INNOVATION IN SUSTAINABLE AVIATION -
Electric, Hybrid, or Hydrogen?

可持续航空领域的创新—

电力、混合动力，还是氢能?

XI' AN,CHINA NOV.2-4, 2026

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AGENDA

议程

EM-POWER

- **INTRODUCTION: ENERGY PERSPECTIVE**
  引言：能源视角
- **DEVELOPMENT TO MARKET**
  从开发到市场化
- **SUSTAINABLE AVIATION EXAMPLES**
  可持续航空案例
- **HURDLES & TRENDS**
  挑战与趋势
- **TAKE AWAYS**
  核心要点

Future Currency Could Be Based on WATTS

未来的货币可能基于 ”能量(电力)”， 而不是美元



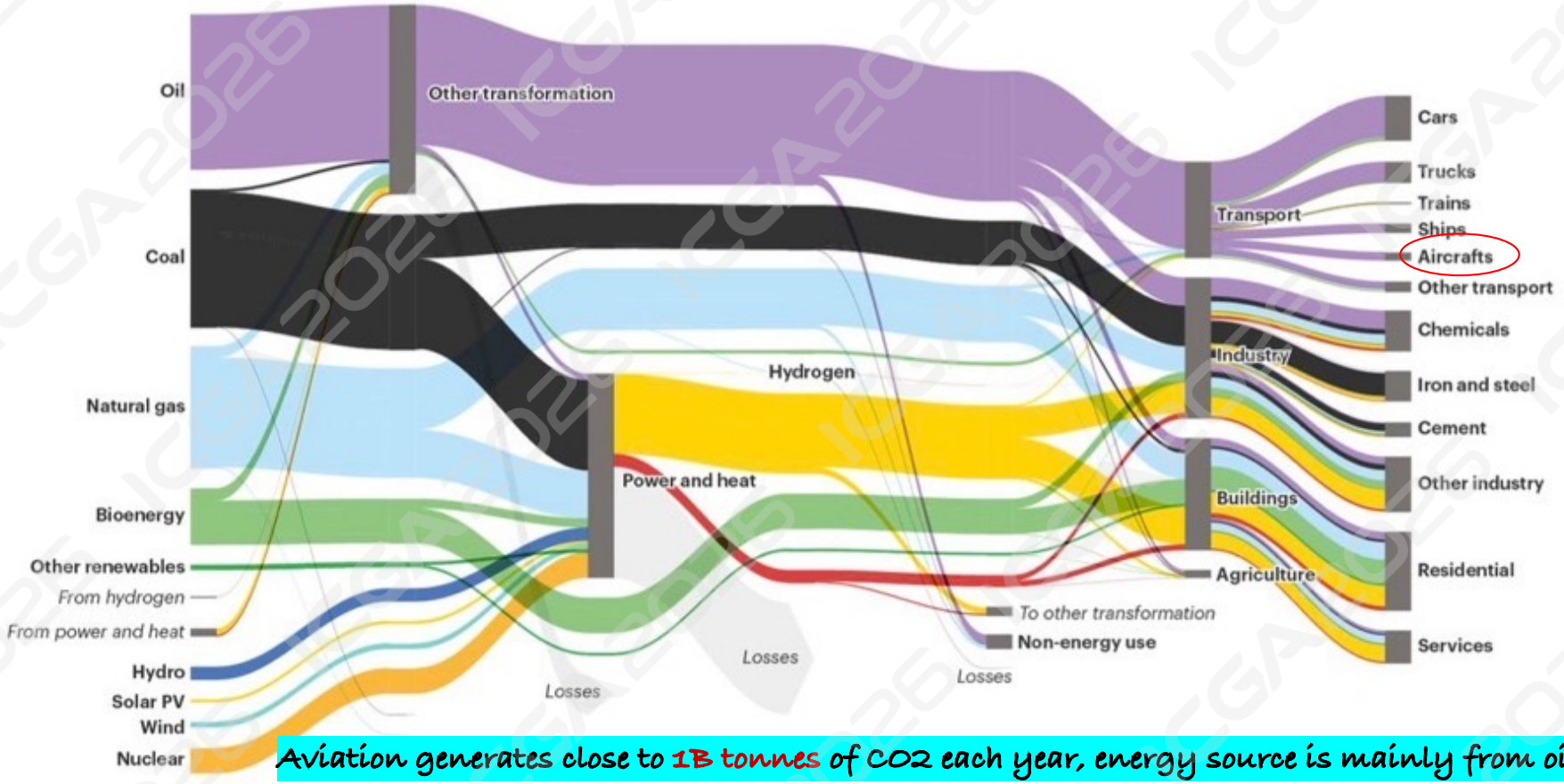
Podcast with Walter Isaacson
October 20, 2026

- Elon Musk believes money could work very differently in the future
- He suggested that future currency could be based on on **physical measures such as power, mass and energy** rather than traditional money.
- ….
- He also discussed the possibility of building a system on the Moon that could launch materials into space using **electromagnetic acceleration.**
- Musk believes technologies (like these) could help create a much larger economy.

Source: The Builders podcast with Walter Isaacson, October 20, 2026; Interesting Engineering.

