



WORKING PAPER

**SEVENTH WORLDWIDE AIR TRANSPORT CONFERENCE
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Agenda Item 4: Emerging technologies, new business models and other associated aspects

**ECONOMIC REGULATORY FRAMEWORKS ON EMERGING
TECHNOLOGIES AND AVIATION CLEANER ENERGIES**

(Presented by the Secretariat)

EXECUTIVE SUMMARY

This working paper examines the economic regulatory implications of emerging technologies and access to cleaner aviation energies for the international air transport system. Developments in areas such as advanced air mobility (AAM), unmanned aircraft systems (UAS), artificial intelligence (AI), Sustainable Aviation Fuels (SAF) and other innovative technologies are reshaping aviation market structures, business models and value chains, while creating opportunities to enhance connectivity, sustainability, and industry resilience.

The paper highlights the need for responsive and internationally-harmonized economic regulatory frameworks capable of addressing evolving operational and market realities, including new entrants and emerging energy supply systems.

It further emphasizes the importance of establishing enabling economic regulatory frameworks that promote investment, innovation and the deployment of emerging technologies and cleaner aviation energy solutions, while supporting the sector's long-term transition towards a more sustainable and resilient future through appropriate incentives, coordinated action and international cooperation.

It further outlines the ongoing role of the International Civil Aviation Organization (ICAO) in supporting States through policy and guidance materials, monitoring and capacity-building initiatives on emerging technologies and cleaner aviation energies.

Action: The Conference is invited to note and adopt actions outlined in section 5 of this paper.

<i>Strategic Goal:</i>	This working paper relates to Strategic Goals: <i>The Economic Development of Air Transport Assures the Delivery of Economic Prosperity and Societal Well-Being for All and Aviation Is Environmentally Sustainable.</i>
<i>Financial implications:</i>	The activities referred to in this paper will be undertaken subject to the resources available in the 2026–2028 Regular Budget and/or from extra budgetary contributions, including the Voluntary Air Transport Fund.
<i>References:</i>	Resolutions Adopted by the 42nd Session of the Assembly, Provisional Edition, October 2025 (ICAO Assembly Resolutions A42-26, A42-21) Doc 9587, <i>Policy and Guidance Material on the Economic Regulation of International Air Transport</i> Doc 9082, <i>ICAO's Policies on Charges for Airports and Air Navigation Services</i> Doc 9161, <i>Manual on Air Navigation Services Economics</i> ICAO Policy on Innovation

1. INTRODUCTION

1.1 Emerging technologies and products, including cleaner aviation energy solutions, are increasingly transforming the aviation ecosystem. Advancements in the area of advanced air mobility (AAM), unmanned aircraft systems (UAS), higher airspace operations (HAO), artificial intelligence (AI), Sustainable Aviation Fuels (SAF), Lower Carbon Aviation Fuels (LCAF) and other innovative technologies are contributing to changes in the structure, operations and economics of civil aviation and are driving the emergence of new aviation stakeholders, including non-traditional aviation actors. Space transport operations, while not regulated by ICAO has a significant, and increasing, impact on Air Transport with which it shares the airspace. These trends are expected to generate new socio-economic benefits, including enhanced connectivity, economic growth and employment generation, as well as new economic opportunities such as the development of new supply chains, infrastructure and associated industrial ecosystems.

1.2 While the technical and operational aspects of these emerging technologies and cleaner aviation energies are being addressed in relevant fora of the International Civil Aviation Organization (ICAO), their broader economic dimensions and considerations require further examination, including implications for market structures, investment needs, economic regulatory frameworks and business models within the air transport system.

1.3 With regard to cleaner aviation energies, significant work is underway by ICAO in collaboration with its Member States and relevant stakeholders to support the global scale-up in development and deployment of SAF, LCAF and other aviation cleaner energies. The Long-Term Global Aspirational Goal (LTAG), adopted by the ICAO Assembly, establishes a collective global aspirational goal of achieving net-zero carbon emissions from international aviation by 2050 (Resolution A42-21, paragraph 7 refers). Recognizing that aviation cleaner energies are expected to have the largest contributions to aviation CO₂ emissions reductions to support the achievement of the LTAG, ICAO and its Member States strive to achieve a collective global aspirational vision to reduce CO₂ emissions in international aviation by 5 per cent by 2030 through the use of SAF, LCAF and other aviation cleaner energies, compared to a scenario of zero cleaner energy use (A42-21, paragraph 8 refers). At the same time, the Assembly recognizes the significant financial implications associated with this aviation decarbonization toward the LTAG, including the need to invest approximately USD 3.2 trillion in producing aviation cleaner energies through to 2050. This highlights the need to further examine the economic and regulatory environment needed to support the long-term viability and implementation of these solutions as well as to enable adequate investment, market development and equitable access, in particular for developing countries and States having particular needs.

