

## **Green Aviation Manufacturing Industry Development Program (2023-2035)**

Developing green aviation manufacturing industry is an inevitable requirement for tackling climate change and achieving sustainable development of the aviation industry. It is an important direction for the new round of aviation science, technology and industrial revolution, and a major strategic initiative to enhance the future competitiveness of aviation manufacturing industry. The 20th National Congress of the Communist Party of China made the decision to promote the new industrialization and push the manufacturing industry toward high-end, smart and green development. To implement the spirit of the 20th National Congress of the CPC in full, accurate and comprehensive manner, grasp the opportunity of aviation power transformation, accelerate the fostering of new business forms in aviation industry, this program is hereby formulated.

### **I. Development Background**

#### **(I) High-quality development puts forward new requirements for green aviation manufacturing industry**

High-quality development is the primary task for building a modern socialist country in all respects. The new era has raised new and higher requirements for the development of aviation manufacturing industry. Firstly, green development is an inevitable requirement for achieving sustainable development of aviation industry, and it is the core and key to enhancing the future competitiveness of aviation manufacturing industry. Major developed countries attach great importance to green aviation development and seize the new frontier in aviation power transformation. Secondly, the development of green aviation manufacturing industry has opened up new technology paths, product forms and application scenarios, so it is imperative to accelerate the establishment of a high-level aviation science and technology innovation system with independent and controllable capabilities adapted to the requirements of green development. Thirdly, the existing aviation technical standards system, airworthiness management system, operational service system and so on urgently need to be updated and improved to meet the needs of green aviation manufacturing development.

#### **(II) China's green aviation manufacturing industry faces major strategic opportunities**

Making great efforts to build China into a manufacturing powerhouse, a strong aviation power and a transportation powerhouse provides rare historical opportunities for China's aviation manufacturing industry to develop the new track of green aviation. Firstly, China has huge potential market in areas like air transport, logistics delivery, urban air mobility and emergency rescue. Secondly, China has accumulated technological advantages in new energy vehicles, rail transit and other equipment fields, forming an advanced industrial foundation, which provides opportunities for green transformation of aviation manufacturing industry. Thirdly, the new round of scientific and technological revolution promotes accelerated integration of new energy, new materials, new generation of information technology with aviation science and technology, while breakthroughs have been made continuously in related technologies such as batteries, motors, sensors and flight control systems. New modes like sharing mobility and smart city also

keep evolving, bringing important opportunities for the intelligent and green transformation of aviation manufacturing industry.

### (III) China boasts good foundation for developing green aviation manufacturing industry

Since the 18th CPC National Congress, under the strong leadership and high attention of the CPC Central Committee and the State Council, all related departments have strengthened top-level planning, achieved synergy between the central and local authorities to accelerate the layout, and make forward-looking deployment in new technologies and products for green aviation, promoting industrialization process and accelerating the development of green aviation manufacturing industry, making positive progress. Technologies for designing, manufacturing and verifying green, efficient and safe aircraft have been continuously updated and iterated. China has achieved a world-leading level in the development of light and micro fixed wing electric aircraft and multi-rotor drones. Innovative products like electric vertical takeoff and landing (eVTOL) aircraft and flying cars have risen rapidly, forming industrial advantages in some fields.

In general, in the period ahead, while facing important strategic opportunities, the development of China's green aviation manufacturing industry also faces many new challenges. We must make overall planning from both current and long-term perspectives based on present conditions and keep in mind future goals, carry out systematic top-level planning, and promote the building of green aviation production system, operation system, service support system in a coordinated manner, so as to foster new business forms for green development of aviation industry and create new growth drivers for the green development of aviation manufacturing industry, providing strong support for building China into a manufacturing powerhouse and a strong aviation power.

