
Griffith UNIVERSITY
Queensland, Australia
AVIATION REIMAGINED
Decarbonising flight
Aviation technology for zero climate impact
Professor Simon Weeks
Simon Weeks Consultancy Limited
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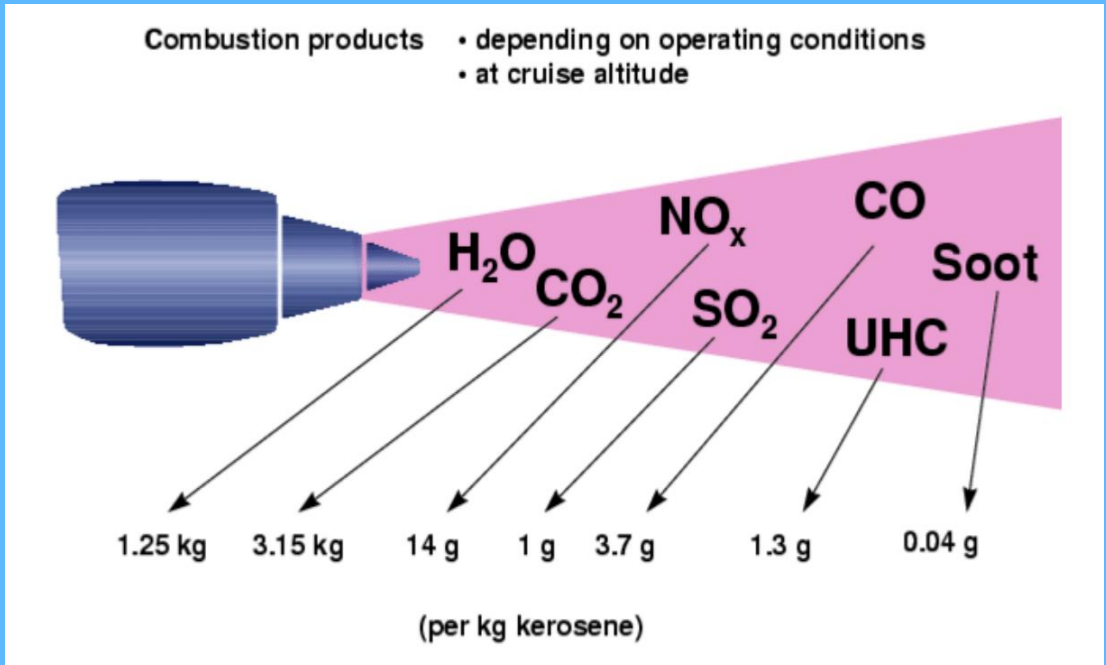
Simon Weeks Consultancy

Aviation – sustainability impact



Climate	Local to airport
• 3.5-5% • CO_2 ~1/3rd of effect • Non-CO_2 (Contrails & NO_x ~2/3rds of effect)	• Local air quality: NO_x , SO_x, UHC, Soot • Noise: Take off, Landing and Taxi • Ground contamination: kerosene, oil and hydraulic fluid from aircraft; de-icing & cleaning chemicals

No Silver Bullet….

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Addressing Climate Change

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- Increase Energy & Resource Efficiencies
- Sustainable Alternative Fuels
- Non carbon energy sources (Batteries & Hydrogen)

Improve Aircraft Energy Efficiency

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- Aerodynamics (aircraft & engines)
- Thermodynamics (engines)
- Aircraft systems electrical power efficiency
- Weight