1.4 Regarding economic regulatory considerations, ICAO Assembly Resolution A42-26 requested the Council to monitor the progress of (UAS), and to promote the sharing of information on best practices in related economic regulatory issues among States. The Resolution also recognized that the expansion of new entrants, including UAS and AAM, necessitates investment in both existing and new aviation infrastructure to support their integration and ensure safe and efficient operations, and requested the Council to continue assessing emerging funding and financing requirements associated with technological advancements, including investments in infrastructure to support operations of such new entrants. These works are currently being undertaken within the relevant expert groups, notably the Air Transport Regulation Panel (ATRP), which is addressing implications for economic regulatory frameworks, and the Airport Economics Panel and Air Navigation Services Economics Panel (AEP-ANSEP), which are examining related aspects within their respective mandates, including cost-recovery mechanisms and economic oversight considerations.

2. ECONOMIC REGULATORY IMPLICATIONS OF EMERGING TECHNOLOGIES AND ACCESS TO CLEANER AVIATION ENERGIES

2.1 While the rapid evolution of emerging technologies and cleaner aviation energies presents significant socio-economic opportunities for international air transport, it also creates challenges for States and regulators in adapting existing economic regulatory frameworks to evolving market dynamics and operational models. Realizing these opportunities will require adequate infrastructure, coordinated planning and enabling policy environments capable of attracting the long-term investments needed across the aviation value chain.

2.2 Economic regulatory frameworks to support the development of emerging technologies and access to cleaner aviation energies

2.2.1 Existing economic regulatory frameworks have largely been developed around traditional air transport operations and the established relationships between regulators, airlines, airports and air navigation services providers (ANSPs). However, emerging technologies, new business models and evolving energy systems are introducing new actors and operational arrangements — including UAS operators, UAS traffic management (UTM) service providers, advanced air mobility operators, HAO, SAF producers and other energy suppliers — which, while sharing certain characteristics with conventional aviation activities, also present distinct market, operational and infrastructure requirements.

2.2.2 These developments may, therefore, require the adaptation of existing, or the development of new, economic regulatory frameworks to facilitate the integration of new entrants, ensure effective economic oversight of emerging service providers, and support the development of associated energy supply chains and infrastructure. Such economic regulatory frameworks will need to be responsive and adaptable to evolving market and technological developments while ensuring a level playing field, promoting investment and maintaining coherence across the aviation system. In this context, differences between existing regulatory structures and the characteristics of emerging technologies, new business models and energy supply systems may lead to situations where current approaches do not fully reflect evolving operational and market realities.

2.2.3 In addition, the development of new technologies and cleaner aviation energies, as well as the introduction of new airspace users and the increase of space transport operations, requires adequate physical, digital and institutional infrastructure to support safe, efficient and sustainable operations. For AAM and UAS operations, this may include UTM systems, communication and surveillance infrastructure, vertiports, charging facilities, cybersecurity systems and integration with existing air traffic management systems. For cleaner aviation energy solutions, key needs include sustainable aviation fuel production and distribution facilities, hydrogen and electric charging or refuelling infrastructure, upgraded airport energy systems and supply chains. All of these developments call for supportive regulatory frameworks, policies and guidance on financing-related infrastructure requirements.

2.2.4 Addressing these considerations will require States to establish enabling economic policy and regulatory frameworks that promote investment and innovation across the aviation ecosystem. This includes the development of forward-looking and adaptable economic regulatory frameworks, together with appropriate policy, financial and market-based incentives to encourage the development, deployment and uptake of emerging technologies, cleaner aviation energy solutions and the supporting infrastructure required for their operations. For example, with a view to facilitating the global scale-up in development and deployment of SAF, LCAF and other aviation cleaner energies, the ICAO [Assembly Resolution \(A42-21, paragraph 11\)](#) highlights the importance of making a balanced progress among the four Building Blocks on 1) policy and planning, 2) regulatory framework, 3) implementation support, and 4) financing.

2.3 **Monitoring and analysis of key economic regulatory provisions**

2.3.1 A comprehensive understanding of the economic implications of emerging technologies and access to aviation cleaner energies is essential to inform effective policy development. In this regard, ICAO and its Member States should strengthen mechanisms for the monitoring, as required, of industry developments, including technological advancements, market dynamics and investment trends with a view to ensuring that these are reflected in a timely and informed manner in national and regional strategic priorities.

2.3.2 Such monitoring should be complemented by the systematic analysis of existing economic regulatory frameworks, including ICAO policies and guidance material, in order to assess their continued relevance and identify where adaptation or new approaches may be required. Particular attention should be given to assessing economic impacts, identifying cross-sectoral synergies, and evaluating the adequacy of existing frameworks in relation to evolving infrastructure and energy supply-chain requirements.

