



Sustainable Aviation Technologies Current Status and Future Prospects

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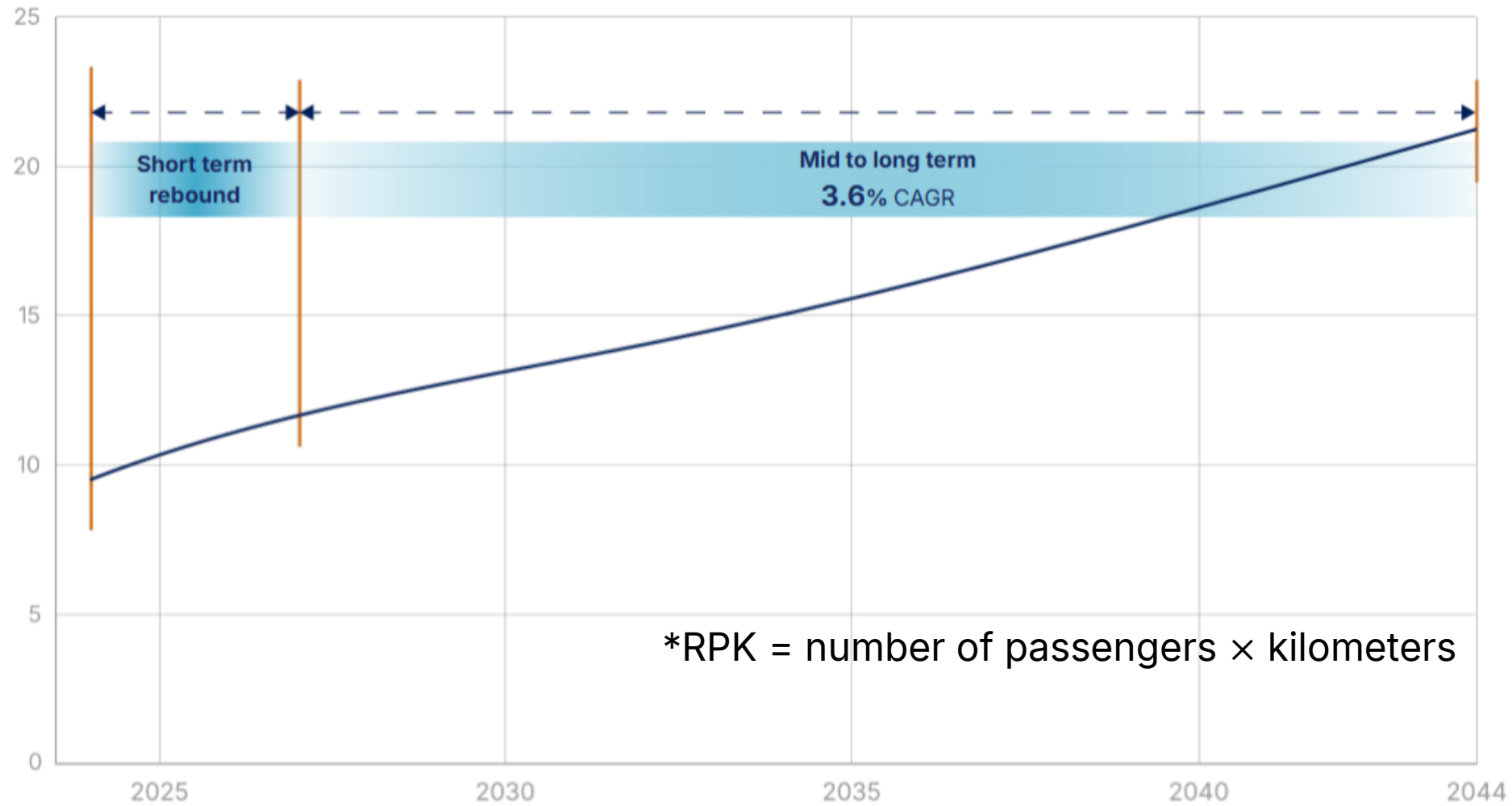
New Uzbekistan University