Energy Sources for future aircraft

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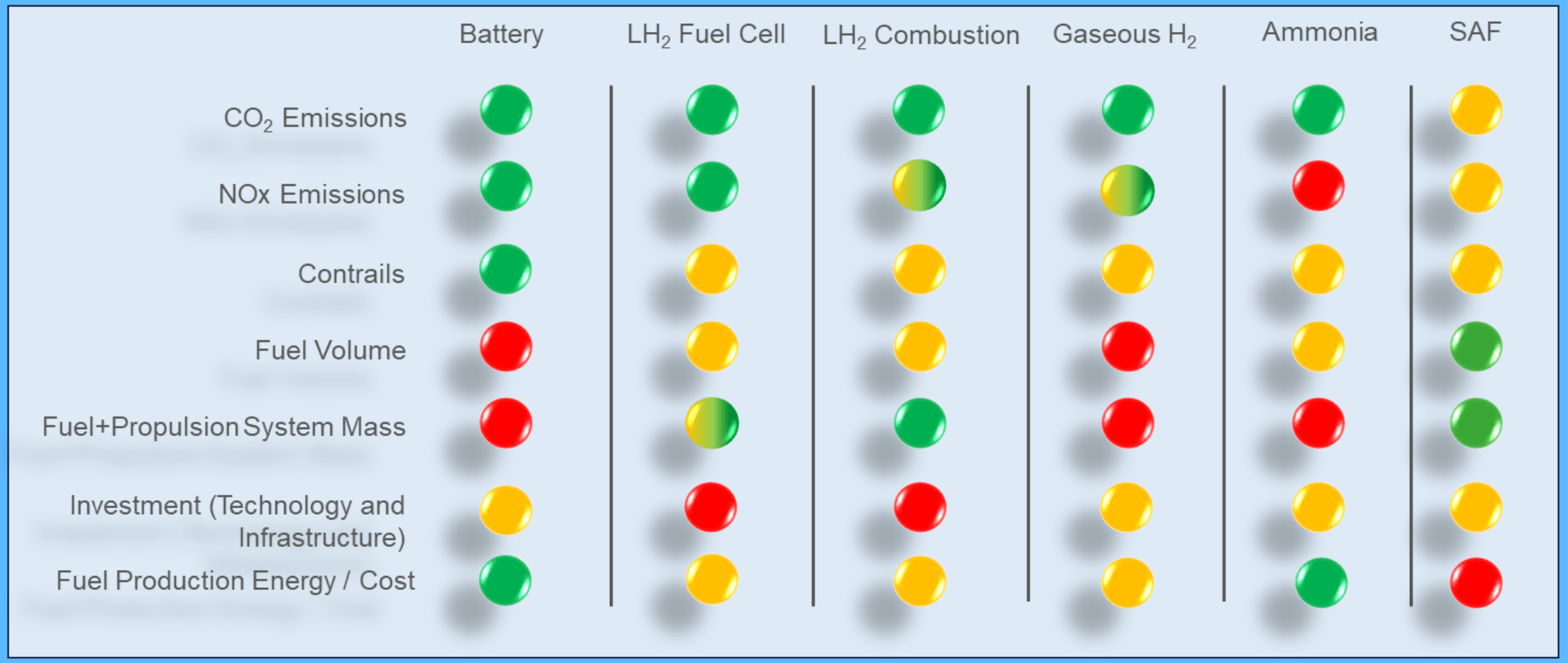

Source: ATI

Green Propulsion Options

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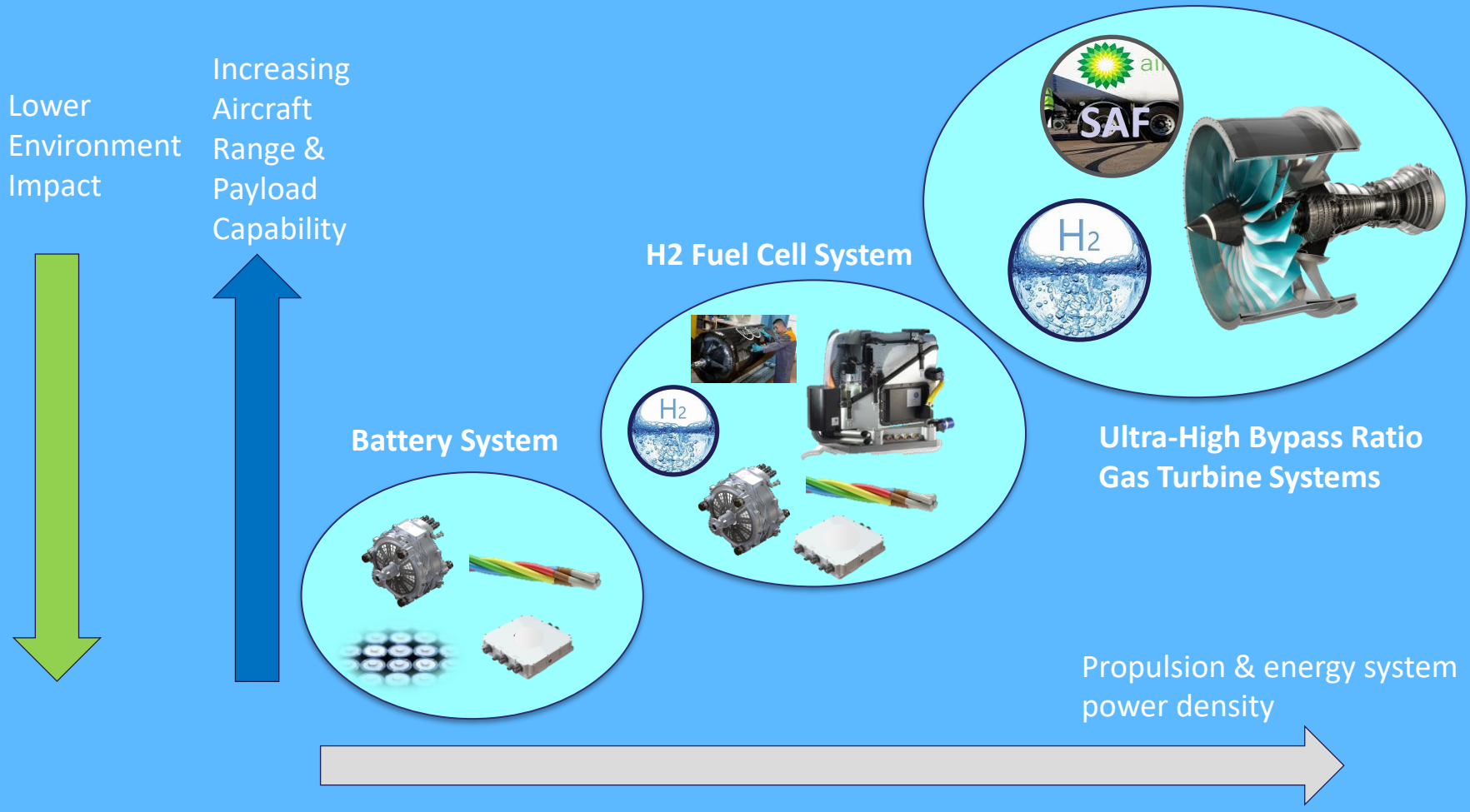