## II. General Requirements

### (I) Guiding Principles

Be guided by Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era, thoroughly implement the spirit of the 20th CPC National Congress and Xi Jinping's thought on ecological civilization, base on the new stage of development, fully, accurately and comprehensively implement the new development philosophy, accelerate building the new development paradigm, closely focus on reaching peak carbon dioxide emissions and achieving carbon neutrality, take the high-quality development of aviation industry as the theme, take technological transformation, power transformation and operation system transformation as the main thread, make coordinated efforts to promote the building of innovation system, industrial system, demonstration application system and service support system for green aviation, foster new business forms for green development of aviation industry, and create new growth drivers for the green development of aviation manufacturing industry, so as to provide strong support for building China into a manufacturing powerhouse and a strong aviation power.

### (II) Basic Principles

Market-oriented, government-guided. Give full play to the decisive role of the market in resource allocation, highlight the principal role of enterprises, strengthen in-depth integration of production, academia, research and application, and actively explore commercialization paths for new energy aircraft. Better leverage the role of government, strengthen top-level guidance, improve industry administration and services, optimize industrial layout, guide sound industrial development, and promote the formation of a unified, competitive and well-ordered market environment.

Innovation-driven, integrated development. Adhere to innovation-driven development, accurately grasp the direction of green aviation innovation and development, focus on breakthroughs and verification in frontier areas through technological exploration and new modes, establish and improve a coordinated and efficient innovation system and industrial chain and supply chain, and continuously enhance industrial competitiveness and innovation capacity. Promote integrated development of digitalization, intellectualization and green development, strengthen smooth development of upstream and downstream enterprises and large, medium and small enterprises of industrial chains, reinforce coordinated cooperation at home and abroad, build manufacturing clusters of international advanced level, and form a new pattern of pooling strengths for collaborative innovation.

Overall planning, systematic implementation. Adhere to the system thinking, make strategic layout with overall planning, balance well the current and long-term, macro and micro aspects of green aviation development. Combine the expanding domestic demand strategy with deepening supply-side structural reform, and promote the transformation and upgrading, product supply, industrialization and service support of aviation manufacturing industry in a coordinated way, so as to achieve unified high quality, structure, scale, efficiency and safety in the development of green aviation manufacturing industry.

### (III) Development Goals

By 2025, energy conservation, emission reduction and noise reduction performance of China-made civil aircraft will be further improved, the level of green aviation manufacturing will be fully upgraded, and phased results will be achieved in the development of green aviation industry. China-made civil aircraft that use sustainable aviation fuels will be put into demo operation, electric commercial aircraft will be put into commercial application, electric vertical takeoff and landing aircraft (eVTOL) will start trial operation, key technologies for hydrogen-powered aircraft will complete feasibility verification, green aviation infrastructure will continue to be strengthened, a number of standards and specifications as well as technology public service platforms will be established and effectively support the building of green aviation production system and operation system.

By 2035, a complete, advanced and safe green aviation manufacturing system will be built up, new energy aircraft will become mainstream, civil large aircraft made in China will reach world top level in terms of safety, environmental protection, economy and comfort, and new general

aviation equipment featured by unmanned operation, electrification and intellectualization will realize commercialization and scale application.

### III. Development Pathways

Adhere to the parallel development of multiple technology routes, and actively explore new fields and new tracks for green aviation. Steadily advance technology research based on technological maturity. During the 14th Five-Year Plan period, light aircraft will mainly adopt electrification, while trunk and regional aircraft will adhere to the parallel development of multiple routes including new aerodynamic configuration, sustainable aviation fuels and hybrid propulsion. Meanwhile, we will actively explore technology routes like hydrogen energy and liquefied natural gas (LNG) and make forward-looking layout for the future industry.

#### (I) "Green+" to facilitate upgrading of civil aircraft industry

Promote further optimization and improvement of existing China-made civil aircraft to achieve weight reduction, drag reduction, noise reduction and more electrification through various means, and continuously improve the economy and eco-friendliness of China-made civil aircraft. Accelerate the building of green aviation manufacturing system, promote green and smart upgrading of production process and workflow in civil aircraft enterprises, develop aviation remanufacturing models, improve whole life cycle management of green aviation technologies/paths, propel carbon emission footprint assessment in the whole industrial chain, and reduce energy and resource consumption as well as greenhouse gas emissions like carbon dioxide. Strengthen the application verification of sustainable aviation fuels in China-made civil aircraft and aero-engines.

