



国际航空二氧化碳减排长期理想目标可行性 高级别会议（HLM-LTAG）

2022年7月19至22日，蒙特利尔

议程项目 1：国际航空长期全球理想目标的二氧化碳减排情景和选项

业界对于实现航空业长期气候目标的看法

（由国际机场理事会（ACI）、民用航空导航服务组织（CANSO）、国际航空运输协会（IATA）、
国际公务航空理事会（IBAC）和航空工业协会国际协调理事会（ICCAIA）
在航空运输行动组织（ATAG）的协调下提出）

摘要

本工作文件阐述了全行业如何看待国际民航长期理想目标的批准对于支持业界气候行动和实现民航业 2050 年净零碳排放目标的重大意义。航空运输产业已采取主动出击、协同配合、积极进取的策略消除自身对气候变化的影响。本工作文件提请 ICAO 在关于长期减排目标的高级别会议上批准一项国际民航长期理想目标。

会议的行动见第 5 段。

1. 航空业承诺解决自身的气候影响

1.1 经过大量分析，航空运输业于 2021 年 10 月集体做出了一项新的长期承诺，将本行业的气候目标提升到了全新高度：全球民航运营到 2050 年将实现净零碳排放，为此，全行业将与世界各国政府开展合作，加快实施一项集有效减排、能源转型和创新突破于一体的综合方案。

1.2 这与《巴黎协定》和《IPCC 1.5°C 特别报告》的目标一致，也承继了民航业早前做出的气候承诺：2009 年，民航业制定了三项全球目标来解决自身的气候影响：短期目标 — 每年增效 1.5%；中期目标 — 通过“碳中和”式的增长限制二氧化碳净排放；长期目标 — 在 2005 年水平的基础上，到 2050 年实现航空二氧化碳净排放减半。

¹ 中文、阿拉伯文、英文、法文、俄文和西班牙文版本由 ACI、CANSO、IATA、IBAC 和 ICCAIA 提供。

1.2.1 通过引进新型飞机技术、提高运营效率以及完善基础设施，民航业已超额实现其短期气候行动目标：分析结果显示，全行业燃效按滚动平均值计算提高了 2.1%，相当于 2009 到 2019 年间燃效提升了 22.8%²。每 PRK 的燃料消耗和二氧化碳排放量自 1990 年以来减少了 54%。

1.3 在既往成果的基础上，本行业决意继续并加快燃效提升和减排进程。但业界也认识到，应对气候挑战还需要付出更大的努力与投入，包括与政府及能源部门展开重要的伙伴合作。

1.4 当前，民航业已着手推进能源转型、淘汰化石燃料，具体措施包括加快部署可持续航空燃料（SAF），此类燃料产自多种来源，包括废物、可持续生物质以及电转液方法（如可再生能源电力和碳捕获）。此外，业界也正针对氢和电力推进解决方案在某些航空营运活动中的潜在应用开展重大创新和研究。

2. 采取措施全面发掘航空业的减排机会

2.1 航空运输业《航路点 2050》（Waypoint 2050）分析报告³就全球航空业如何实现 2050 年净零碳排放目标给出了若干说明性行动路径。从中可见，航空部门高度依赖可持续航空燃料来满足其脱碳需求。报告提出的情景设想针对一系列前景广阔的新技术飞机（包括 2035 年前后开始转向氢和电力动能系统）假定了不同的采用率和部署情况。根据不同的情景设想：

- 53%到 71%的航空脱碳要靠业界改用可持续航空燃料来实现 — 包括从当前的 SAF 来源逐步转向更多的 SAF 应用机会，例如随着生产工艺的成熟和成本的降低，航空业可以采用电转液技术生产 SAF。
- 12%到 34%的减排要靠开发部署新技术来实现，这既包括传统机身效率的改善，也包括前所未有的全新技术方案，例如更为乐观的情景设想中提到的氢推进技术。
- 7%到 10%的减排将来自运营和基础设施效率的持续提升。这部分减排尽管在 2050 年整体脱碳结构中显得微不足道，但对于航空业的早期气候行动以及维持航空运输系统的整体效率都至关重要。在这方面，空中交通管理现代化之类的项目发挥着关键作用。
- 最后，净零碳排放目标还有 6%至 8%的减排可能要靠行业外脱碳机会来实现，此类机会有望解决业内减排方案未能消除的剩余排放。

2.2 ICAO CAEP “LTAG” 报告遵循的分析线索与该报告十分相似，不同之处在于前者采取了自下而上的方法，而不是《航路点 2050》、区域路线图⁴以及各类国家产业路线图中常见的指标导向式方法。LTAG 报告证实，可持续航空燃料有望为 2050 年之前的碳减排做出最大的贡献。