Bio SAF

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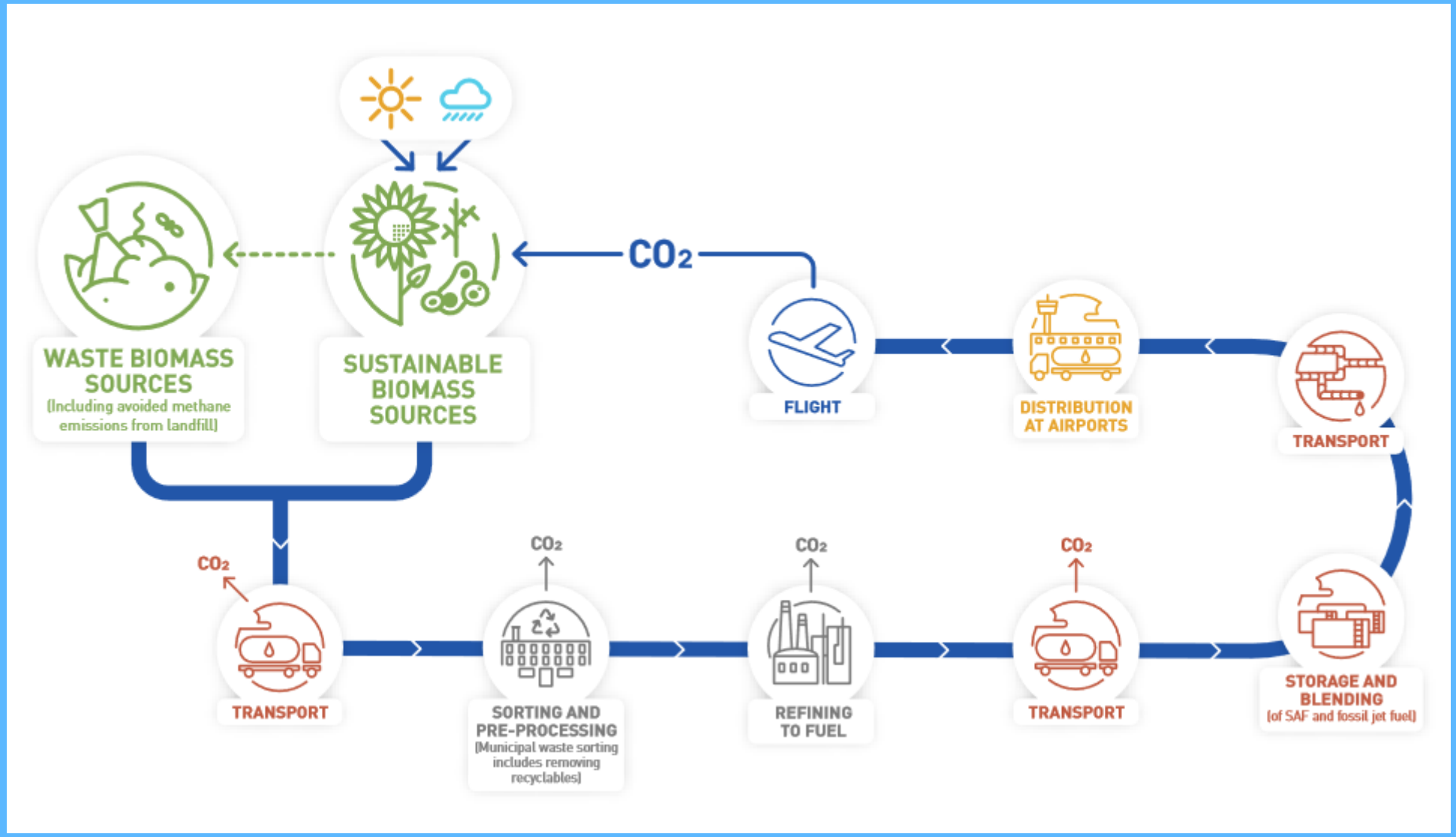