International Energy Agency on Energy from Source to Various Sectors Use

国际能源署关于能源从源头到各产业的使用情况

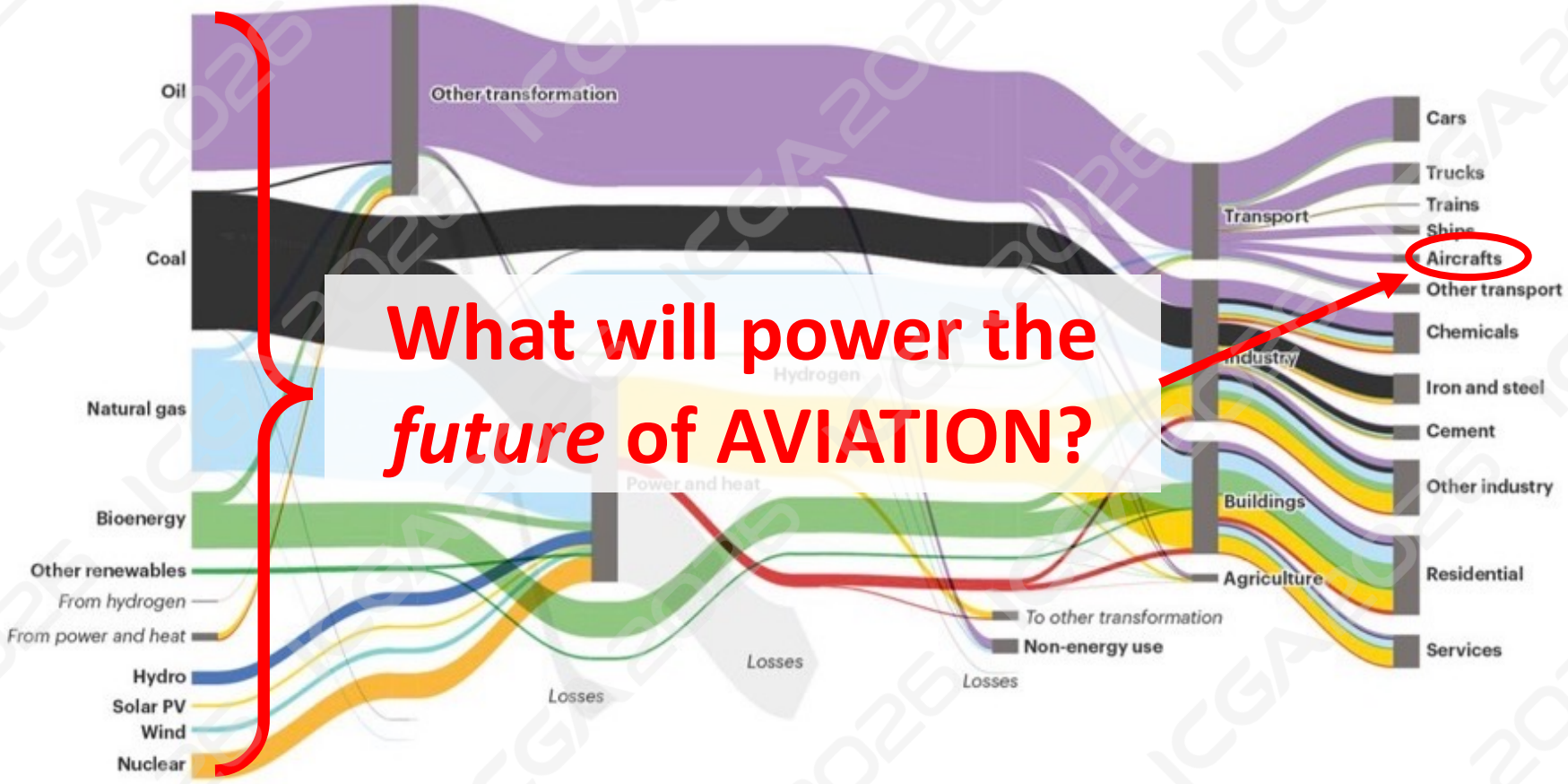


Aviation generates close to 1B tonnes of CO2 each year, energy source is mainly from oil

International Energy Agency on Energy from Source to Various Sectors Use

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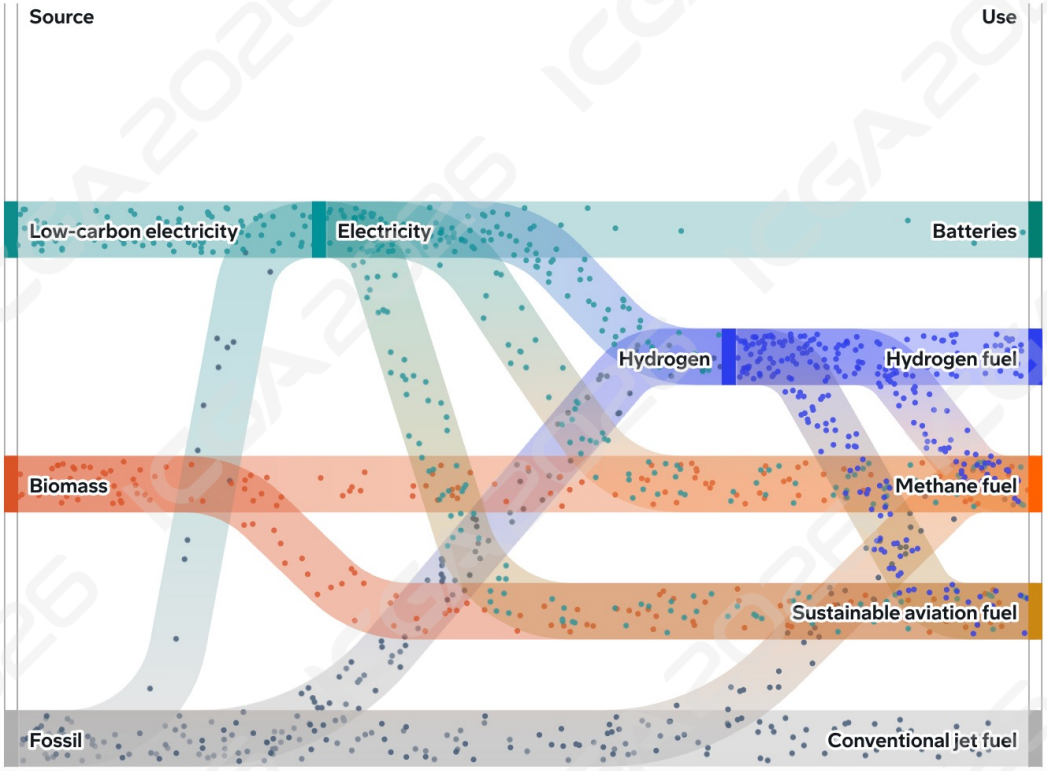
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What will power the *future* of AVIATION?

Exploring the *Future* of Aviation Energy: Well to Wake

探索航空能源的未来：“从油井到航迹”



BOEING & NASA: Advanced Aircraft Concepts for Environmental Sustainability (AACES) – June 2026

System-of-Systems (SoS) View

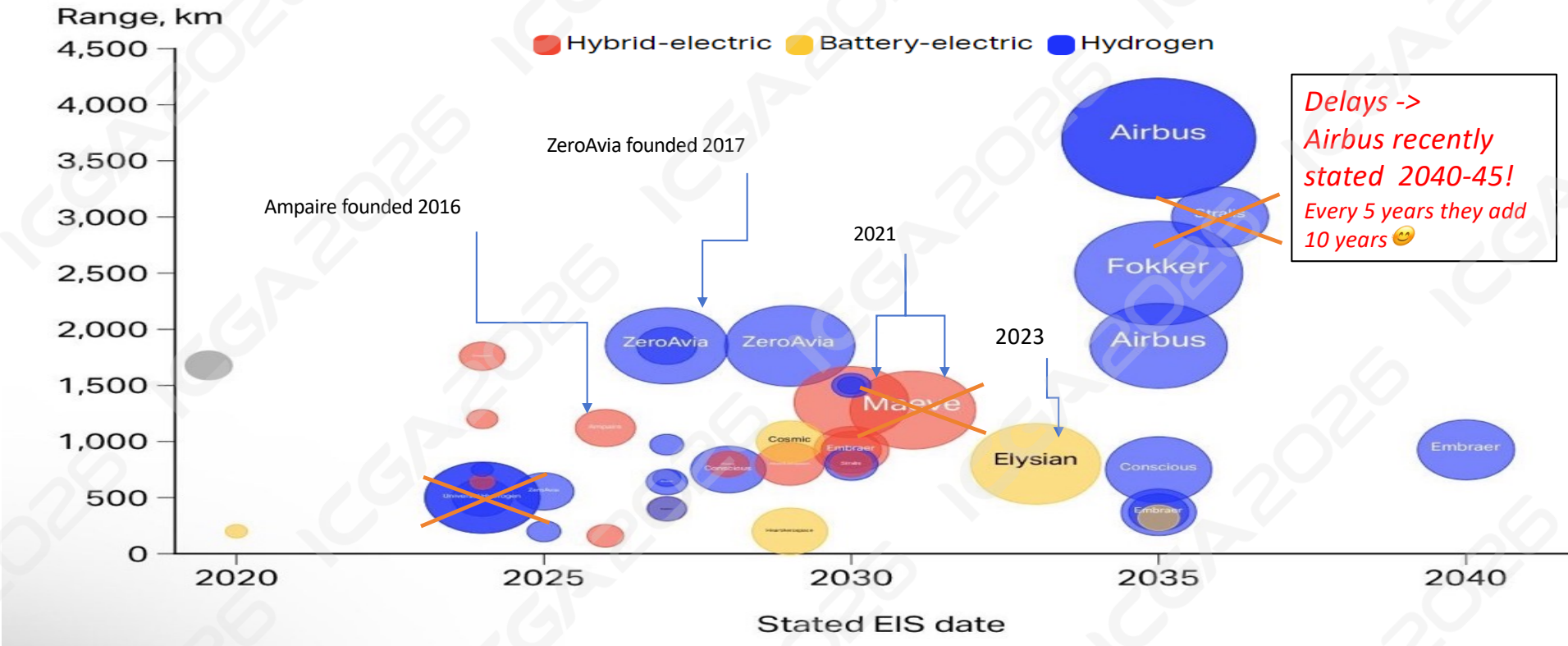
- Energy Efficiency
- Lifecycle Greenhouse Gas Emissions
- Cost of Production
- Infrastructure (storage, transport, etc)
- Safety