2.3.3 Effective monitoring and analysis may also require enhanced collaboration and joint data initiatives across the aviation ecosystem and relevant stakeholders. In this regard, ICAO can play an important coordinating role in facilitating the collection, exchange and analysis of reliable and comparable data to support evidence-based policymaking, identify emerging trends and support the development of harmonized approaches at the global level.

2.4 **Cross-sectoral coordination and stakeholder engagement**

2.4.1 The cross-cutting nature of emerging technologies and access to aviation cleaner energies require enhanced coordination among a wide range of stakeholders. This includes coordination between aviation authorities and other relevant regulatory bodies, such as those responsible for energy, environment, digital technologies, finance, and space-related activities.

2.4.2 Effective coordination should also extend to close collaboration with industry stakeholders, emerging aviation stakeholder, and out-of-sector stakeholders, including new entrants and providers of innovative business models, such as AAM operators, UAS service providers, AI and digital solution developers, energy producers and suppliers, and infrastructure developers, as well as financial institutions, ICAO partners and relevant international and regional organizations.

3. **GLOBAL HARMONIZATION AND THE ROLE OF ICAO**

3.1 The ICAO Strategic Goal “*The Economic Development of Air Transport Assures the Delivery of Economic Prosperity and Societal Well-Being for All*” aims to foster a sound, sustainable and economically viable air transport system that supports global connectivity and inclusive economic growth. In this context, emerging technologies and aviation cleaner energies offer significant potential to contribute to these objectives by enabling new forms of connectivity, stimulating investment and innovation, creating employment opportunities and strengthening global value chains, while supporting the long-term sustainability of the sector.

3.2 Divergent regulatory frameworks may create barriers to market development, limit investment flows, and hinder the realization of potential socio-economic benefits. The development of internationally consistent approaches, in line with ICAO policies and guidance, will be necessary to promote regulatory certainty, facilitate cross-border operations, and support the efficient allocation of resources. Such harmonization will be particularly important in ensuring equitable access to opportunities arising from these developments, including for developing States and those with special needs.

3.3 ICAO will continue to monitor developments in this area and assess their economic implications, while supporting its governing bodies and expert panels in the development and update of relevant policy and guidance material. ICAO shall also continue to provide a global forum for dialogue among States and industry stakeholders to facilitate the exchange of information, experiences and best practices, with a view to promoting coherent and harmonized approaches at the international level.

3.4 Furthermore, consistent with the *No Country Left Behind* (NCLB) Strategic Goal, ICAO is committed to continuing to support States in strengthening their regulatory capacities and institutional frameworks to effectively respond to these developments. Various dedicated programmes have been launched and implemented to this end, such as the ICAO Assistance, Capacity-building and Training for SAF (ACT-SAF) programme. Such support should aim to ensure that all States are able to participate in and benefit from the opportunities arising from emerging technologies and cleaner aviation energies.

3.5 The critical role of economic regulatory frameworks in support of the objectives of the ICAO policy on innovation, particularly that of facilitating the development and deployment of innovation by Member States and ensuring that all States have a fair opportunity to develop and deploy innovations in aviation, should also be noted.

4. CONCLUSION

4.1 Emerging technologies and access to cleaner aviation energies are transforming international air transport, bringing both opportunities and new regulatory and investment challenges. Evolving market structures, new entrants and infrastructure needs underscore the importance of responsive and coherent economic regulatory frameworks. Addressing these developments will require improved coordination and internationally consistent approaches to ensure sustainable and inclusive benefits for all States.

5. ACTION

5.1 The following recommendations are proposed for consideration by the Conference:

- a) States should put in place appropriate economic regulatory frameworks and policy measures to support the development, operation and accessibility of emerging technologies, in particular advanced air mobility (AAM), unmanned aircraft systems (UAS), UAS traffic management (UTM), higher airspace operations (HAO), and aviation cleaner energy sources, including through the provision of incentives, investment facilitation and other enabling mechanisms necessary to accelerate the sector's transition towards a sustainable future;
- b) States should establish effective coordination between aviation authorities and other relevant regulatory bodies, such as those responsible for energy, environment, digital technologies, finance and space-related activities.
- c) ICAO will continue to monitor developments on emerging technologies and aviation cleaner energy sources and conduct their transformative impact analysis, as appropriate, on international air transport; and
- d) ICAO will continue to support States, particularly developing countries, through targeted capacity-building, technical assistance as well as knowledge-sharing and

revenue mobilization activities, in line with the *No Country Left Behind* (NCLB) Strategic Goal, to enable the development of appropriate economic policy and regulatory frameworks and facilitate the effective adoption of emerging technologies and aviation cleaner energy sources.

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