#### (II) Developing new fields of electric aviation

Targeting application scenarios like urban air mobility, emergency rescue, logistics transportation, accelerate the application of innovative products like eVTOL, light and micro fixed wing electric aircraft, new energy drones, etc. Build up capabilities in supplying electric aircraft, operating support and industrialization development guided by typical scenarios, creating new economic growth poles. Encourage green aviation demo operation to promote commercial operation of light and micro fixed wing electric aircraft and eVTOL. Accelerate the integration of eVTOL into comprehensive three-dimensional transportation networks, establish a unified air-ground intelligent interconnection management platform, build low-altitude Internet of Things, and initially form a safe, convenient, green and economical urban air mobility system. Based on application scenario demands and combined with pure electric propulsion technology and turbo hybrid electric propulsion technology, carry out preliminary research on new energy commercial aircraft from small to large sizes.

#### (III) Making layout for new tracks like hydrogen energy aviation

Actively make layout for R&D of key technologies for hydrogen energy aviation, accelerate

tackling key and core technologies such as hydrogen storage devices, power devices, etc. Carry out research on new aircraft configuration technologies suitable for hydrogen-powered aircraft. Advance theoretical research and technical verification of hydrogen fuel cells combined with hydrogen internal combustion engines, hydrogen turbines, hydrogen hybrid electric propulsion aircraft, and open up technical application modes featuring coordination and synergistic innovation with upstream and downstream hydrogen energy industry. Focusing on future development trends of hydrogen energy aviation, explore new modes for commercial operation of hydrogen energy aircraft. Actively explore application methods and paths for other energy sources like LNG in the aviation field.

#### IV. Major Tasks

##### (I) Building an efficient and coordinated green technology innovation system

1. Strengthen tackling key and core green aviation technologies. Continuously promote technology upgrading and transformation in areas like overall design, aerodynamics, structure, engine, avionics, materials, manufacturing process and so on, accelerate the development of hybrid propulsion systems, and constantly improve energy conservation, emission reduction and noise reduction of trunk lines, regional jets, general aviation aircraft and so on. Speed up the R&D of high energy density, high discharge efficiency and high safety aviation power batteries, as well as highly reliable, high specific power and high efficiency aviation electric propulsion technologies. Strengthen research on highly efficient gas turbine-electric energy integration technologies. Guide leading enterprises and research institutes to continuously make breakthroughs in intelligent, highly reliable, lightweight and low-cost energy control and flight control technologies, carry out overall design of new energy aircraft, energy system design, all-electric avionics system and other technological research. Continuously explore key technologies for hydrogen energy aircraft such as hydrogen fuel storage technologies, hydrogen fuel cell technologies, hydrogen internal combustion engines, hydrogen turbine engines, hydrogen hybrid electric propulsion technologies, and energy management technologies. Focusing on the strategic needs of China's green aviation development, accelerate the layout of basic research and applied basic research to solve the source and underlying technological problems that restrict green aviation development.

Box 1: Green Aviation Technology Innovation Program
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<p>1. Technology upgrading of "green +" products. Carry out iterative technology upgrading of "green+" around further energy conservation, emission reduction and noise reduction of China-made civil aircraft. Carry out tackling of technologies such as distributed propulsion configuration centering on aircraft aerodynamic layout. Carry out tackling of technologies such as wing-body structure, fan structure centering on new structural design. Accelerate the layout of new generation of avionics. Carry out tackling of technologies such as energy management, energy harvesting/conversion and energy storage centering on efficient energy utilization. Carry out tackling of technologies such as assisted piloting, autonomous flight control, intelligent avionics, etc. centering on intelligent, systematic and networked technology trends. Combined with the performance advantages of new energy aircraft and new technologies like 5G, big data, artificial intelligence, promote leapfrog upgrading of avionics.</p>
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2. Development of hybrid propulsion system demonstration verification platform. Carry out prototype development, ground test and demonstration platform development for hybrid propulsion system, to realize flight verification of hybrid propulsion system. Achieve breakthroughs in aviation materials, smart materials, integrated functional structure materials and other material technologies, avionics technologies like multi-electric system integration, fuel-electric APU, electric taxiing, air-ground integrated operation system.