² 上述数字剔除了 2020 和 2021 年新冠肺炎疫情期间全球运量下降所产生的影响以及后续造成的正常运营程序中断和效率损失。ATAG 简报（ATAG Fact Sheet），2021 年

³ 航空运输行动组织《航路点 2050》报告，2021 年：www.aviationbenefits.org/W2050

⁴ 例如，《目标 2050》（Destination 2050）是一份区域性航空业路线图，旨在指引欧洲航空业实现净零碳排放：www.destination2050.eu

2.3 在向氢或电力动能系统等技术方案转型的阶段，航空业仍将需要大量的可持续航空燃料来达到净零排放目标⁵。而《Fueling Net Zero》报告⁶显示，在正确的政策支持和市场信号下，扩大 SAF 产量是可以实现的。投资于这个新能源生态系统不仅有望促进能源生产在全球范围的公平分布，还能创造或支撑多达 1 400 万个就业岗位。重点在于，航空业使用的任何 SAF 都必须符合全球公认的可持续性标准，以此作为航空营运无害于生物多样性、土地使用、粮食系统、水系或当地居民的必要保证。

3. 行业主导的减排措施

3.1 航空运输业的各个领域都在努力发掘各自的减排机会，并协力实现全行业的长期脱碳目标。关于业内各领域如何应对减排挑战，更多详情参见以下资料文件：

- 航空公司（IATA）
- 公务航空（IBAC）
- 机场航空公司（ACI）
- 航空导航服务提供商（CANSO）
- 制造商（ICCAIA）

4. 长期气候行动的成功实施离不开伙伴关系、协同合作以及相互促进的减排承诺

4.1 航空业人士坚信，长期理想目标在 ICAO 大会第 41 届会议上的获批将产生一系列成效：降低长期投资的风险，并为资本市场提供回报保证，从而帮助航空业筹集资源实现减排目标；避免相互竞争的国际航线运营商之间出现市场失衡；确保全行业的气候行动有着统一的全球框架和共同的目标追求；维护 ICAO 在民航领域的领导地位，为国际行动的协调一致奠定坚实基础。

4.2 正如第 1.1 条所述，航空业承诺到 2050 年实现全球民航营运（国内和国际）净零碳排放。为兑现这一诺言，并以可持续方式继续为全世界提供四通八达、便捷高效的航空运输，本行业需要各个利益相关方给予协助：

4.3 敦促各国政府在全球层面支持 ICAO 的行动，以促成航空业气候行动长期理想目标在 ICAO 大会第 41 届会议上采纳通过，并助力开展后续的目标实施手段研究工作，这包括能力建设、技术转让（尤其是 SAF 部署方面）以及航空运输业脱碳融资。

4.4 在区域和国家层面，各国政府应为以下活动创造有利的政策环境：技术部署；基础设施效率改进（包括 ICAO GANP 中的所有措施）；以及转向低碳能源、采用可持续航空燃料，并将航空业需求纳入政府氢能战略的考虑范围。实施合理的监管并制定明智的政策能够营造长期可持续的稳定投资环境，而非短期的惩罚措施。未来十年将成为航空业基础设施投资的关键窗口期，关系着本行业能否得到必要的资金来实现 2050 年目标以及更长远的可持续发展。附录 A 中给出了一系列支持性政策措施（英文）。

⁵ 据估计，2050年的SAF需求可能在3.3亿公吨到4.45亿公吨之间。

⁶ ICF和航空运输行动组织《Fueling Net Zero》报告，2021年：www.aviationbenefits.org/W2050

4.5 能源部门需要在全球范围有力扩大可持续航空燃料和替代能源的生产，以支持能源转型。

4.6 包括多边开发银行在内的金融机构必须理解航空运输网络的重要战略意义，并提供必要的投资来支持航空运输业部署低碳化技术方案、基础设施和能源系统。

4.7 包括航空公司的企业客户和散客在内，客户可以自愿参与碳排放抵消计划并购买可持续航空燃料，以此帮助航空运输业减缓排放并改用 SAF — 这两种方式在中短期阶段尤其适用。

5. 高级别会议的行动

5.1 请高级别会议：

- a) 认可业界在气候行动方面取得的进展，强调航空运输业雄心勃勃的长期目标：到 2050 年实现全球民航净零碳排放；
 - b) 注意到业界观点：各国政府应为国际民航确立一项宏伟的长期理想目标，这对于支持全行业的气候行动以及 2050 年净零碳排放愿景的实现具有关键意义；
 - c) 在今年的 ICAO 大会第 41 届会议上建议批准一项全行业范围的 ICAO 长期理想目标，以促进航空业采取气候行动，该目标要与《巴黎协定》的 1.5°C 温升目标相一致，并以科学领域关于避免气候变化恶果的最新建议为依据；
 - d) 请求理事会在全行业的鼎力支持与配合下制定一项工作方案，借以明确航空业气候行动长期目标的实施手段，举例来说，此类手段可能包括：采取政策行动推进可持续航空燃料的部署；根据这一新目标协助开展“国家行动计划”；为需要帮扶的国家提供能力建设支持；和
 - e) 鼓励各国采取诸如第 4.3 和 4.4 条所述的行动，在自身能力范围内，依托于 ICAO 和其他国家在能力建设、技术转让和融资方面提供的援助，支持推进长期理想目标的实现。
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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. The full list, including action items for other stakeholder groups, can be found in the *Waypoint 2050* report.