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10+ Round Trips at age of 4

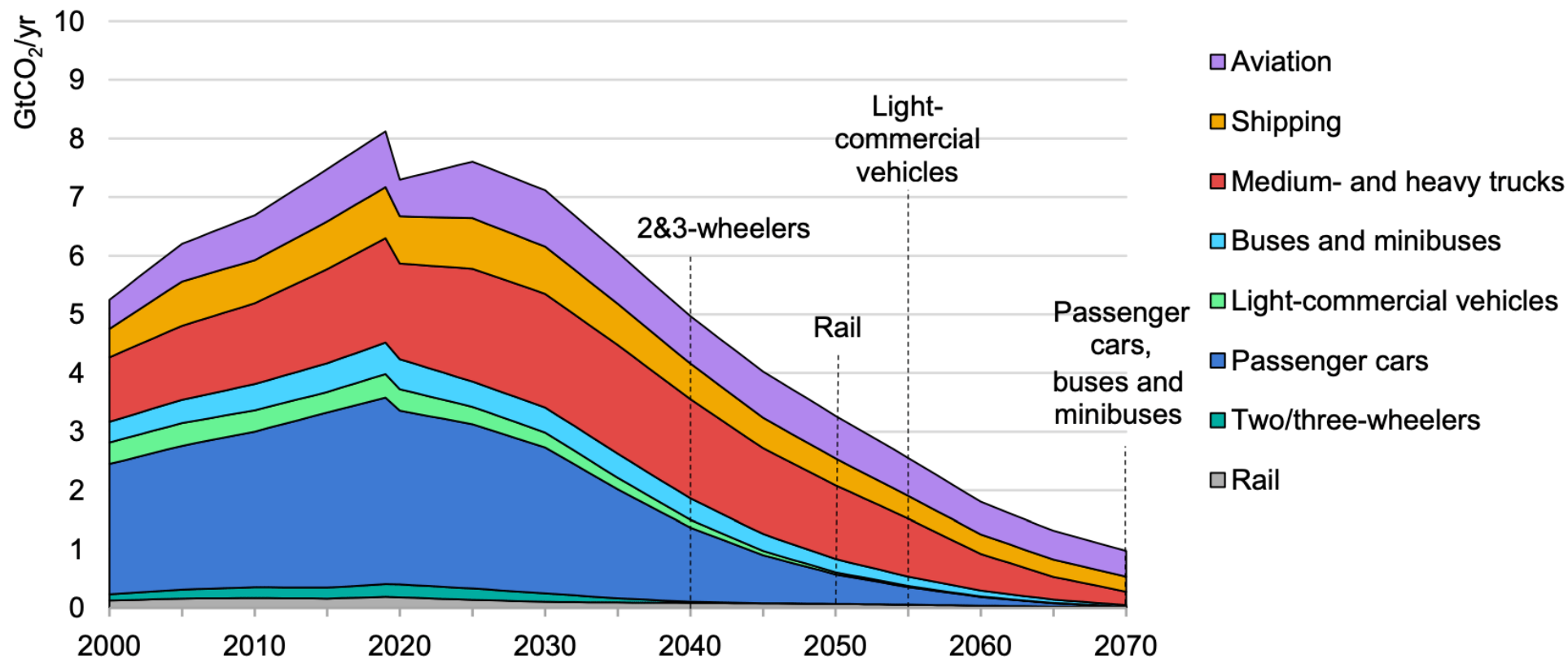


World air traffic (trillion RPK)*



*RPK = number of passengers × kilometers

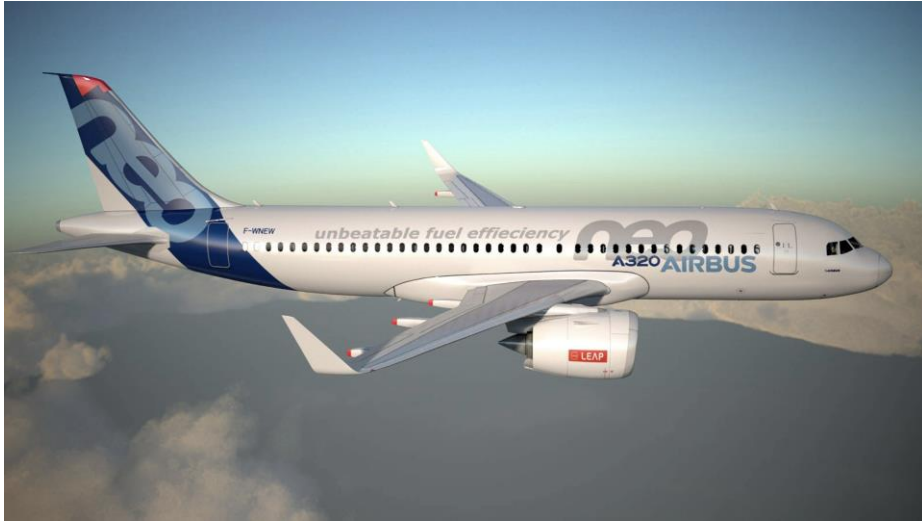
Figure 3.16 Global CO₂ emissions in transport by mode in the Sustainable Development Scenario, 2000-70