Source: ATAG

Power To Liquid (PTL) SAF

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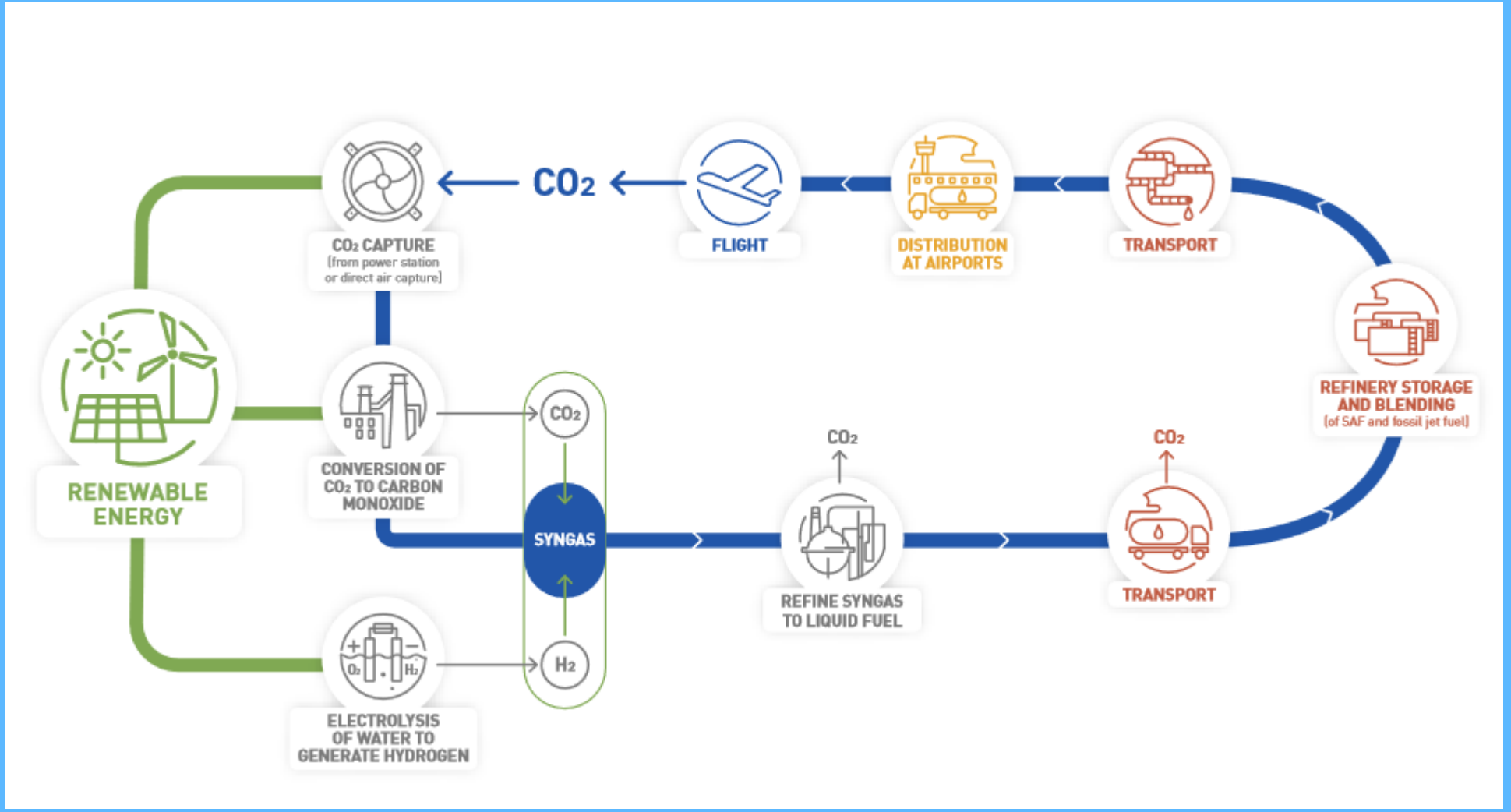

Source: ATAG

Types of hydrogen

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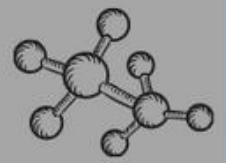
Grey Hydrogen