Source: https://cascade.boeing.com/learn/what-will-power-the-future-of-aviation/; Boeing presentation at AIAA AVIATION , AACES: Exploring the Future of Aviation Energy

SUSTAINABLE AIRCRAFT DEVELOPMENT TO MARKET

可持续航空飞行器从创新到市场化

By Date of Enter-Into-Service (EIS)



Source: https://www.rolandberger.com/publications/publication_pdf/roland_berger_aircraft_electrical_propulsion.pdf

Source: IATA Sustainability and Economics

SUSTAINABLE AIRCRAFT

Powered by Electric, Hybrid, or Hydrogen Energy

采用电力、混合动力或氢能驱动

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Companies filed for insolvency
企业破产案例

- Universal Hydrogen shut down and liquidated in June 2024 after failing to secure further funding.
- Volocopter filed for insolvency in Dec 2024, acquired by Diamond Aircraft in Mar 2025
- Lilium Aerospace shut down and liquidated operations after filing for insolvency for a 2nd time in Feb 2025
- Eviation has placed an indefinite pause on development of its all-electric aircraft (Alice) and laid off the overwhelming majority of its staff due to a severe funding shortage in Feb 2025
- VOLT AERO: faced financial insolvency in late 2025 after a key planned equity investment fell through; acquired by Aura Aero June 2026
- Maeve Aerospace entered bankruptcy in May 2026. A final attempt to rescue the company thru a corporate acquisition also fell through.

Hydrogen, eVTOL, eCTOL, and Hybrid

SUSTAINABLE AIRCRAFT w INNOVATIVE TECHNOLOGIES

Development Milestones 开发里程碑

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- Innovative technologies
- eVTOL (vertical lift), eCTOL (conventional fixed wing), hydrogen, hybrid
- $$Millions (or Billion) funding raised (and expensed)
- Public market listed
- Impressive demonstration flights
- Impressive order books

VALLEY OF DEATH: Innovation to Market

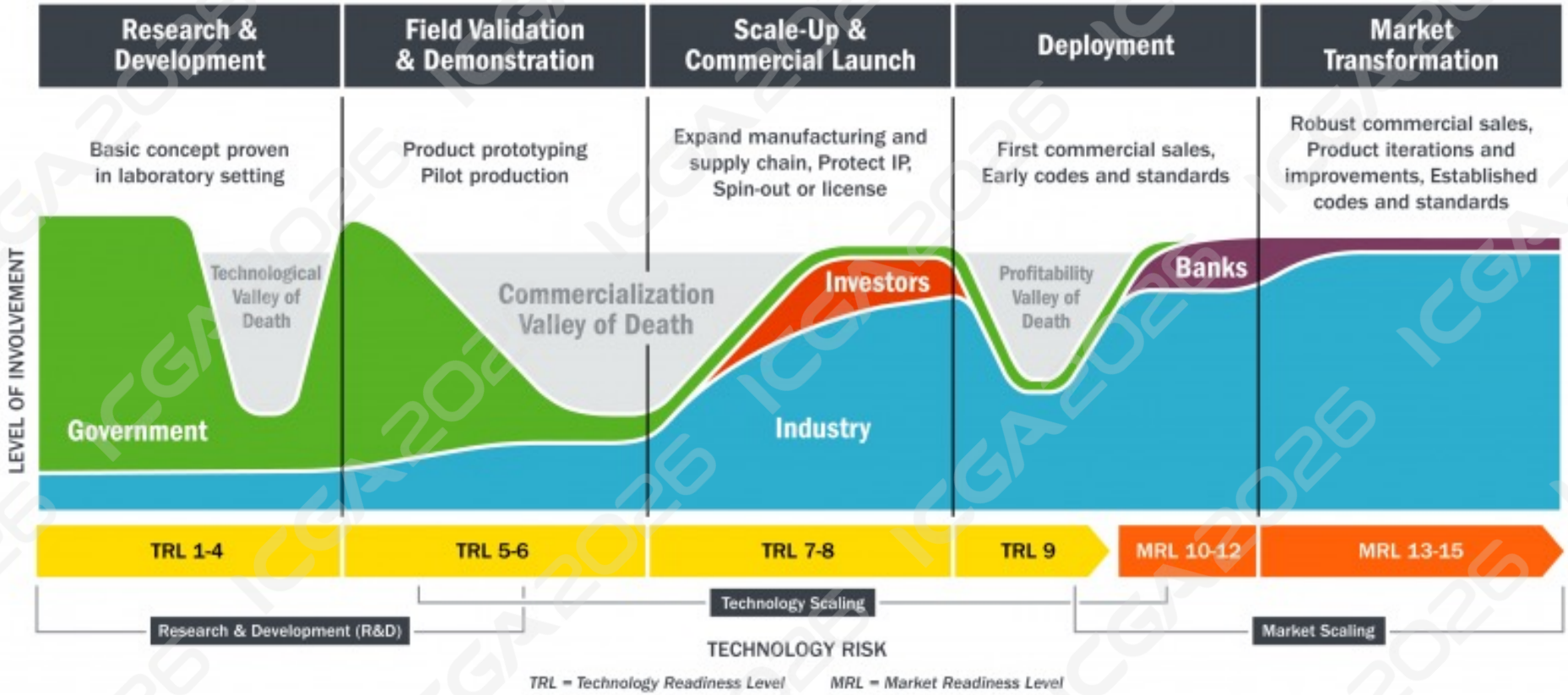
死亡之谷: 从创新到市场化





VALLEYS OF DEATH : Innovation to Market

死亡之谷: 从创新到市场化



Source: https://publicenterprise.org/the-project-finance-valley-of-death/; CPE (Center for Public Enterprise), Nov 2024