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Notes: Dotted lines indicate the year in which various transport modes have largely stopped consuming fossil fuels and hence no longer contribute to direct emissions of CO₂ from fossil fuel combustion. Residual emissions in transport are compensated by negative emissions technologies, such as BECCS and DAC, in the power and other energy transformation sectors.

Modern Aircraft Are Already Very Efficient



**2 – 3
liters / (100 km * passenger)**

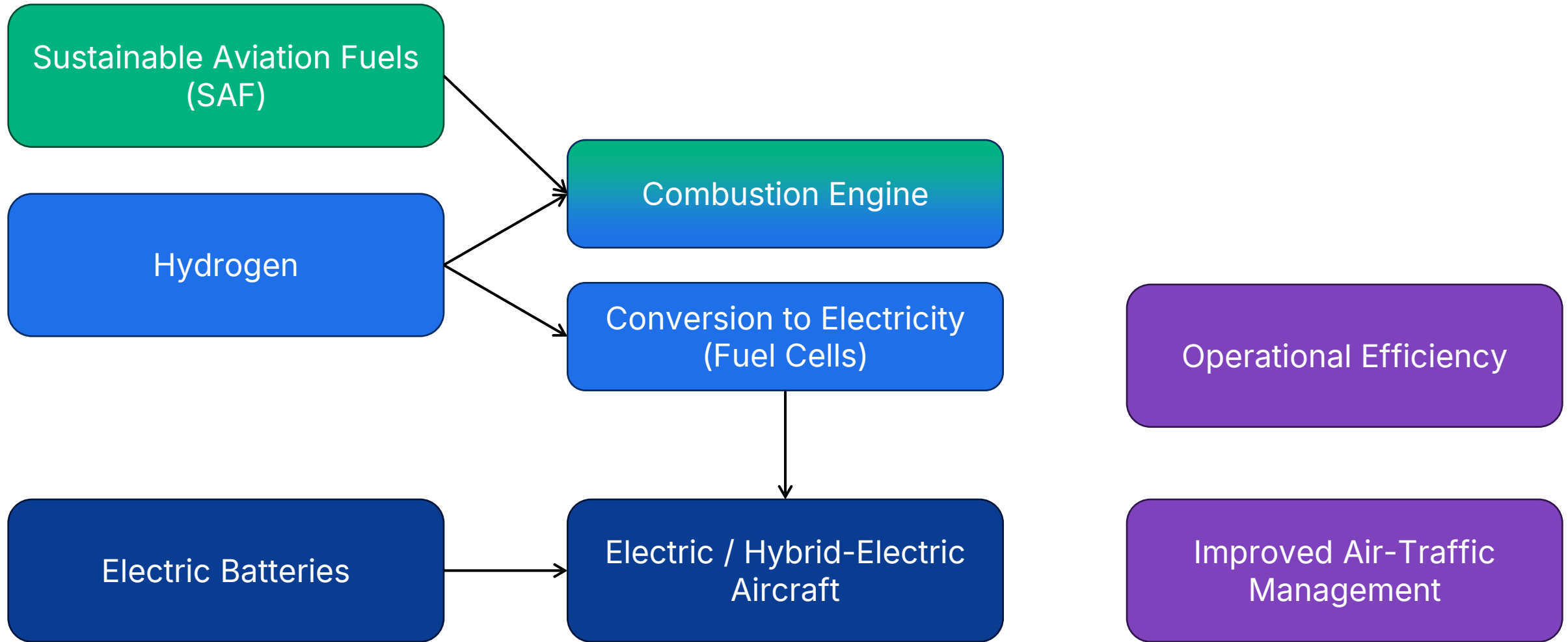
- **Why aircraft are so efficient?**
 - Very high passenger density
 - Optimized engines
 - Operation near optimal condition (cruise)
- Further improvement is very difficult



