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CLIMATE ACTION FROM MANUFACTURING INDUSTRY IN SUPPORT OF INDUSTRY DECARBONISATION

(Presented by International Coordinating Council of Aerospace Industries Associations (ICCAIA))

EXECUTIVE SUMMARY	
The information paper presents actions being undertaken and planned by the manufacturing industry sector to contribute to the global aviation industry goal of net-zero carbon emissions by 2050. The air transport sector has taken a proactive, collaborative and ambitious approach to dealing with aviation climate change impact, including by all sub-sectors in the industry.	
Strategic Objectives:	This working paper relates to Strategic Objective: *Environmental Protection* - Minimize the adverse environmental effects of civil aviation activities.
Financial implications:	Not applicable
References:	

1. COMMITMENT TO CLIMATE ACTION

1.1 In October 2021 the collective air transport sector raised its ambition with a new long-term climate commitment: global civil aviation operations will achieve net-zero carbon emissions by 2050, supported by accelerated deployment of a comprehensive programme of effective emission reduction, energy transition and innovation across the aviation sector and in partnership with governments around the world.

1.2 The industry is determined to continue and accelerate the efficiency improvements and CO_2 emissions reductions it has achieved so far. But it also understands the climate challenge requires an even greater commitment, including critical partnerships with governments and the energy sector. All parts of the aviation industry are committed to making the net-zero carbon goal a reality. The Original Equipment Manufacturers (OEMs) are undertaking a range of measures that reduce global aviation emissions. In particular, the industry is now preparing for an energy transition away from fossil fuels. This includes accelerating deployment of sustainable aviation fuels (SAF) produced from a range of sources, including waste, sustainable biomass and power-to-liquid options. In addition, significant innovation and research is underway into potential use of hydrogen and electricity for some aviation operations.

1.3 Industry's *Waypoint 2050* analysis identified several illustrative pathways that will allow global aviation to reach net zero carbon emissions by 2050, confirming a significant reliance on sustainable

aviation fuels to meet the decarbonisation needs of the sector. The scenarios provide for different adoption rates and deployment of a range of ambitious new technology aircraft (including a push towards hydrogen and electric propulsion from around 2035). Depending on the scenario, between 12% and 34% of the emissions reductions will need to come from the development and deployment of new technologies, including both evolutions in conventional airframe and engine efficiency and new technology options such as new airframe configurations and hydrogen propulsion systems.

2. MEASURES TO UNLOCK AVIATION EMISSIONS REDUCTION AT ORIGINAL EQUIPMENT MANUFACTURERS (OEMs)

2.1 ICCAIA members are committed to advancements in all fields including aerodynamics, propulsion, structures, aircraft systems, manufacturing technologies, and all types of potential energies (sustainable aviation fuels, electricity and hydrogen).

2.2 Already, today's aircraft operate incredibly efficiently given their operating conditions, speed, and safety. Evolutionary technology will continue to be developed, bringing with it as much as 20% improvement in fuel efficiency for each generation of aircraft. In the next 30 years, the industry will likely see radical shifts in propulsion energy sources. From the 2030's onwards, it is expected that electric-, hybrid-, and hydrogen-powered propulsion will have the potential to serve regional, short-haul, and perhaps some medium-haul markets. Liquid drop-in fuels are expected to remain necessary for long-haul aircraft and for the remaining short and medium haul aircraft that have not shifted to electric or hydrogen. However, these flights will transition toward 100% sustainable and low carbon sources. Aircraft and engine systems will need to adapt to the improved formulation of those fuels so they can operate reliably and safely.

2.3 Airframe and propulsion technologies are focused on increased efficiency and further carbon emissions reductions as a feasible way to significantly reduce aviation's climate impact over the long term.

2.4 In the 2019 ICAO Environmental report, ICCAIA and ICAO shared a technology perspective for 2014 to 2019 by showcasing technology advancements on newly introduced and updated commercial aircraft. These aircraft are currently in service and are providing substantial reductions in fuel burn relative to the previous generation of airliners. Expanded use of these aircraft will continue to reduce the rate of emissions per revenue passenger kilometer (RPK). In the Business Aircraft and Regional Aircraft markets, a host of new technologies were also introduced in this period on new, more efficient aircraft. Advanced airframe and propulsion technology continues to be developed, matured and applied to next generation aircraft.