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SUSTAINABLE AIRCRAFT - Hydrogen

Companies in Operation
在运营的氢能企业

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- Zero Avia there is "**material uncertainty**" about its ability to continue as a going concern. There appears enough funding for ZA to survive into late 2027, but its long-term survival questionable.
- H2FLY acquired by Joby Aviation in April 2021, to be used for hydrogen-electric propulsion as a **range-extender** on its eVTOL aircraft. Completed landmark 523-miles demo flight (in Joby airframe).
- ZEROe hydrogen aircraft (Airbus) EIS milestone pushed into the late 2040s or beyond. Oct 20, 2026 Airbus **scales back hydrogen ambitions**, aiming for 80-seat aircraft. July 2026 announcement: it would form a joint venture with MTU Aero Engines “dedicated to the development and commercialisation of a fully-electric hydrogen fuel cell engine”.
- Beyond Aero completed Y Combinator in 2022. Secured $2bn in Letters of Intent (LOIs), completed fully hydrogen-electric flight ("Blériot," a retrofitted ultralight), and acquired Universal Hydrogen Co.'s assets, IP, and flight data.

Source: https://aerospaceamerica.aiaa.org/airbus-scales-back-hydrogen-ambitions-aiming-for-80-seat-aircraft/; quote of Lars Wagner, head of Airbus’ Commercial Aircraft business,

SUSTAINABLE AIRCRAFT – Electric Regional Aircraft

Innovation to Demonstration

电动支线飞机：从创新到示范

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Heart Aerospace Completes First Flight of World's Largest Electric Aircraft

Aug 13, 2026



ES-30 mission lasted 27 minutes, during which X1 reached an altitude of 1,100' AGL and its all-electric propulsion system delivered more than one MW of power; which used $5 worth of electricity.

- Heart Aerospace Founded in 2019. HQ'ed in Torrance, CA. Backed by $190M in mission-aligned capital supporting next-generation aviation. (ES-36 will be a hybrid, planned EIS 2031)
- NOEMI Aerospace Founded in 2018, developing the world's first fully electric amphibious seaplane. HQ'ed in Bergen, operations at Torp Airport, Norway, raised over $17.5 M to date.
- VÆRIDION Founded in 2021, headquartered in Munich, developing the Microliner, a battery-electric aircraft. Raised over €18 M in total to date.
- Elysian Founded in 2023 based in NL, focused on large-scale battery-electric pax aircraft (E9X). Raised around €12.5M and €5M grant via the Dutch National Growth Fund.

SUSTAINABLE AIRCRAFT – General Aviation (GA) eCTOL Aircraft

Innovation Demonstration, Milestones & Commercialization

通用航空创新示范、里程碑与商业化



Source: Aerospace Testing International Oct 21, 2026
The FAA has issued Beta's Alia eVTOL, designated the A250, a Special Airworthiness Certificate for market survey carrying passengers, first in record.

- BETA Techologies Founded in 2017, raised over $1.66B to date in 11 rounds. IPO Nov 2025.
- Bye Aerospace eFlyer 2: 2-seat electric trainer powered by Safran ENGINeUS electric motor (world's first certified e-engine by EASA) that successfully demo'ed first flight Sep 2026. Funding raised $53.9M in 7 rounds to date.
- Helios Horizon (project): modified Pipistrel Taurus by replacing the battery (260 wh/kg with all solid-state batteries 410 wh/kg on June 5, 2026 (FL, USA). Achieved the world's first crewed, fixed-wing flight powered by all-SS batteries.
- RX4E (aircraft): World's First Commercially Certified 4-Seat Electric Aircraft (CCAR-23 by CAAC) Dec, 2024. Commercialization by Volar Air Mobility.

SUSTAINABLE AIRCRAFT – Electric eVTOL Aircraft

Innovation Demonstration, Milestones

eVTOL创新示范与里程碑

AutoFlight unveils world's first 5-ton eVTOL aircraft (the Matrix) capable of carrying 10 passengers
Feb, 2026



The Matrix all-electric version offers a maximum range of 250 kilometers, while the hybrid variant can reach up to 1,500 kilometers. The passenger model accommodates 10 people

- AutoFlight founded in 2017, HQ'ed in Shanghai, China, raised $100 M disclosed funding to date.
- Volant Aerotech founded in 2019. HQ'ed in Shanghai, China. Completed China's first piloted transition flight in Sichuan on May 28, 2026. Total fund raised est $600 M+
- Joby Aviation: founded in 2009. HQ Santa Cruz CA, US. Total fund raised est $2.7 B. Entered Stage 5 (final stage) of the FAA TC process for its electric air taxi. SPAC in 2021. (Joby Energy founded in 2008)
- Archer Founded in 2018 based in San Jose, CA. Raised around $4B. Closed Phase 3 of the FAA 4-phase TC process and secured 100% acceptance of its MoC. Was named the official air taxi provider and sponsor for the **2028 LA Olympic Games.** SPAC in 2021.
- Eve Air Mobility idealized by the innovation division of Embraer EmbraerX, founded Oct 2020, HQ'ed in São Paulo, Brazil, IPO May 2022. Funding raised $1.2B to date.

SUSTAINABLE AIRCRAFT - Hybrid

Innovation Demonstration, Milestones

混合动力飞行器创新示范与里程碑



The longest hybrid-electric aircraft flight was completed by Ampaire with its **Electric EEL** demonstrator, which flew a 12-hour, 1,375-statute-mile (1,195-nautical-mile) journey from Mojave, California to Hays, Kansas.

- Ampaire (Eco-Caravan) AMP-H570 system of integrated parallel architecture combining a compression-ignition piston engine (compatible with Jet A and SAF) and an electric motor with a cargo-pod-housed battery pack.
- AURA AERO (ERA) a 19-seat hybrid-electric regional aircraft designed to enter service before 2030. DEP featuring 8 Safran ENGINeUS e-motors + 2 turbo-generators in SERIES-hybrid
- Electra.Aero (EL9) DEP with External Blown Flap (EBF) tech to take off in 150’ (eSTOL), hybrid uses turbogenerator (Safran TG600) for crusing & batteries for TO and landing.
- AeroOne Aviation 翊飞航空科技 (ES1000, 4.5 tons) DEP, eSTOL, Turbine-based distributed hybrid-electric propulsion combined with blown-lift technology

Source: https://www.aerospacetestinginternational.com/news/electric-hybrid/longest-hybrid-electric-flight-made-by-ampaires-eel-aircraft.html

Re-imagine Sustainable Flight: Hybrid-Electric *SUSAN*

重新想象可持续飞行：混合动力 **SUSAN**

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***SU**bsonic **S**ingle **A**ft e**N**gine*