Action items and policy proposals for governments: technology

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.	2020-2030	■ ■ □ □ □
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 and provision of low-carbon electricity and green hydrogen 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. Low-carbon energy supply will also enable reduced CO2 emissions from ground operations including airport terminals, for example, as well as provisions for power-to-liquid SAF production.	2020-2050	■ ■ ■ ■ □

Action items and policy proposals for governments: operations and infrastructure

Action item	Description	Timeline	Difficulty
Implement the ICAO Aviation System Block Upgrades	<p>The ICAO Global Air Navigation Plan (GANP) sets out a series of Aviation System Block Upgrades or technology modernisation projects focused on four performance improvement areas: airport operations; global interoperable systems and data; optimum capacity and flexible flights; and efficient flight paths. The initiatives reflect consensus around the series of technologies, procedures, and operational concepts needed to meet future capacity and ATM challenges.</p> <p>An analysis by ICAO found that if implemented Block 0 and 1 elements would deliver global fuel and CO2 savings of between 1.6 – 3.0% in 2025. Governments must carry through implementation plans for this vital project.</p>	Already underway, block 1 technologies are scheduled for 2019-2023	■■■■□□
Ensure programmes such as single European sky are implemented	The single European sky initiative was launched in 1999 to improve the performance of air traffic management through better integration of European airspace. Whilst some of the early building blocks of single European sky have delivered efficiency improvements through better cooperation between ANSPs in the region and a range of operational initiatives, the full scope of the project could triple airspace capacity, halve the costs of ATM, improve safety tenfold and reduce the environmental impact of aviation by 10%. Slow or no progress is being made by Governments towards the full implementation of the plan.	Early actions underway, but full scope some time away	■■■■□□
Make military air space flexible use	Large blocks of airspace are controlled by military and are often unavailable for civil operations. A number of States have successfully implemented flexible use of this airspace – handing it over to civil air traffic management when not in use by military and allowing much more direct routing of aircraft. Could reduce emissions significantly over a number of States.	Available immediately	■■□□□□
Develop new systems for regulators to progress on national, regional and global harmonisation of standards	Regulators need to accelerate the change process without sacrificing safety. With closer aircraft manufacturer, regulator and ANSP focused collaboration, the development of guidance material, criteria, and policies for new operational capabilities could likely be reduced from 5-10 years to 3-5 years. Having regulator participation supports the assurance that new investments will be returned in the form of cost savings, capacity enhancements, and other direct benefits.	Possible today	■■□□□□
Ensure balanced comparison of transport modes	Designing the solutions for the future sustainable mobility of citizens requires a thorough assessment of all environmental aspects for those transport modes (air, road, rail, sea) which can be complimentary. Bringing together particularly rail and aviation operations for seamless mobility between transport modes can provide benefits in some geographies, but there is a need to avoid policy decisions made by only considering operational emissions and not the full lifecycle environmental impact.	Possible today	■■□□□□