**Driver Only (1 person)
6 – 10
liters / (100 km * passenger)**

**4 People
1.5 – 2.5
liters / (100 km * passenger)**

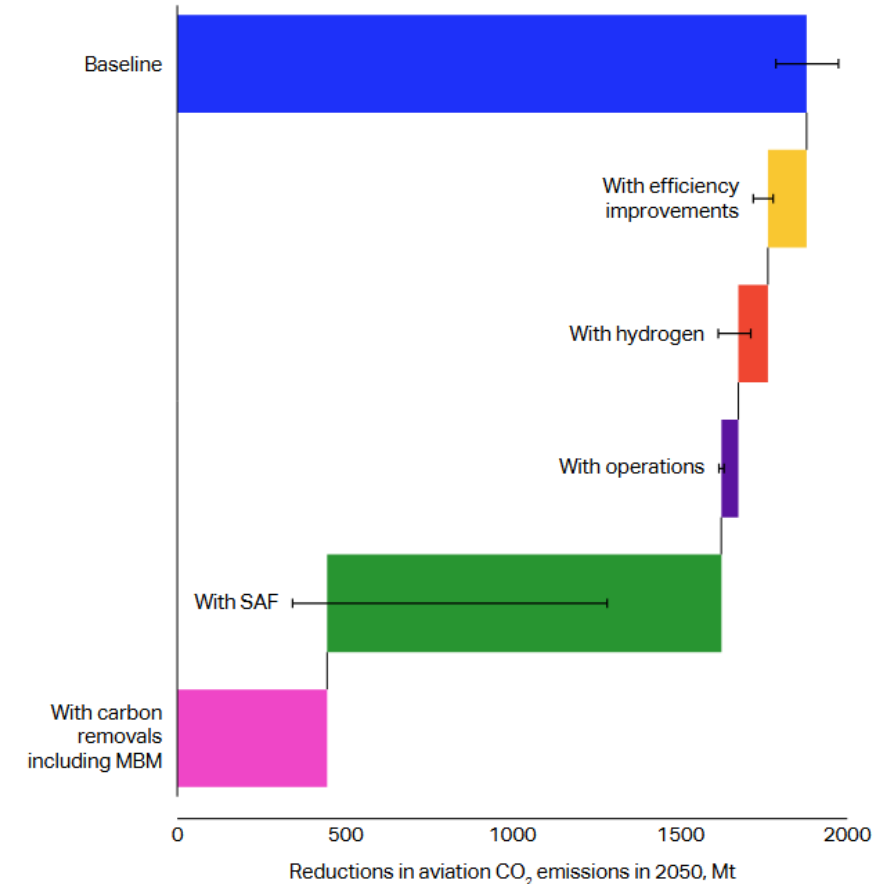
Aviation Decarbonization Strategies



Sustainable Aviation Fuel (SAF)

- A drop-in fuel compatible with existing aircraft and infrastructure
- Produced from:
 - Biomass (waste oils, residues)
 - Synthetic fuels (Power-to-Liquid)
- Up to ~80% lifecycle CO₂ reduction vs fossil jet fuel
- Key solution for long-haul aviation
- Challenges
 - Very low current share (<1%)
 - High-cost vs conventional fuel
 - Dependence on feedstock and energy

Chart 2: Reduction in aviation CO₂ emissions in 2050 achieved through the different levers of action. The solid bar indicates the central case and the black lines indicate maximum and minimum reductions based on the scenarios modeled.