2.5 OEMs continue to benefit from national and international research programs, with cooperation between industry, governments and academia to rapidly mature advanced carbon reduction technologies and new generations of aircraft. OEMs have seen, for example, prototyping with smaller aircraft used in the development and testing of technology demonstrators with hydrogen fuel cells, hydrogen propulsion, advanced battery technology, more electric or electric hybrid propulsion, and aircraft systems technologies. Technologists and engineers will leverage cooperation to advance development, testing, and demonstration of readiness of new technologies to speed the years/decades-long development process for new airplanes without sacrificing safety or reliability.

2.6 OEMs are currently developing a range of technology and design innovations with the objective to prepare the next generation of aircraft to enter into service in the 2030s in the field of:

- New aircraft concepts that may facilitate integration of advanced propulsion and propulsion-energy systems
- Aerodynamic efficiency such as:
    - Increased wing span (afforded by advanced composite materials and load-alleviation technologies)
    - Wing, nacelle and empennage laminar flow and flow control technologies
    - Turbulent skin-friction reduction technologies
- Aircraft systems
- Structures
- Materials (lightweight materials and alloys)
- New propulsion systems (including increased efficiency of turbofan engines, Boundary Layer Ingestion (BLI), hybrid electric, unducted fan
- Alternative fuels (sustainable aviation fuels, hydrogen)

2.7 The Air Transport Action Group (ATAG) developed a technology roadmap that supports its CO_2 emissions roadmap in its Waypoint 2050 report (https://aviationbenefits.org/environmental-efficiency/climate-action/waypoint-2050/). In addition, the ICAO LTAG report provides a similar technology roadmap.

3. MEASURES TO UNLOCK ADDITIONAL EMISSIONS REDUCTIONS NOT INCLUDED IN THE INDUSTRY GOAL

3.1 In the mid- and long-term, innovative propulsion technologies, sustainable and alternative energy sources, and changes in overall aeroplane configurations and operations will impact both regulations and operations. The manufacturer-supported technology roadmap developed as part of CAEP's Long-Term Aspirational Goal (LTAG) report identifies technologies likely to arrive in various time frames and market segments.

3.2 This roadmap provides the most complete technology picture available and could thus be used as a basis for a complete review of the impact on SARPs of new technologies. Such a review could then be used to develop the necessary regulatory framework and associated timing to enable the development, certification and delivery of the revolutionary technologies and operations.

3.3 However, the regulatory framework outside of the environmental sphere is disconnected from this vision of the future. Manufacturers are already making significant investments in research and development to deliver innovations and technologies to decarbonise aviation while maintaining high levels of safety. ICAO must move at a pace that secures these investments with a modern, predictable, global and performance-based regulatory framework across all aspects of design and operations, not only for development of environmental SARPs.

3.4 This is why ICCAIA believes that a comprehensive regulatory framework should be developed leveraging the CAEP LTAG technology roadmap to promote development and deployment of new energy sources, propulsion and airframe technologies, new efficient operations and vehicle configurations to achieve sustainability goals.

4. CONCLUSION

4.1 Much of the aviation community has committed to net zero carbon operations by 2050 via uptake of SAF and e-fuels or direct use of alternative energies in concert with efficiency improvements driven by new technologies and operational / ATM enhancements.

4.2 To deliver on objectives, OEMs, like the entire aviation industry, need certainty and stable global frameworks that support the ambitions and unlock investments.

4.3 The OEM community will take action and will need all aviation stakeholders to support the collective effort to reach the objective. The Air Transport Action group (ATAG) has identified all the areas that will need action plans to support the necessary technological developments to reach the industry's objective (see the Appendix).

4.4 In this context, governments at a global level are encouraged to support action by ICAO to deliver a long-term aspirational goal for aviation climate action at the 41st Session of the ICAO Assembly, and any subsequent work on means of implementation, including capacity building, technology transfer (particularly for SAF deployment) and financing of the decarbonisation of the air transport sector.

4.5 Governments at a regional and national level should implement supportive policies for technology deployment; infrastructure efficiency improvements (including the full scope of the ICAO GANP); and particularly the energy transition to sustainable aviation fuels as part of governments' hydrogen strategy. The coming decade will be vital in making the investment in infrastructure to meet the needs of the sector to 2050 and beyond. A range of supportive policy measures are identified in the Appendix.