***SUStainable Aft eNgine (SUSAN)* Electric Aircraft**

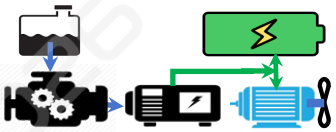
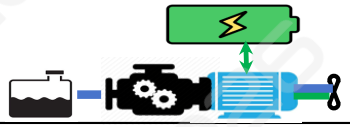
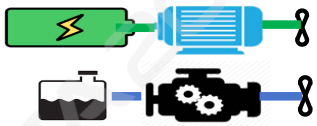
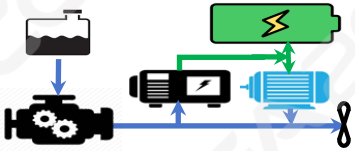
"Subsonic Single Aft Engine (SUSAN) Transport Aircraft Concept and Trade Space Exploration", Ralph H. Jansen at el, AIAA SciTech Forum, January 3-7, 2022, San Diego, CA & Virtual, AIAA SCITECH 2022 Forum

Credits: Ampaire, NASA

Hybrid Aircraft Development – Architecture Trade Space

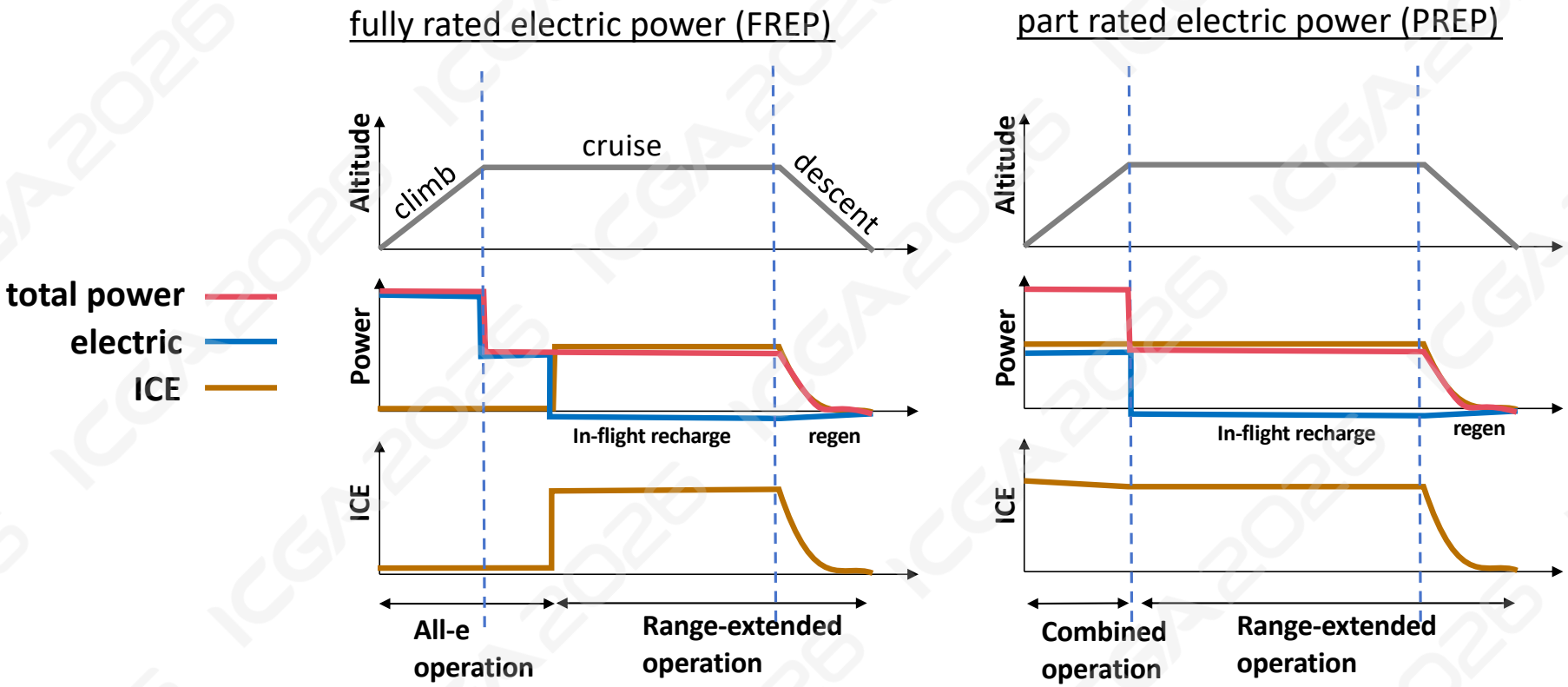
混合动力飞行器开发——架构权衡空间

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Hybrid Powertrain Architecture *Automotive Examples*	**Notional Schematic Architecture**	**ICE[1] Efficiency**	**Electric Efficiency**	**Single-Prop ICE Power Sizing**	**Ground Charging**	**Simplicity (dev/cert time, cost, scalability)**	**Emission**
Series *Karma, Nissan e-Power*		High	High	Moderate	Optional	Moderate	Highest
Integrated Parallel *Civic*		Optimized	Optimized	Variable	Optional	High	Optimized
Independent Parallel *AWD V60, i8, RAV4*		Highest	Highest	N/A	Required	Highest	Low
Series-Parallel *PRIUS, other TOYOTAS, VOLT*		Optimized	Optimized	Small	Optional	Low	Optimized

Hybrid Aircraft Development – Energy optimisation

混合动力飞行器开发——能源优化



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Main Hurdles

氢能面临的主要障碍

- **AIRPLANE Technical Complexity:** Storing hydrogen safely inside aircraft limits weight and passenger capacity [lab → pilot / demo]
  - Compressed Gas: very high pressure (700 bars or 10k psi)
  - Liquid: cryogenic temperatures (-250°C) inside aircraft
  - Solid-state: absorbed into or bonded with solid materials (e.g. metal hydrides). When the solid material is gently heated, it releases the hydrogen gas.
  - Fuel-Cell (for H-electric aircraft): Need for designing a low parasitic power TMS (Thermal Mgt System) and still need a battery in system.
- **AIRPORT / NETWORK Infrastructure Deficit & Safety:** Slow rollout of airport hydrogen storage and refueling networks. [pilot → commercial ops]
- **FUEL Economic Viability:** High production costs of green hydrogen compared to traditional or Sustainable Aviation Fuels (SAF). [commercial → economical / scale]