3. Systematic tackling for engineering application of electric general aviation aircraft. Accelerate the series and family development of electric general aviation aircraft. Achieve breakthroughs in key technologies such as high energy density lithium batteries, high specific power hydrogen fuel cells, high efficiency electric propulsion systems, high thrust-weight ratio ducted fans, advanced aerodynamic layout ducted fans, solar-powered drones. Put into mass production 400Wh/kg class lithium batteries for aviation, carry out small-scale verification of 500Wh/kg class products; put into mass production 250kW class aviation motors and drive systems, carry out small-scale verification of 500kW class products, making specific power reach 20Nm/kg. For manned aircraft and urban air mobility aircraft for logistics, achieve breakthroughs in key technologies such as airworthiness design for safety, high efficiency aerodynamic configuration design, low noise and high efficiency electric propulsion, high reliability flight control for electric tilt-rotor, manned flight control for vertical takeoff and landing, and carry out tackling and test flight verification.

4. Feasibility study and tackling key technologies for hydrogen-powered aircraft. Carry out research on hydrogen internal combustion engines, hydrogen turbine engines, hydrogen hybrid electric propulsion, efficient hydrogen storage technologies, avionics and reliability to realize verification of key technologies for hydrogen-powered aircraft. Carry out research on infrastructure to improve convenience, flexibility and safety of ground transportation, storage and refueling of hydrogen fuels. Carry out prototype development, ground test and demonstration platform development for hydrogen energy system. Accelerate tackling key and core system technologies such as efficient liquid hydrogen storage systems, hydrogen power component and whole aircraft test rigs, efficient and low-emission hydrogen combustion, precision hydrogen control, integrated thermal management.

2. Establish and improve coordination mechanisms for innovation. Strengthen the principal role of green aviation enterprises in scientific and technological innovation, promote the concentration of various innovation elements to enterprises, support enterprises in enhancing innovation capabilities, and fully stimulate corporate innovation vitality. Promote in-depth integration of the innovation chain and industrial chain, construct a technology innovation system led by enterprises, market-oriented, and deeply integrating production, academia, research and application, establish commercial green aviation industrial technology innovation centers and innovation consortiums, build new energy storage manufacturing innovation centers, and accelerate the R&D of green aviation key common technologies and new energy aircraft products. Strengthen cross-industry integration, rely on common technologies and industrial foundations in related industries like new energy vehicles, ships, rail transit to promote green aviation development, and build a mutually beneficial and reinforcing coordinated relationship.

Actively promote coordination between manufacturers and operators to accelerate the promotion and application of green low-carbon technologies.

3. Strengthen professional talent training. Encourage colleges and universities to strengthen the building of knowledge maps in fields like sustainable aviation fuels, electric aircraft, hydrogen energy aircraft, and promote the development of teaching resources and demonstration courses. Encourage industry enterprises to actively connect and cooperate with colleges and universities, accelerate the fostering of versatile talents across disciplines for green aviation technologies, and form a gradient, multi-level talent training ecosystem that supports coordinated innovation.

#### (II) Building an open and integrated green aviation industrial system

4. Develop green aviation manufacturing. Vigorously promote green design technologies, develop green surface treatment, clean processing, low-energy consumption processes, build a green manufacturing technology system for environment, energy and materials. Promote the integration of aviation manufacturing technologies with industrial Internet, big data, 5G, artificial intelligence and other new generation information technologies, improve the level of energy, resource and environmental management, and build a number of green smart manufacturing factories. Develop recycling methods for metals, composite materials, power batteries and so on to facilitate the formation of a new business model featuring aviation equipment dismantling and regeneration.

