared to 2020 state-of-the-art engine available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (megajoules) per ASK as applicable, on a typical mission

[165] compared to 2020 state-of-the-art engine available for order/delivery and measured as fuel kg per Available Seat Kilometre (ASK) or energy (megajoules) per ASK as applicable, on a typical mission

[166] cfr. table of other relevant projects

More robust processes and methods are mandatory to guarantee the compliance of innovative and disruptive technologies (e.g. hydrogen technologies) and architectures with certification requirements and a safe integration of these new sustainable concepts. In this context, defining key inputs/dispositions on process and methods for draft certification conditions is an essential step to future certification basis and the implementation of new regulations and potential new rulemaking.

Each project is encouraged to exploit the involvement and expertise of EASA to de-risk and secure the certification of novel technologies.

Proposals shall include a detailed project plan with key milestones and deliverables together.

Performance Targets:

A number of top level goals will be the basis for performance targets, in particular:

- A certification methodology at a maturity level deemed sufficient to support the down selection of system/subsystem and aircraft concepts proposed at the end of phase 1.
- A substantial step in overall certification approach towards demonstrating a Time To Market Reduction (TTMR) of 30%[167] and a cost reduction of certification compliance demonstration of 30%[168] in 2030, compatible with TRL6 at aircraft level before the end of the Clean Aviation programme and compatible with an EIS by 2035.
- It is implicit that targets must be compatible with safety as overarching requirement.

The performance targets, including key performance indicators (KPIs), shall be defined by the applicant and calibrated with the objective of meeting or exceeding the project goals at completion, allowing efficient progress monitoring and providing a sound basis for the subsequent work in view of best contributing to the achievement of overall high-level goals:

- it is strongly recommended that the definition of targets be guided by principles such as those of S.M.A.R.T.[169] objectives;
- these performance targets shall be established, developed and actual corresponding quantified values shall be specified by the applicant consistently with all constraints pertaining to the design of HER and SR/SMR aircraft;
- the applicant shall provide the assumptions and the rationale underlying those target definitions and values;
- the applicant shall also explain how the project is developing solutions compliant with them, including effective means of monitoring progress and optimizing the work statements.

Proposals shall include a detailed project plan with key milestones and deliverables, together with a list of performance targets per critical technologies associated with this plan. Project risks shall be identified and assessed, and mitigated as appropriate.

[167] Compared to 2020 state of the art certification processes

[168] Compared to 2020 state of the art certification processes

[169] S.M.A.R.T.: Specific, Measurable, Achievable, Relevant, Timely

5. Clean Aviation – Coordination and Support Actions (CSA)

I. CLEAN-AVIATION-2022-01-CSA-01: Developing an Integrated European Clean Aviation Regional Ecosystem (ECARE)

Description of the call topic and topic specific conditions	
Specific eligibility criterion	Given the illegal invasion of Ukraine by Russia and the involvement of Belarus, legal entities established in Russia, Belarus or in any occupied territory of Ukraine are not eligible to participate in any capacity. Exceptions may be granted on a case-by-case basis for justified reasons, such as for humanitarian purposes, civil society support or people-to-people contacts.
Expected EU contribution per project	The Clean Aviation Joint Undertaking estimates that an EU contribution of EUR 720,000 would allow this specific challenge to be addressed appropriately and brings the expected outcomes. In addition, this budget will allow the involvement of as many participants, from Member States, regions, and clusters, as possible. Nonetheless, this does not preclude submission and selection of a proposal requesting different amounts.
Indicative budget	The total indicative budget for the topic is EUR 720,000. The Clean Aviation Joint Undertaking expects to award 1 project with funding depending on the outcome of the evaluation and the complementarity of the proposed actions.
Indicative project duration	Maximum 36 months This does not preclude submission and selection of a proposal with a different project duration.
Type of Action	Coordination and Support Actions
Special skills and/or capabilities expected from the Applicant(s	The Clean Aviation Joint Undertaking expects proposals to be submitted by consortium(a), including the participation of clusters. The applicants shall have the following capabilities and skills: • capacity of coordination and support actions, as well as of dissemination and communication activities at national and regional level; • proven track records in relevant activities in research and innovation programmes; • an extended knowledge of the European aeronautics landscape; • capacity to build networking activities/mechanisms (including a digital platform) and provide technical support to stakeholders. Applicant(s) shall also be able to demonstrate the link(s) with the national/regional policies related to Clean Aviation programme, as well as the ability to exchange with the relevant competent national and/or regional authorities. The applicant(s) involvement in the entrepreneurial discovery and the definition of the priorities of the national/regional Research and Innovation Smart Specialisation Strategy (RIS3) will be an advantage.