Process:
Steam Reforming

Source:
Natural Gas



Blue Hydrogen

Process:
Steam Reforming
With Carbon Capture

Source:
Natural Gas

Green Hydrogen

Process:
Electrolysis

Source:
Renewable Energies

Black Hydrogen

Process:
Gasification

Source:
Coal

Pink Hydrogen

Process:
Electrolysis

Source:
Nuclear Energy

Turquoise Hydrogen

Process:
Pyrolysis

Source:
Natural Gas

Yellow Hydrogen

Process:
Electrolysis

Source:
Solar Energy

Making low carbon impact hydrogen

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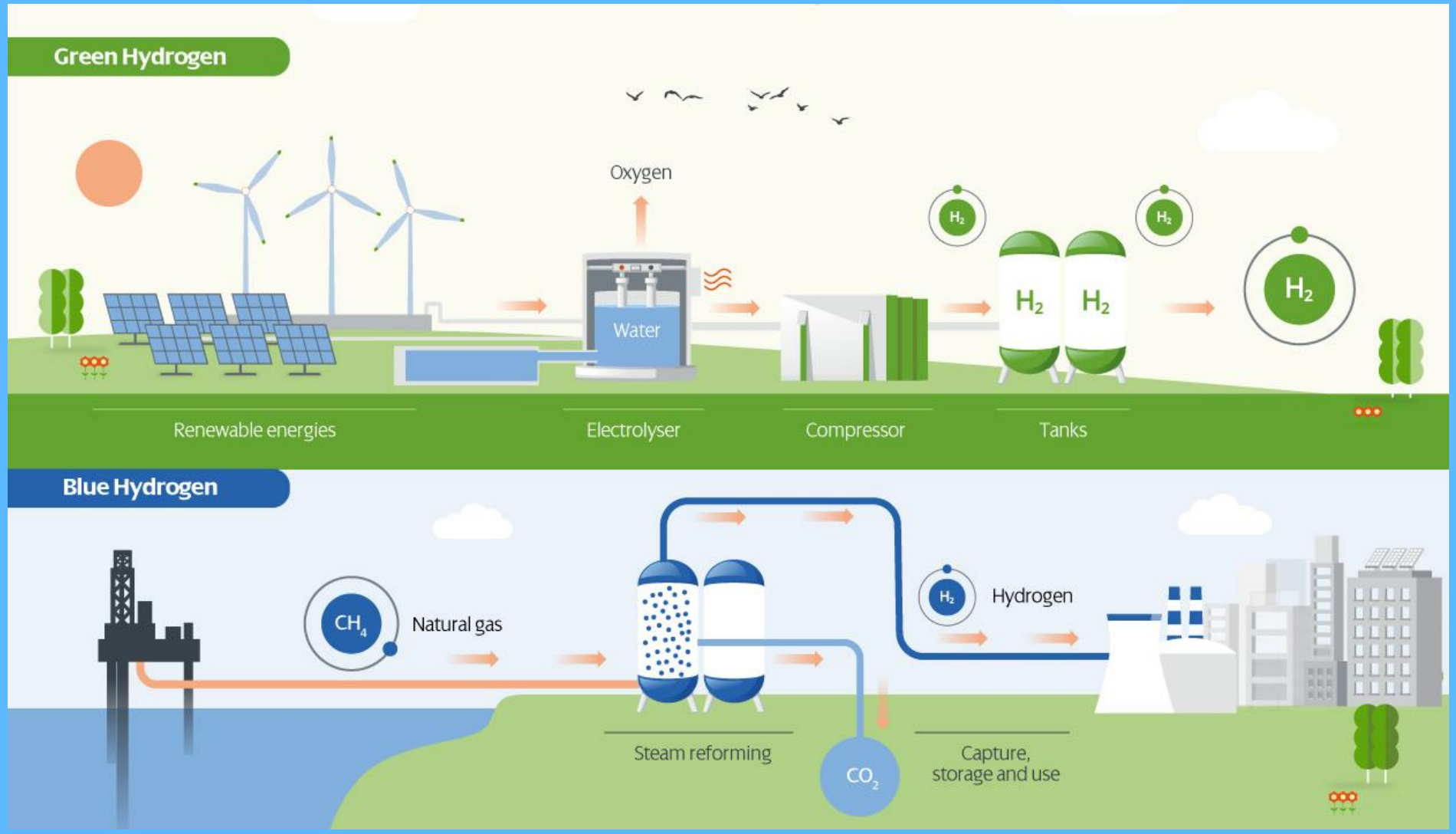

Storing and Transporting Hydrogen

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Pressurised Gas (Up to 700bar)

Cryogenic Liquid (20.4K/-252.6C)