5. Build green aviation industrial chains. Give full play to the role of backbone enterprises and SMEs in green aviation field. Strengthen the cultivation of high-quality enterprises in steps. Leverage the advantages of backbone enterprises in technologies, standards, funding and talents as well as the supporting role of SMEs in industrial innovation and strengthening and stabilizing industrial chains. Focusing on electric aircraft, accelerate the formation of modern industrial chains of safe and efficient motors, batteries, flight control, materials and so on, and continuously enhance the resilience and safety of industrial chains. Promote the integration of manufacturing and operation by backbone enterprises, and explore safe, efficient and economical business operation models.

6. Deepen international cooperation on green aviation. Strengthen policy communication, technological exchange, project (technology) cooperation, personnel training in the field of green aviation development, encourage research institutes, colleges, universities and enterprises to actively participate in the formulation of relevant international standards and regulations, and build international technology innovation cooperation platforms for green aviation. Encourage enterprises to "bring in" and "go global" facing green aviation development, integrate into the international green aviation industrial chain and supply chain system, and explore the international green aviation market.

#### (III) Building a market-oriented green demonstration application system

7. Promote regional application demonstration of new energy aircraft. Relying on advantageous

regions, build demonstration zones for green upgrading of China-made aircraft. Encourage all regions to carry out trial demonstration application of electric aircraft for general aviation and eVTOL based on local economic development foundations and demands, and explore new models for application scenarios, specifications, operation systems and customer service solutions. Encourage regions with the basis and conditions to build test bases for key green aviation technologies, product solutions and safety verification.

Box 2: Green Aviation Innovation Application Demonstration Program

1. Relying on advantageous civil aviation industry clusters in the Yangtze River Delta, Chengyu-Guiyang, Changzhutan and other regions, build demonstration zones for green upgrading of China-made aircraft, carry out feasibility studies and trials for green smart manufacturing factories, improve the economy and eco-friendliness of China-made aircraft.
2. Encourage advantageous regions like the Pearl River Delta, Yangtze River Delta, Ring Bohai Sea, Chengyu to set up low-altitude economy demonstration zones, carry out large-scale demonstration operation of light and micro electric aircraft, commercial demonstration operation of eVTOL, promote feasibility studies in application scenarios, product specifications, operation systems, customer service solutions for electric aviation.
3. Encourage regions like Beijing-Tianjin-Hebei, Yangtze River Delta, Changzhutan, Chengyu with the basis and conditions to build hydrogen energy aviation R&D test bases, carry out hydrogen power transformation of China-made civil aircraft, promote feasibility studies of the hydrogen energy aviation technology system.
4. Leverage the locational advantages of abundant energy resources and airspace in central and western regions, build test bases for green aviation technologies, products, safety, promote feasibility studies of green aviation product solutions and safety verification.

8. Carry out pilot application of sustainable aviation fuels on China-made civil aircraft. Based on the mature application of sustainable aviation fuels, carry out pilot verification of different blending ratios on China-made civil aircraft. Actively carry out the development of standards, systems and specifications for using sustainable aviation fuels on China-made civil aircraft.

(IV) Building a safe and effective service support system

9. Build a green aviation industrial standard system. Adhere to the principle that standards and regulations go first and lead, compare with industrial standard systems for carbon peak and carbon neutrality, accelerate the formulation of standards in areas like sustainable aviation fuels, green manufacturing, aircraft dismantling, and promote the industrialization and development of key technologies. Focusing on product safety, technical performance, market operation of new energy aircraft, accelerate the formulation of industry standards and vigorously develop association standards. Carry out preliminary studies on hydrogen-related standards and establish a standard system for hydrogen energy aviation. Promote the development of green aviation metrology system, strengthen research on metrological benchmarks in green aviation, and



promote capacity improvement and key technological breakthroughs in metrological standards.