Expected Outcomes:

Project results are expected to contribute to the following expected outcomes:

- Strengthen the synergies between the Clean Aviation JU and Member States/associated countries/regions that have an aviation policy or the aviation policy is a part of their national/regional strategy for R&I especially to contribute towards the target of the climate-neutral aviation by 2050.
- Based on the prioritization of Horizon Europe aviation-related topics (i.e., Clean Aviation / Clean Hydrogen and Clusters 4 and 5) identify the National/Regional projects (recently finalised, ongoing, and planned to commence) and making a comprehensive mapping of regional/national programmes, technologies and capabilities by area and TRL in order to facilitate potential synergies with the Clean Aviation programme. The mapping exercise will prioritise to the countries/regions that have in place a Memorandum of Cooperation (MoC) with the Clean Aviation JU.
- In coordination with the States Representatives Group, establishing a networking platform consisting of all the interested and involved parties, including the National Contact Points (NCPs). The national and regional authorities could be members of networking platform and its management body. This platform will act as a forum for the exchange of information and views on research and innovation policy linked to Clean Aviation programme, monitor, and provide feedback on national/regional policies, developments, and activities, as well as on complementarities/synergies with the Clean Aviation programme. The networking platform should foster the participation of other interested regions or EU/Horizon Europe associated countries with technologies or capabilities linked to Clean Aviation programme, or correlated national, regional and RIS3 priorities areas.
- As part of the mission of this networking platform, dedicated actions should be addressed to:
    - facilitate the exchange on the implementation of the RIS3 strategies priorities in the relevant field;
    - partnerships and strengthen the links with the Clean Aviation industrial Leaders;
    - promote the implementation of Clean Aviation related synergies with the European Regional Development Fund (ERDF) as part of their National or Regional Operational Programmes and funding schemes;
    - define R&I national/regional complementary activities to Clean Aviation, fostering synergies and complementary projects eligible for ERDF;
    - foster interregional cooperation activities relevant to Clean Aviation programme.
- Fostering the Clean Aviation national/regional MoC (Memoranda of Cooperation) network and supporting its networking, exchange of best practices and actions.
- A digital platform and organisational set up, with a dedicated budget, accessible also to national/regional authorities, OEMS and high tiers, that will be put in place to:
    - promote the synergies between Clean Aviation and regional and national authorities in charge of ERDF implementation, national/regional programmes and applicable funding mechanisms viable to support Clean Aviation related complementary activities;
    - direct regional stakeholders (e.g., SMEs) towards the right source of information regarding Clean Aviation and other relevant EU R&D&I programmes;

- increase the interaction between the national/regional stakeholders (SMEs, academia, research organisations, clusters) in participating in Clean Aviation activities.

The set up could take into account the experience from existing networks and digital platforms (e.g., RIS3 platforms, Vanguard Initiative) and should propose a viable plan for a sustainable digital platform that could be able to extend its activities over the duration of Clean Aviation/ Horizon Europe.

- Promote specific measures at national and regional level that aim to increase the involvement of SMEs, Universities, and Research Organisations in Clean Aviation research and innovation activities, and any other actions that aim to promote the cooperation and deployment of aeronautical technologies.
- Identify, highlight, and disseminate the contribution from Clean Aviation, in particular from projects focused on breakthrough technologies that will facilitate the transition to a climate neutral aviation and the realization of the European Green Deal.
- Spreading of innovation on aeronautics across Europe and its regions.
- Dedicated communication and dissemination activities should be proposed and organised in cooperation with Clean Aviation JU during the implementation phase.

Scope:

The objective of this CSA is to establish a Clean Aviation regional ecosystem and develop further the synergies between Clean Aviation programmes/projects and the regional or national authorities implementing the European Regional Development Funds (ERDF), and/or other national/regional R&I initiatives and programmes. It will result in the establishment of a networking platform that will facilitate the interaction between the national and regional stakeholders (including clusters), support and coordinate the national and regional activities with the Clean Aviation programme and identify specific measures aimed at increasing the involvement of SMEs and other stakeholders in Clean Aviation programme. This CSA also aims to increase interaction and better planning and programming between the Clean Aviation and National/Regional programmes.

In line with these objectives, all the following aspects should be addressed:

- Strengthening the strategic cooperation between Clean Aviation and Member States/regions/clusters and facilitating the synergies with ERDF and other national/regional programmes for the interested regions and countries;
- Fostering of the links between Clean Aviation and national/regional programmes and activities for aviation research and innovation and supporting coordination of activities with Member States and regions.
- Investigation of plans and implementation of suitable tools and mechanisms to foster the communication and collaboration between the participating countries/regions/clusters, to increase the awareness of Clean Aviation activities and to promote the synergies and investments from EU funds;
- Organisation of events, conferences, workshops and dissemination activities to present and discuss the Clean Aviation results, exchange experience and foster innovation aspects of aviation research and innovation;

- Setting up a digital platform that will facilitate the exchanges between the members, and the described mission of the platform;

The networking activities will also aim to strengthening the interregional cooperation on aeronautics R&I between participating regions and build joint R&I plans complementary to Clean Aviation programme objectives eligible for ERDF or other regional/national funding. Where appropriate, the networking activities should establish close links or build on the existing networks (e.g., networks of aeronautic clusters such as the European Aerospace Cluster Partnership (EACP).