ECONOMICS: Well-to-Wake Energy Cost

经济性：从油井(源井)到终端的能源成本

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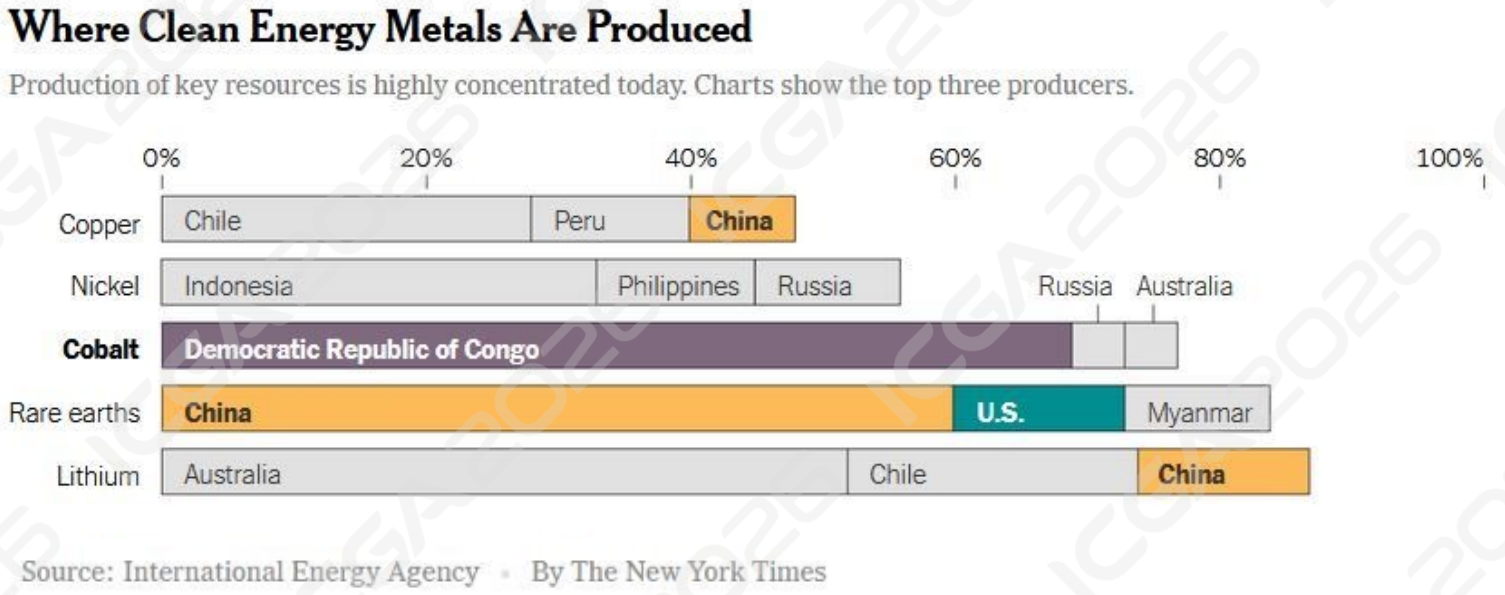
		Direct Charging battery electric	Hydrogen fuel-cell electric	Power-to-Liquid / SAF ICE with SAF
		100% green electricity	100% green electricity	100% green electricity
	% Energy Losses in	↓	Hydrogen source ↓	Liquid fuel source ↓
Sample market price of the fuel source	CO2 air-capture FT-synthesis			**37%**
	Market price after production/ distribution /storage ($/kwh)*	**0.084**	**0.57 ~ 0.81**	**0.34 ~ 0.41**
fuel/electrons to engine	inversion AC/DC	**5%**		
	battery charge efficiency	**5%**		
	H2 to electricity conversion		**50%**	
	inversion DC/AC	**5%**	**5%**	
	engine efficiency	**10%**	**10%**	**50%**
	Resultant shaft energy cost ($/kwh)	*0.084 x 1.05^3 x 1.1* **0.11**	*(0.57 ~ 0.81) x 1.5 x 1.05 x 1.1* **0.99 ~ 1.40**	*(0.34 ~ 0.41) x 1.5* **0.51 ~ 0.62**

*the cost for Hydrogen assumes similar range at the "pump" (e.g. for ground vehicles), range taken from US and EU.

SUSTAINABLE AVIATION - Electric Aircraft & Hybrid
Main Hurdles

电动及混合动力航空器面临的主要障碍

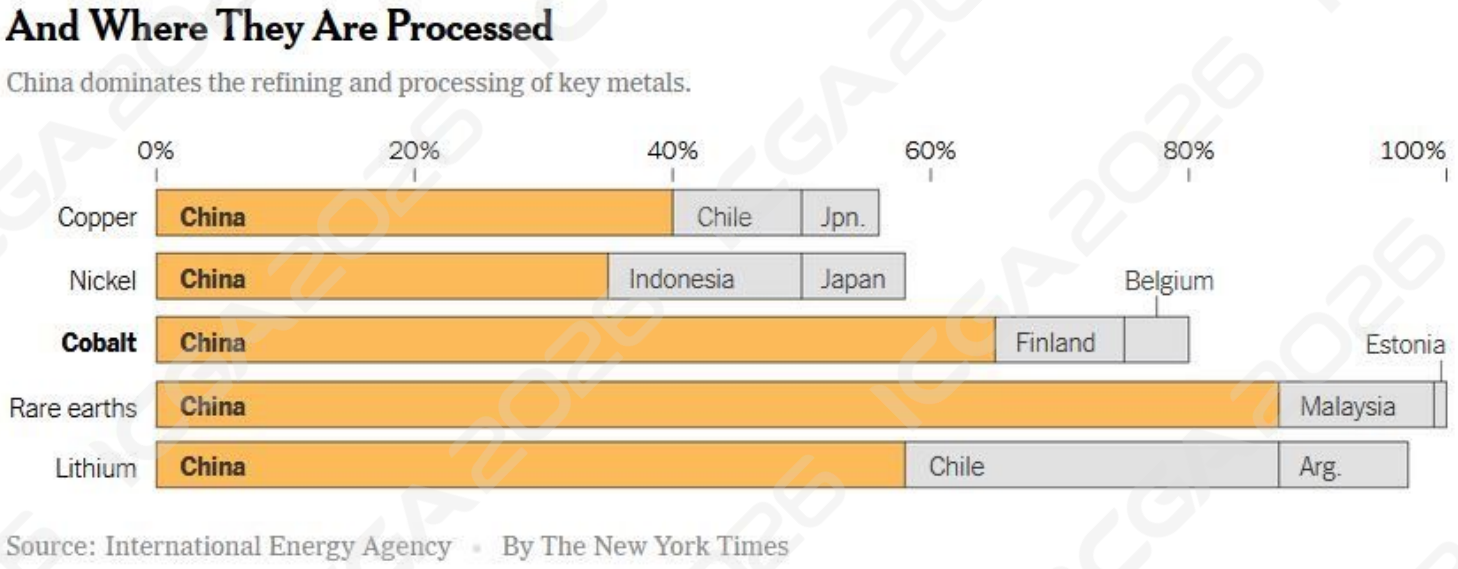
- **AIRPLANE Technical Complexity:** Weight challenge in aircraft configuration and safety
  - ➢ **EPU (Electric Propulsion System) & ESD (Energy Storage Device):** geopolitical tension for Clean Energy Metals [pilot → commercial ops]



SUSTAINABLE AVIATION - Electric Aircraft & Hybrid
Main Hurdles

电动及混合动力航空器面临的主要障碍

- **AIRPLANE Technical Complexity:** Weight challenge in aircraft configuration and safety
  - **EPU (Electric Propulsion System) & ESD (Energy Storage Device):** geopolitical tension for Clean Energy Metals [pilot → commercial ops] *(Joby-Archer lawsuit / Joby Motors LLC)*