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APPENDIX

ACTION ITEMS FOR MEMBER STATES TO HELP DELIVER NET ZERO 2050

There are a number of broad means of implementation that ICAO can assist with, but much of the policy work needs to be done at a national (or regional) level to help ensure aviation's long-term climate goal and support industry decarbonisation. Below is a list of potential action items from governments related to technology. The full list, including action items for other stakeholder groups, can be found in the *Waypoint 2050* report.

Suggested action items and policy proposals for governments:

Action item	Description	Timeline	Difficulty
Continue to fund research programmes where they exist and develop projects where they do not	In the coming years, government must ensure that access by aerospace industry to ongoing funding for high-value collaborative R&D, essential for delivering highly efficient future aircraft and propulsion systems, remains in place. Examples include the Clean Aviation Partnership project in the EU.	Today – 2030	■■□□□
Provide strong guidance to green aviation research	Execute a national or supra-national research agenda that places the highest priority on; advances in environmentally friendly aviation, including radical new aircraft concepts, new sustainable propulsion energies, such as electricity and hydrogen, and highly efficient operations and infrastructure.	Possible today	■■□□□
Research into non-CO2 impacts also vital	Expand the focus from 'CO2 emissions reduction' to 'climate impact mitigation', considering also the impact of non-CO2 effects and how technology and adapted flight operations can reduce these effects. Some research is already ongoing in this space and while there is better understanding, the work has so far not provided conclusive operational or technology fixes and answers for the industry.	Already underway, can be expanded immediately.	■■■□□
If putting in place a market-based measure, invest a portion in R&D	As global and regional market-based measures are adopted, Governments should invest a portion of any funds collected in aircraft and propulsion technology that accelerates the sector's path to reducing CO2.	Available today	■□□□□
Implement ICAO aircraft CO2 Standard	The ICAO CO2 Standard should be implemented in national legislation.	Required today	■□□□□
Develop a wider hydrogen economy strategy for all potential users of hydrogen	Build a coalition of potential users and providers of green hydrogen in your country / region to start planning for a significant increase in hydrogen use by transport, including aviation. More generally, the changing energy needs of the aviation sector should be included in national energy strategies.	Possible today	■■■■□
Ensure sufficient infrastructure for low-carbon electricity across your economy	Support the introduction of hybrid-electric and full-electric propulsion, as key enablers to reach medium- and long-term CO2 emissions reduction goals.	Today – 2050	■■■■□

Action items for the aviation sector

Action item	Description	Timeline	Difficulty level
Collaborate in government – industry – research institution programmes and champion their development	Industry should be an active supporter of programmes like Clean Aviation (successor to CleanSky 2) in the EU, the FAA CLEEN project in the US and other existing programmes at a national level. Where such programmes do not exist, industry can encourage governments to invest alongside industry commitments. Should be accelerated in all regions, but also in emerging economies to take advantage of new talent in the developing world.	Possible today	■□□□□
Accelerate research into radical airframe designs, electric and hydrogen propulsion	Manufacturers: explore the potential of the emergence of new non drop-in energies for aviation. Explore new design and aircraft architecture concepts, in addition to exploring all advanced technologies. Accelerate product cycles and innovation speed with enhanced digital capabilities in order to enable sufficient market penetration of climate-friendly technologies until 2050 and beyond. Keeping affordability of new products in focus is important to ensure airlines have the ability to bring them into the fleet.	Today – 2050	■■■□□
Accelerate research into radical airframe designs, electric and hydrogen propulsion	Airlines: show interest and support for new technologies by participating in evaluation, making it easier for manufacturers and research establishment to drive forward the necessary developments and justify the related funding. Airlines (and similarly airports and ANSPs) are the end users of new technologies. They have a role in defining requirements for day-to-day operations and in validating if new solutions are fit-for-purpose.	Today – 2050	■■■□□
Form partnerships with non-aviation technology providers	Manufacturers: work with other industrial sectors (battery technology, automobiles, long-haul trucking, hydrogen sector) to form partnerships on accelerating necessary technology development.	Today – 2035	■■□□□