Source: IATA Sustainability and Economics, ICAO LTAG SAF availability scenarios

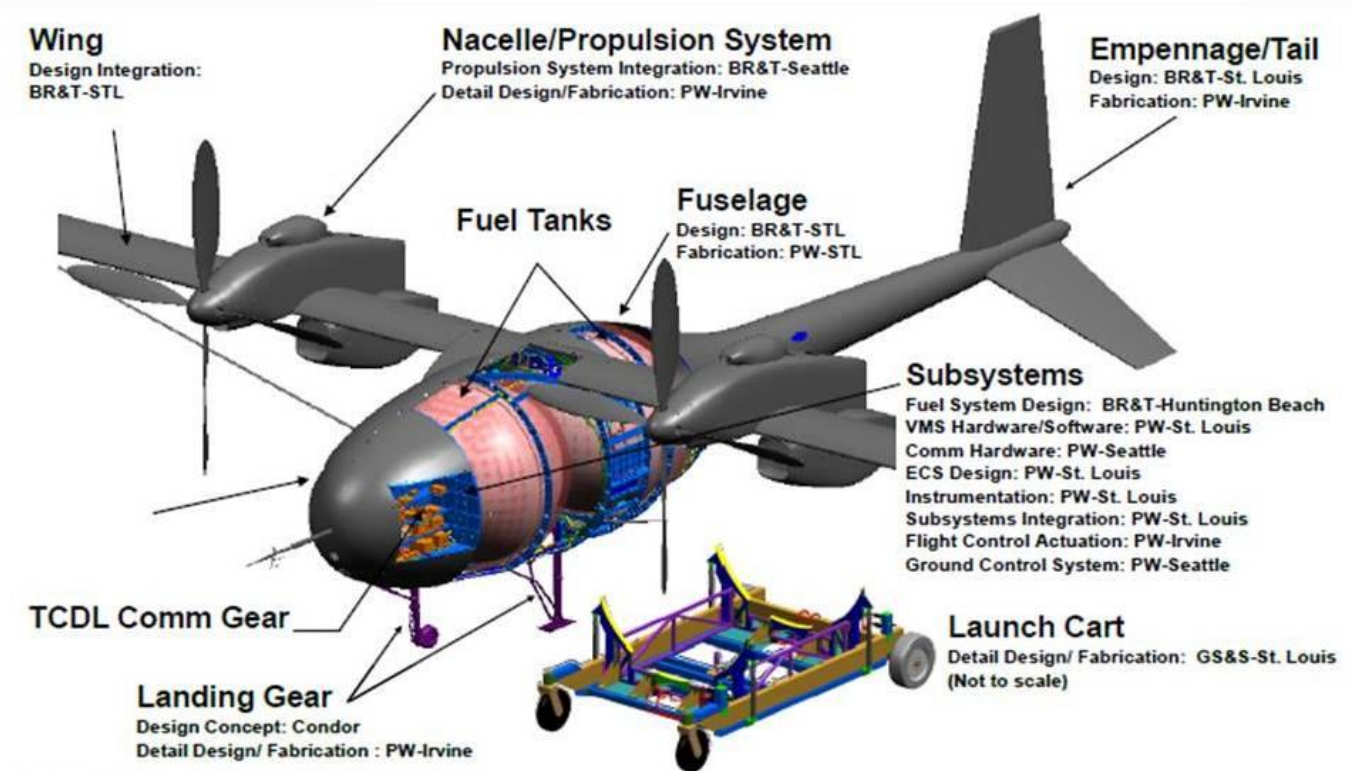
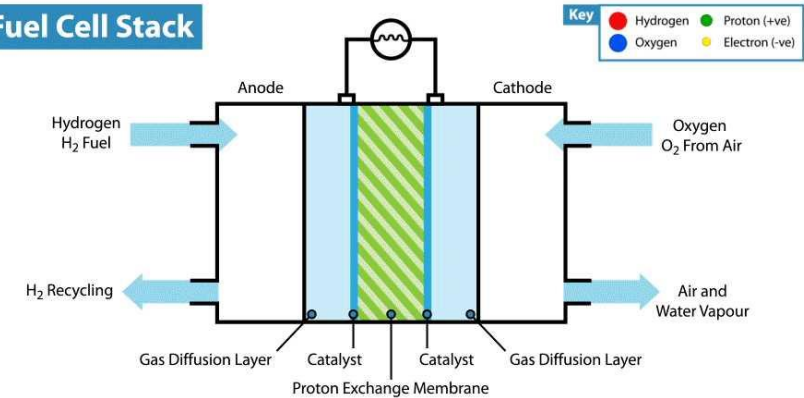
Hydrogen

- Two main paths
 - **Combustion** in modified gas turbines
 - No CO₂, but still produces NOx
 - **Conversion** to electricity via fuel cells
 - Zero CO₂ and low emissions

- Characteristics
 - Very high energy per mass
 - Very low energy per volume

- Challenges
 - New aircraft design
 - New infrastructure
 - High-pressure or cryogenic storage