SUSTAINABLE AVIATION - Electric Aircraft & Hybrid
Main Hurdles

电动及混合动力航空器面临的主要障碍

- **AIRPLANE Technical Complexity:** Weight challenge in aircraft configuration and safety [lab → pilot / demo]
  - **EPU (Electric Propulsion System) & ESD (Energy Storage Device):** geopolitical tension for Clean Energy Metals [pilot → commercial ops]
  - **HIGH-Voltage POWER SYSTEM:** Arcing, partial discharge and corona of high power/voltage transmission cables can occur. [lab → pilot / demo]
  - **THERMAL MGT SYSTEM (TMS):** Significantly less heat generated (battery-e) but more difficult to extract than that from the conventional ICE, e.g. use heat pump instead of heat exchanger.
- **AIRPORT / NETWORK Infrastructure:** Large energy storage and (fast) charging or battery swapping networks. [pilot → commercial ops]

COMMERCIAL OPS TO MARKET TRANSFORMATION

商业运营向市场化转型

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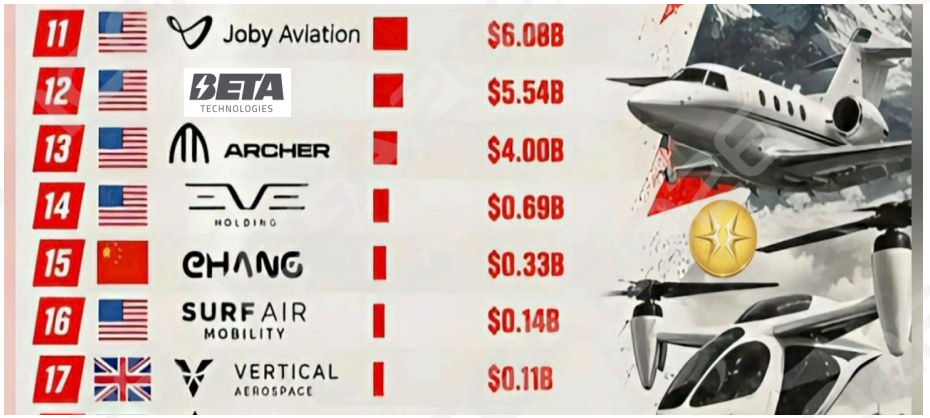
COMMERCIAL OPS TO MARKET TRANSFORMATION: Trend