Provide robust incubator opportunities for new technology start-ups	Manufacturers: could fund an incubator for ideas and start-ups across the spectrum of aviation environmental efficiency. Many inventors have ideas which need to be explored and encouraged without the constraints that large global manufacturers may have.	Possible today	■■■□□
Implement necessary infrastructure adaptations	Airports: in airport expansion plans, foresee the provision of necessary infrastructure for (clean) electricity supply, (green) hydrogen and battery recharging facilities at the time when they will be needed (small-scale soon, substantial part of regional traffic in the 2030s).	Possible today	■■□□□
Implement necessary infrastructure adaptations	Airports: foresee ground infrastructure adaptations for radical new aircraft concepts, e.g. blended wing bodies, hydrogen.	2025-2035	■■□□□

Action items and areas for research institutions

Action item	Description	Timeline	Difficulty level
Ensure that research programmes take into account real-world requirements	The organisations in charge of defining aviation research and technology policy and strategy, such as ACARE in Europe, are giving special emphasis to the innovation and integration aspect, with stronger participation of end users, namely airlines, airports and air navigation service providers; this is also reflected in ACARE's name change from 'Advisory Council for Aeronautic Research in Europe' to "Advisory Council for Aviation Research and Innovation in Europe".	Possible today	■□□□□
Help facilitate clean energy and technology collaborations between industry sectors	Research programmes should support closer R&D cooperation between different sectors (such as aviation and energy) to create synergies.	Possible today	■□□□□
Provide a platform for visionary thinking and radical departures from standard research	The strategic research organisations have extended their goal-setting timeframe further into the future, with ACARE's vision document 'Fly the Green Deal' and NASA's strategic planning including an additional generation of long-term future ultra-green aircraft concepts. More room is thus given to radically	Possible today	■■□□□

	new ideas for the air vehicles and air transport concepts of the future, which rely on out-of-the-box thinking and leaving the classical concepts of tube-and-wing aircraft as well as today's forms of airports and airspace organisation.		
Ensure sustainability is part of any aviation-related curriculum at specialist universities	Educate aviation students on aviation's potential for green growth and willingness to decarbonise to ensure they are ready to innovate to support this technological challenge.	Possible today (and already happening in many cases)	■□□□□

Action items for the energy industry

Action item	Description	Timeline	Difficulty level
Plan strategic energy needs	Include aviation as a future customer of large amounts of clean electricity and hydrogen.	Required today	■□□□□
Develop worldwide hydrogen supply structure	Develop a worldwide hydrogen supply network, in collaboration with the aviation industry, ensuring that hydrogen is available at the majority of airports in the world – this is a prerequisite for the development of a hydrogen-powered aircraft programme, as manufacturers normally develop for a world market rather than a regional one.	2025-2040	■■■□□
Development of new SAF pathways and maturation of existing ones	The energy industry should prioritise and contribute to the development of new SAF pathways and push the maturity of already existing pathway-feedstock combinations and newer technologies like power-to-liquid.	Possible today	■■■□□

Action items for the finance community

Action item	Description	Timeline	Difficulty level
Focus funding on new efficient aircraft acquisition	Regional and multilateral development banks can play a proactive role in supporting the fleet replacement with new efficient aircraft.	Possible today	■■■□□

Sustainable finance opportunities	Aviation should be able to access sustainable finance, green bonds etc to support decarbonisation projects through technology, SAF, infrastructure improvements etc	Possible today	■□□□□

Action items for other stakeholders

Action item	Description	Timeline	Difficulty level
Develop synergies with the automotive sector	Automotive sector: this industry is fairly advanced in building vehicles using new clean propulsion energies (electricity, hydrogen). Collaboration between the automotive and aviation sectors is needed to benefit from synergies in the development and implementation of clean energy solutions.	Today – 2050	■□□□□
Develop synergies with the hydrogen sector	Hydrogen sector: ensure potential aviation demand for hydrogen is included in green hydrogen scale-up planning: for traditional SAF production, power-to-liquid production and also direct hydrogen use. Included in planning should be an exploration of the potential need to deliver large quantities of hydrogen to airport sites (storage, liquefaction, pipelines, etc)	Today – 2050+	■■■□□

— END —