10. Build green aviation airworthiness certification system. Improve airworthiness certification methods for sustainable aviation fuels, and actively promote airworthiness certification for alternative fuels. Strengthen cooperation between industry and airworthiness certification authorities to accelerate the establishment of airworthiness certification systems and continued airworthiness systems for new energy aircraft. Strengthen initial airworthiness certification for electric aircraft in aspects like flight performance, structural strength, avionics and so on to accelerate airworthiness certification for urgently needed new energy aircraft. Carry out preliminary research on airworthiness certification technologies for hydrogen energy aviation to accelerate its development.

Box 3: Green Aviation Standards and Airworthiness Compliance Verification System Development Program
<p>1. Airworthiness certification system for sustainable aviation fuels. Formulate technical standards for sustainable aviation fuels and acceptable compliance methods. Carry out research on adaptability of storage, transportation, refueling and application on China-made aircraft of domestic sustainable aviation fuels, and carry out test flights and demonstration.</p> <p>2. Airworthiness certification system for new energy aircraft. Carry out research on risk-based airworthiness compliance design and verification system for new energy aircraft, establish airworthiness certification standards and compliance technology roadmaps suitable to China's conditions.</p>

11. Build green aviation safety oversight system. Use technologies like 5G, Beidou, low orbit satellite Internet, ADS-B to carry out space-based communication, navigation and surveillance applications, strengthen research and verification on integrated operation of manned and unmanned aircraft, promote digitalization and intellectualization of green aviation service oversight, build a low-altitude Internet of Things with interconnection of facilities and intercommunication of information. Strengthen market oversight of new energy aircraft, establish and improve quality assurance systems for new energy aircraft design, and study and demonstrate safety administration policies for new energy aircraft. Promote the establishment of third-party technical testing institutions.

12. Promote the building of supporting infrastructure system. According to existing infrastructure conditions and economic affordability of all regions, study and demonstrate urban air mobility and logistics delivery facility networks, and incorporate them into urban transportation infrastructure planning. Make overall planning of new energy trunk lines, regional jets technologies and adaptability to existing airport facilities. Study and build multi-scenario, multi-layer takeoff and landing point networks with capabilities of takeoff and landing, parking, charging for eVTOL and other aircraft.

## V. Organization and Implementation

#### (I) Strengthen implementation of the Program

Strengthen organization and promotion of the development of green aviation manufacturing industry, enhance resource allocation and policy coordination. Strengthen departmental cooperation and central-local linkage, actively promote related departments to refine and implement measures, encourage related regions to study and formulate local green aviation manufacturing industry development implementation guides and action plans based on the Program's deployments and local realities, and introduce supporting policies and measures.

#### (II) Strengthen policy support

Leverage government procurement to encourage relevant departments and local governments to proactively procure and use green aviation equipment. Support the promotion and application of green aviation equipment through first-unit insurance compensation for major technological equipment. Give full play to national production-finance cooperation platforms, encourage enterprises to make good use of green funding, green bonds, green credit, green insurance and other financial support policies. Encourage enterprises to make full use of market-based investment and financing channels. Encourage social capital to actively participate in R&D and operational services of green aviation equipment through financing lease, equity investment and other means.

#### (III) Strengthen publicity and guidance

Support industry associations, industrial alliances, professional institutions and other entities to vigorously advocate green aviation through sci-tech innovation activities, aviation cultural popularization and other means, raising social recognition and acceptance of green aviation. Support holding international professional exhibitions, forums in green aviation field to promote industry exchange and information sharing, creating a good atmosphere for the development of green aviation manufacturing industry. Strengthen research and decision consultations on forward-looking and strategic major issues, guiding the formation of industrial development consensus.

#### (IV) Strengthen safe development

Uphold safety first, carry out safety publicity and education on new energy aviation, improve safety awareness of enterprises and related practitioners. Guide enterprises to establish and improve quality management systems for new energy aircraft, implement safety management accountability system, and ensure quality and operational safety of new energy aircraft.