从商业运营向市场化转型的趋势

EM-POWER





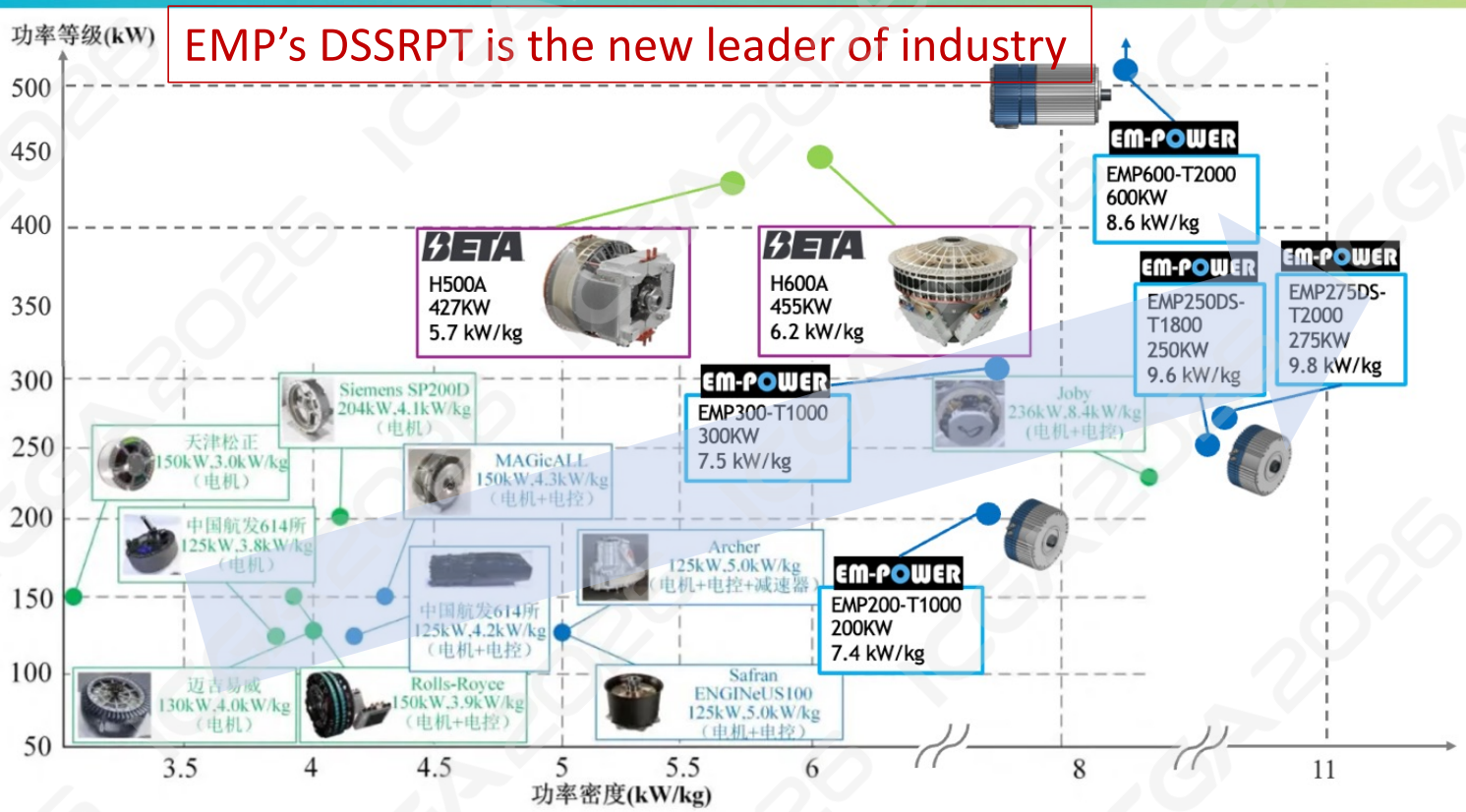


#11 - #17 All ELECTRIC & HYBRID

COMMERCIAL OPS TO MARKET TRANSFORMATION： EPU Trend

最先进电动机趋势

EMP's DSSRPT is the new leader of industry

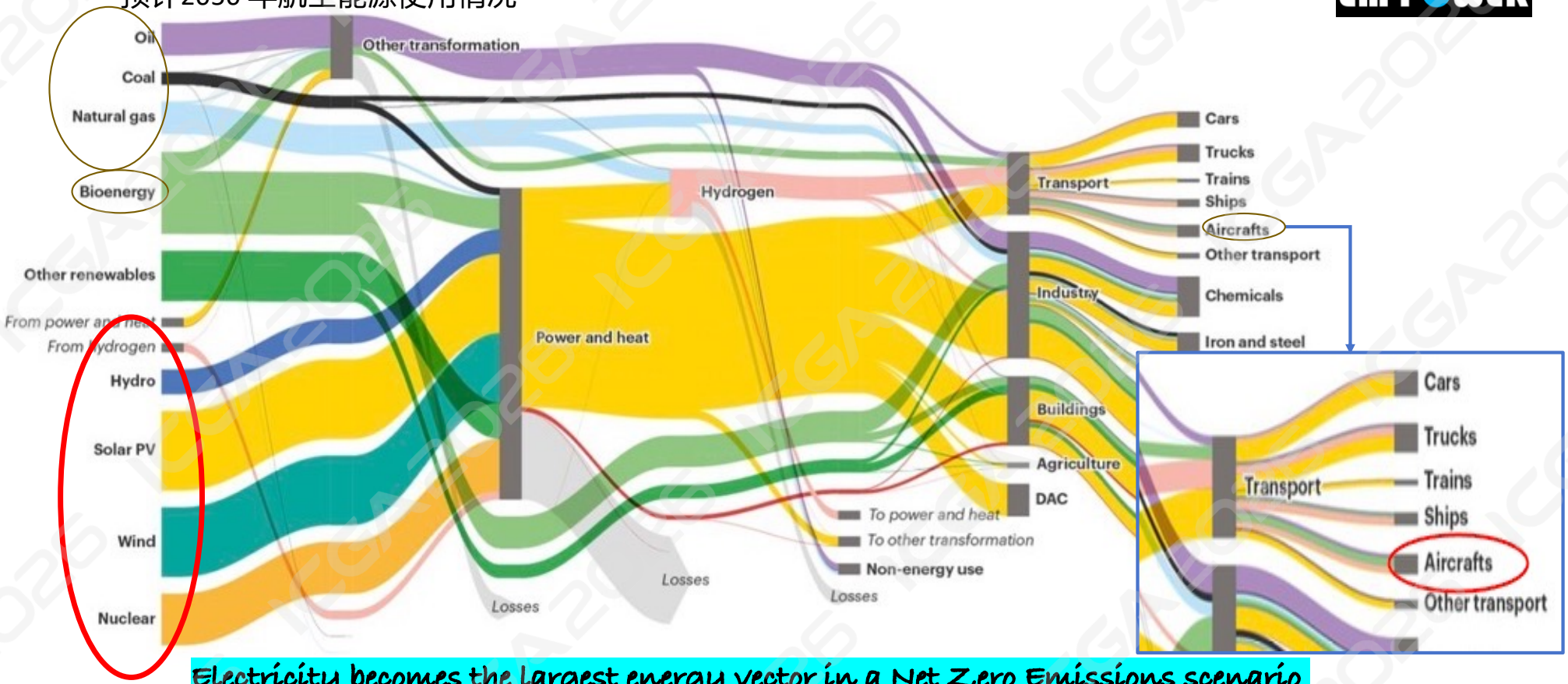


国内eVTOL电驱系统水平现状（含国内外主要eVTOL电驱系统), Original 低空破晓君 未来低空
2025年07月31日 03:21 https://mp.weixin.qq.com/s/XGCytCDFI7zqKLna8-LjrA?poc_token=HDQrq2ijc84DM8MP3jookXHBaByfut5edGh6TwYs

*DSSRUPT = Dual Stator Single Rotor Unique Power-DenseTechnology

Aviation use of Energy for 2050

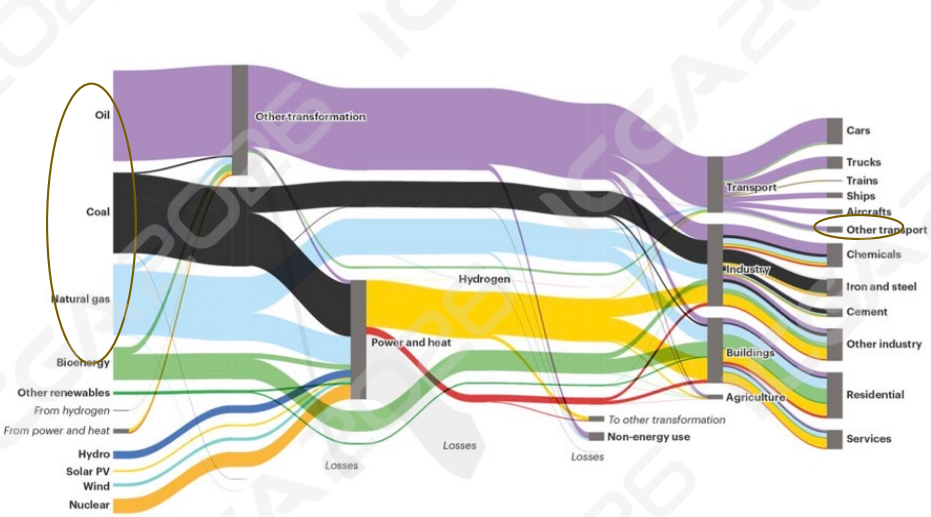
预计2050 年航空能源使用情况

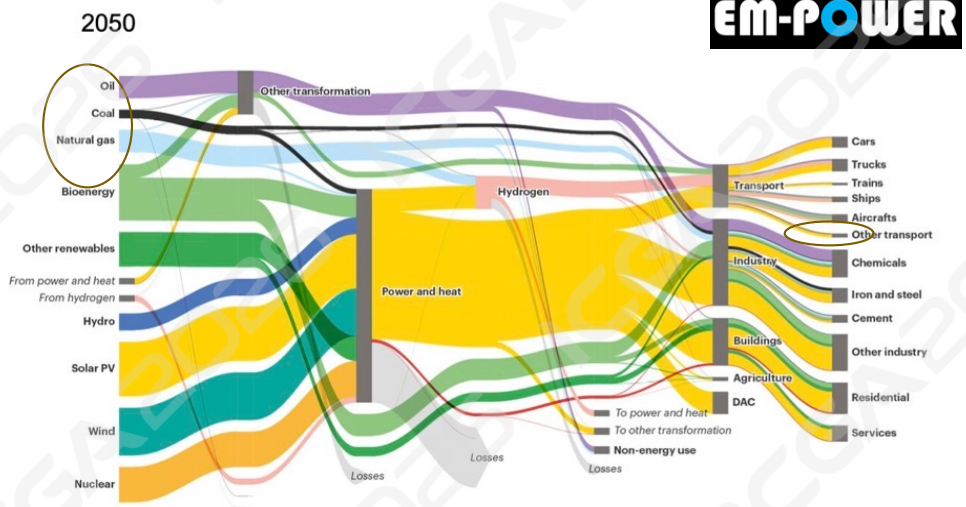


Electricity becomes the largest energy vector in a Net Zero Emissions scenario

Massive buildout of new power generation and network infrastructure across technologies required

Take Aways 核心要点





- **System-of-Systems Development** is needed taking innovation to market transformation
- Most practical solution for sustainable flight in near future (2030s) **Hybrid-electric**
- All-electric aircraft great in **short-haul, training, niche applications** already
- Long-term solutions must be **economic** and sustainable.

Innovation in Sustainable Aviation

Electric, Hybrid, or Hydrogen?

EM-POWER

可持续航空领域的创新—*电力、混合动力，还是氢能?*





Susan Ying

Look Forward to Hearing
Your Questions and Feedback!