Fuel Cell Stack



Recent Revolutions in Electric Transportation

- Electric cars started by Tesla



- Drones started by DJI



- AAM – an umbrella term for next generation aircraft
- Remotely piloted, autonomous, electric/hybrid, vertical takeoff and landing

Advanced Air Mobility

**Unmanned
Aerial System
(UAS)**

**Urban Air
Mobility (UAM)**

**Regional Air
Mobility (RAM)**



Urban Air Mobility – top layer for urban mobility



- Small electric vertical takeoff and landing highly automated aircraft
- Transportation of passengers and cargo
- Low altitude within urban and suburban areas

UAM Aircraft – larger, safer and more efficient version of a drone



 **VOLOCOPTER**

- 1 pilot, 1 passenger
- 27 km range
- Speed 70 km/h
- Gross weight 450 kg



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- Speed 180 km/h
- All electric
- 2-seater
- Autonomous
- 100 km range with reserves

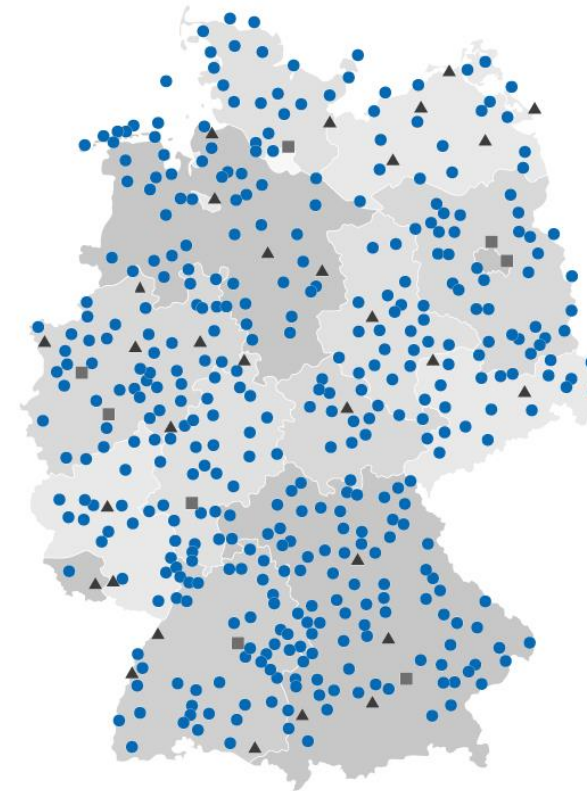


 **Joby**

- All electric
- 240 km range
- 320 km maximum speed
- Piloted
- 1 pilot and 4 passengers

Regional Air Mobility

- An emerging market that is expected to raise in next 10-15 years
- Future short-range electric RAM aircraft will probably have the following characteristics
 - Short haul flight (100-400 km)
 - Fully electric or hydrogen fuel cell powered
 - Operations from small airfields
 - Part 23 certified