Action items and policy proposals for governments: sustainable aviation fuels

Action item	Description	Timeline	Difficulty
Clean energy transition push across government, including SAF, low-carbon electricity and green hydrogen.	Commit to supporting an energy transition through significant investment in sustainable aviation fuels. This can help drive new energy industries and re-use refining and other infrastructure.	Required from today	■■■■□
Pursue partnerships for SAF scale-up	Launch SAF partnership and cooperative projects bringing together local aviation industry stakeholders, energy suppliers, research institutions and potential feedstock suppliers.	Possible today	■□□□
Pursue partnerships for SAF scale-up	Engage in public-private partnerships for sustainable aviation fuel production and supply, including the necessary import regulations for SAF in the early years.	2020-2025	■□□□
If putting in place a market-based measure, invest a portion in SAF	As global and regional market-based measures are adopted, Governments should invest a portion of the funds collected in SAF and SAF R&D that accelerates the sector's path to reducing CO ₂ .	Available today	■□□□
Prioritise aviation (and other hard-to-abate sectors) as a user of alternative fuel	Set priorities for the sustainable energy mix in your country to ensure that the right type of low carbon energy is developed for each sector – aviation does not have alternatives at this time, particularly for long-haul operations and so should be seen as a priority user of feedstocks for liquid fuels.	Possible today	■□□□
Prioritise aviation (and other hard-to-abate sectors) as a user of alternative fuel	Road transport has historically had more advantages for feedstock use, making aviation use of these resources uneconomical – this situation should be reversed.	Possible today	■□□□
Explore potential for SAF development at a national or regional level	Undertake local supply opportunity assessments to investigate where potential SAF could be developed.	2020-2025	■■■□□
Support innovation into new energy alternatives	Support sustainable aviation fuel R&D and demonstration plants with academic and research organisations across the range of feedstock sources.	2020-2040	■□□□
Support development of SAF production	Attract capital to expand SAF capacity through loan guarantee programmes for construction of SAF production facilities (de-risking the early investment anxiety for new technologies).	2020-2035+	■■■□□
Support development of SAF industry	Direct research and development activities for local SAF production pathways and new energy industries.	2020-2025	■■■□□
Support development of SAF industry	Commit to policy certainty, or, at a minimum, policy timeframes that match investment timeframes.	2020-2030	■□□□
Demonstrate leadership	Commitment for government travel to be undertaken on SAF, either directly or through book-and-claim options initially.	Possible today	■□□□
Demonstrate leadership	Adopt globally-recognised sustainability standards and work to harmonise global standards.	2020-2025	■□□□
Demonstrate leadership	Encourage user-friendly sustainable aviation fuel accounting methods and work to harmonise global standards.	2020-2025	■□□□
Provide incentives for airline use of SAF	Make SAF zero-rated under carbon taxation or other market-based measures, if they are being developed.	2020+	■■■□□
Blending or production incentives for SAF producers or suppliers.	Ensure existing policy incentive frameworks, often designed for ground transport, also include aviation and evaluate higher incentives for aviation over ground transport which has other energy alternatives.	2025+	■□□□
Take a global leadership role in managing the aviation energy transition.	Showcase Government action at a regional and global level by championing SAF opportunities with other governments and at ICAO.	2020-2030	■□□□

- In addition, *Guidance on potential policies and coordinated approaches for the deployment of Sustainable Aviation Fuels* has been developed by ICAO.
- The Governments of Kenya, the Netherlands, Singapore, the United Arab Emirates and United Kingdom developed the Sustainable Aviation Fuel Policy Toolkit in 2021: www3.weforum.org/docs/WEF_Clean_Skies_for_Tomorrow_Sustainable_Aviation_Fuel_Policy_Toolkit_2021.pdf

Action items and policy proposals for governments: market-based measures

Action item	Description	Timeline	Difficulty
Support CORSIA	Volunteer for the early stages of CORSIA (as of publication, 112 countries have done so) and take part in capacity building to ensure CORSIA is successful. For those States exempted from the mandatory phase from 2027, commit to participation in CORSIA anyway.	2020-2035	■□□□
Ensure CORSIA continues to evolve	Work with other States at ICAO to ensure CORSIA meets the intended environmental motivation, remains fit for purpose and balances the need to deal with the growth in international aviation CO ₂ with the desire for inclusive action across a large number of countries. Ensure CORSIA's standards are maintained and new offset and carbon removal opportunities are evaluated (based on rigorous sustainability criteria) on a regular basis.	2020-2035	■■■□□
Set a long-term CO₂ goal	Through ICAO, set a long-term CO ₂ goal for international aviation at the 2022 ICAO Assembly compatible with the most recent scientific evidence from the Intergovernmental Panel on Climate Change.	2020-2022	■■■□□
Do not duplicate market mechanisms, base any domestic measures on CORSIA principles	CORSIA should be the single robust market mechanism on international flights, to avoid duplication and danger of market distortions. If States wish to deploy market-based measures on domestic flights for climate reasons, the industry encourages the use of the CORSIA framework to ensure ease of compliance and a reduction in duplication of systems and monitoring.		■□□□
If putting in place a market-based measure, invest in in-sector CO₂ reductions	As global and regional market-based measures are adopted, Governments should invest a portion of the funds collected in SAF, SAF R&D and technology R&D (among other opportunities) that accelerate the sector's path to reducing CO ₂ .	Available today	■□□□
Promote development of carbon capture opportunities	Carbon capture – particularly direct air capture – is a vital component of long-term carbon removal and is a key component for allowing the world to meet the Paris Agreement goals	2020-2050	■■■■□
Develop robust forestry accounting standards with other States and promote forestry offset development	Cooperation is needed between private sector and government-led forestry programmes, e.g. jurisdictional-level approaches and nested REDD+ projects, within national or subnational accounting systems.	2020-2025	■■■□□