Cryogenic Hydrogen Aircraft

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Source: Boeing

Source: H2FLY

Source: ATI

Source: ATI

Refueling a hydrogen aircraft

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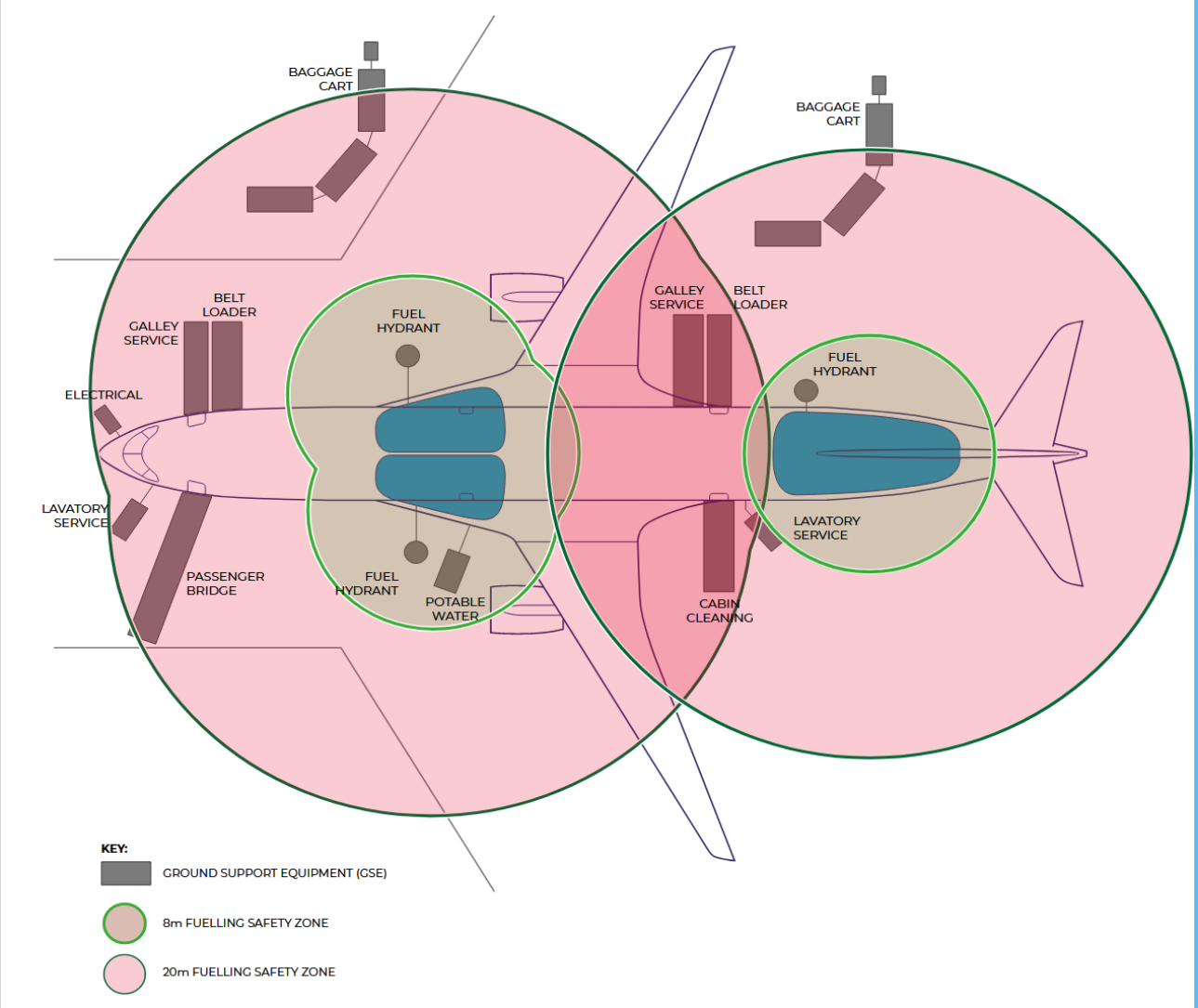