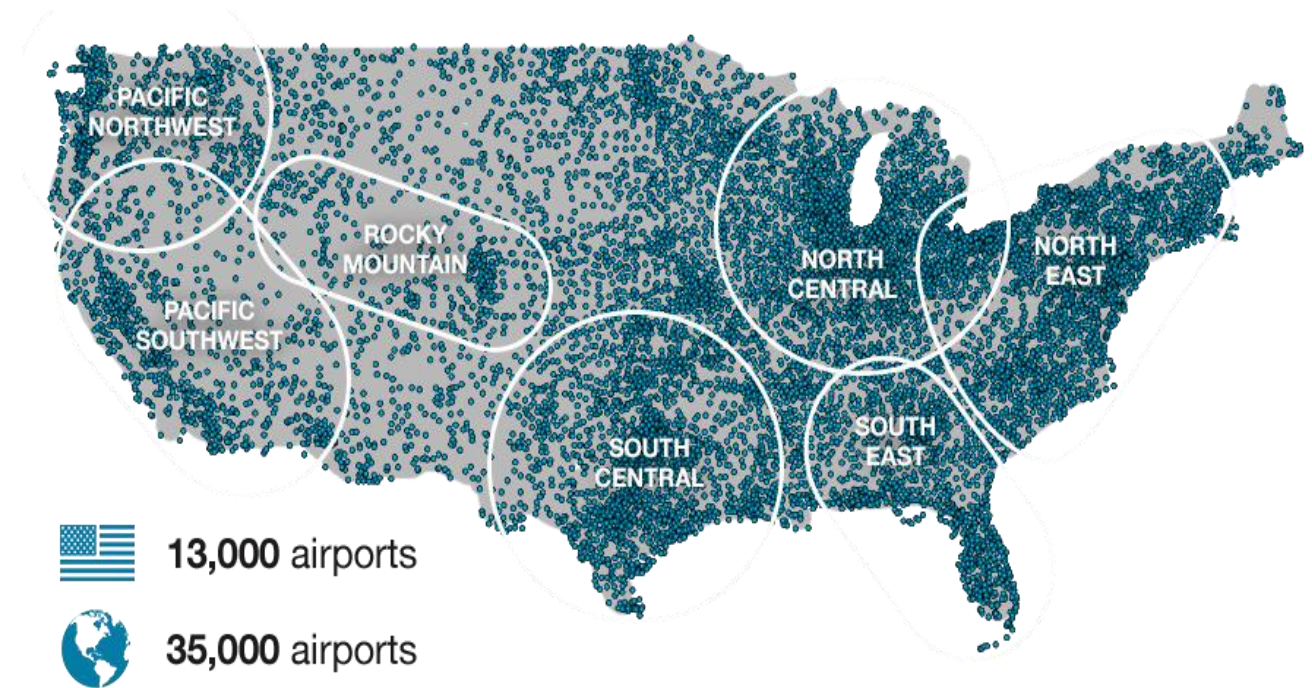
● Airfield

▲ Regional airport

■ International airport

Use Cases for Regional Air Mobility

- Use existing airports and airfields
- Stand alone travel (100-400 km)
 - Inter-city
 - Inter-island
 - City-to-rural
 - City-to-beach
- Commercial travel
 - Feeders to major hubs (Incheon, Frankfurt, JFK)
 - Route opener (new thin routes)
 - Potentially replace conventional aircraft with more energy efficient service



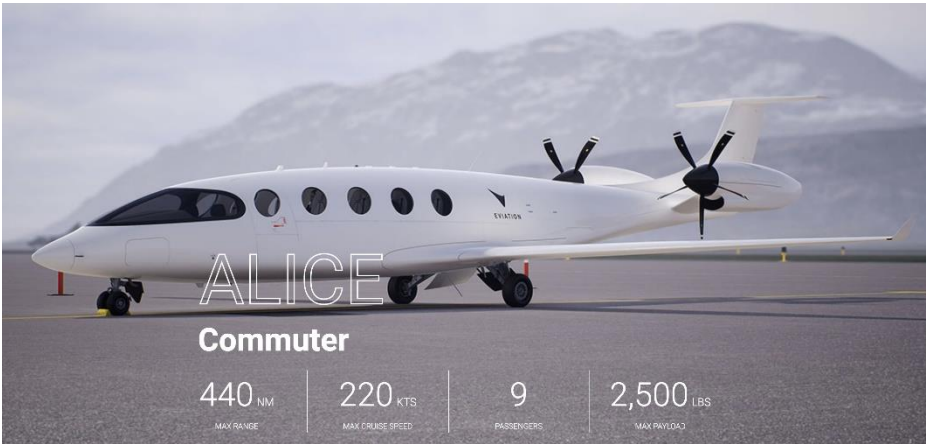
<https://zunum.aero/technology/>

A Thin Route in Uzbekistan

- Antonov AN-2 operates daily between Fergana and the Sokh exclave
- 75 km route
- Electric regional aircraft is a perfect replacement



Projects by Industry Leaders and Startups



Eviation Alice

The first commercial electric RAM that started flight tests in 2022

Cessna Caravan upgraded with MagniX electric powertrain



NASA Maxwell X-57

Distributed electric propulsion (DEP) demonstrator

Tecnam P2002 with newly designed wing

What's Next for Aviation

- Aviation is a small, but rapidly growing source of emissions
- Modern aircraft are already highly optimized
- Main decarbonization paths
 - Short term: sustainable aviation fuel
 - Medium term: regional electric aircraft
 - Long term: hydrogen, operational efficiency





<https://www.youtube.com/watch?v=EKG-6rxXAXE>