Source: ATI

Batteries

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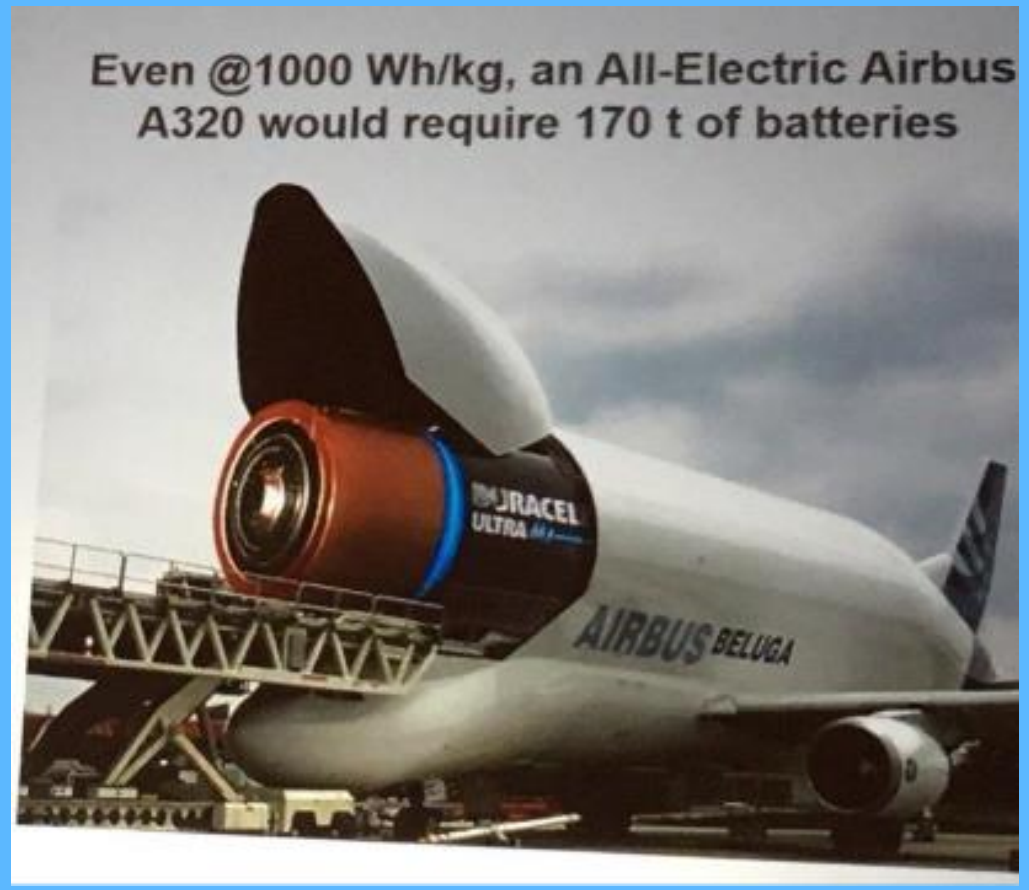

A320 NEO Dry Weight: 44t
A320 NEO Fuel Capacity: 19t

UK Battery and Hydrogen Powered Demos

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Battery

H2 gas + Fuel Cell

Path to Net Zero Carbon

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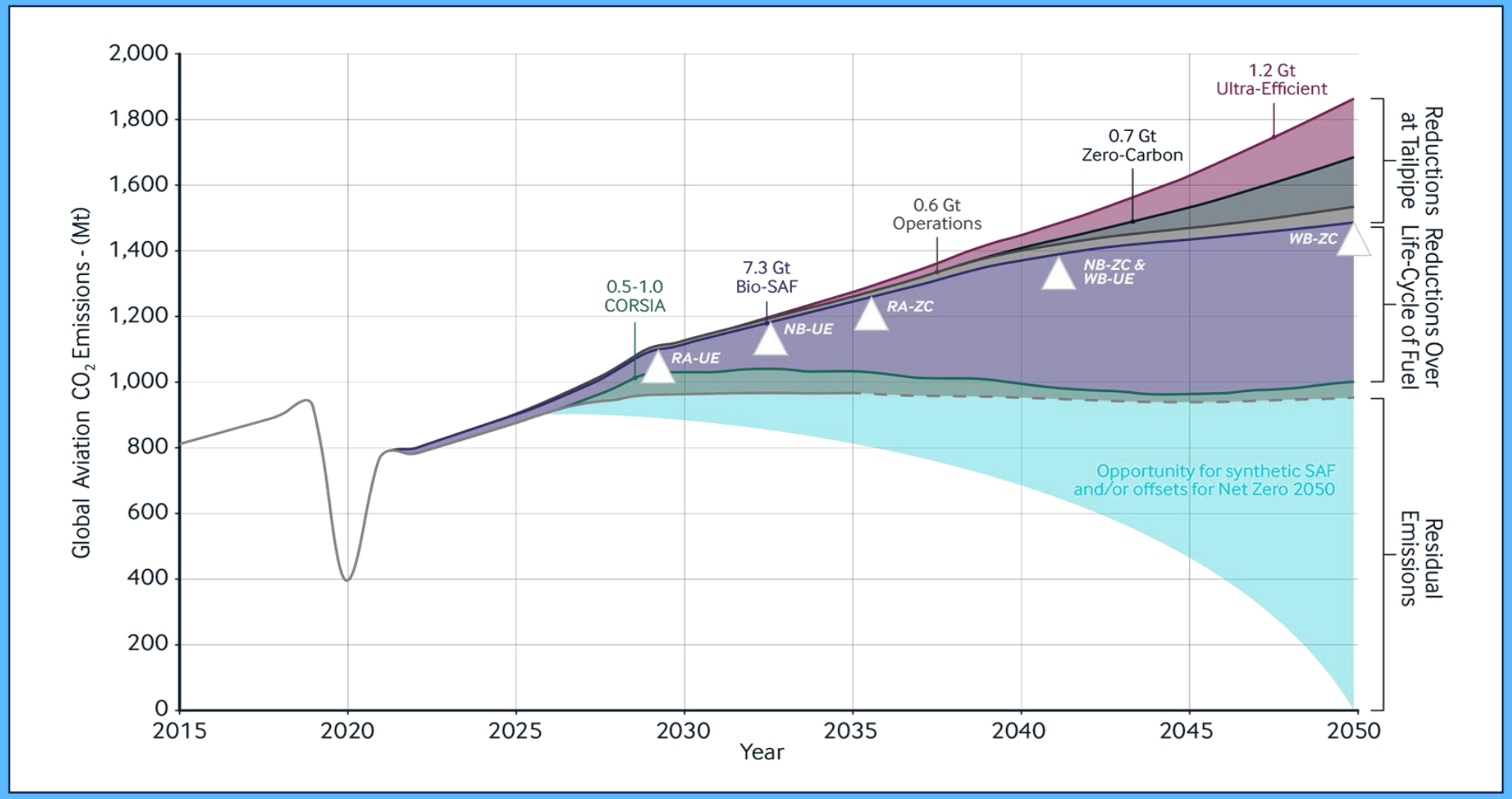
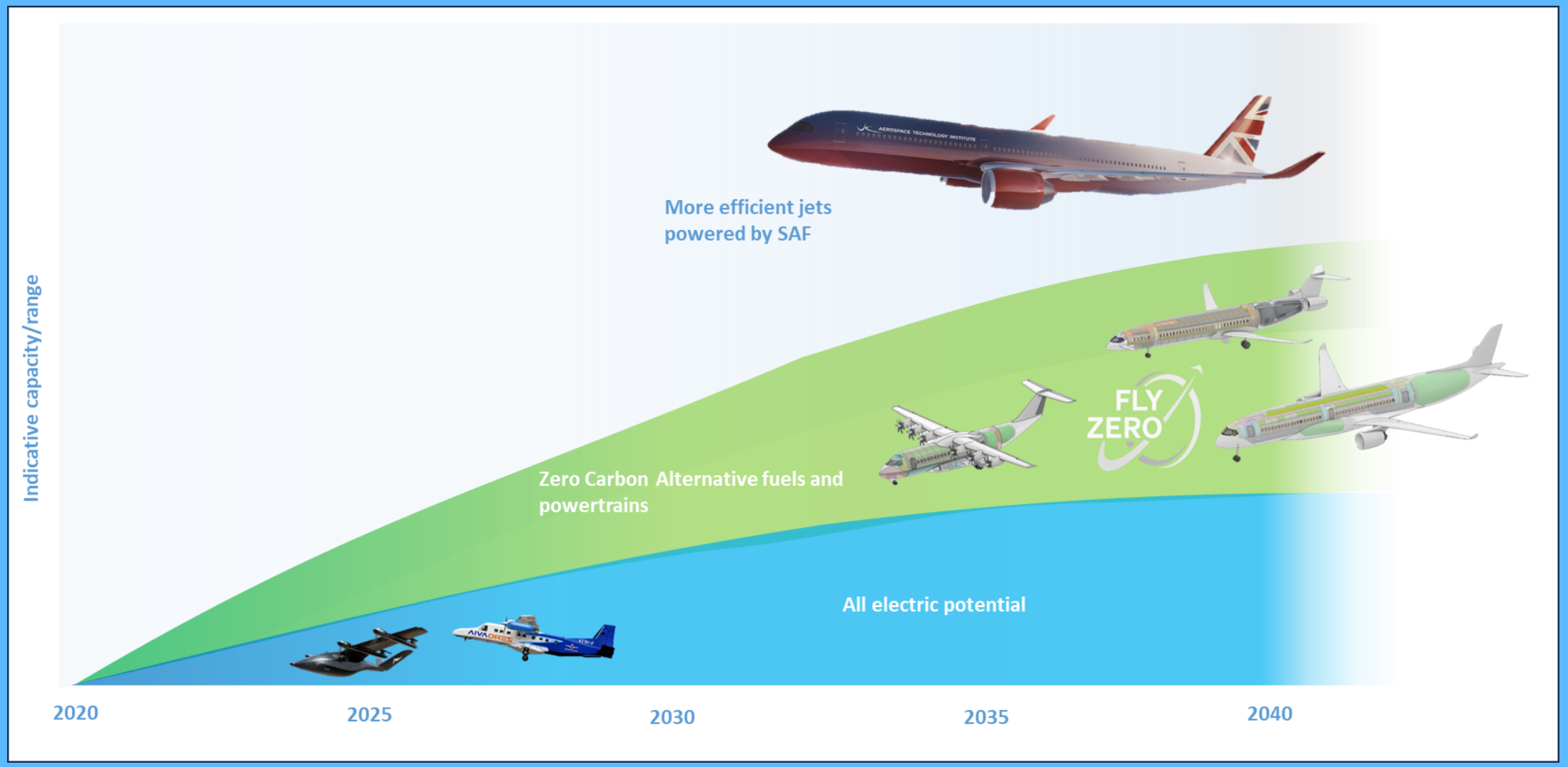


Source: ATI

Climate Change Priorities



Competition to decarbonise

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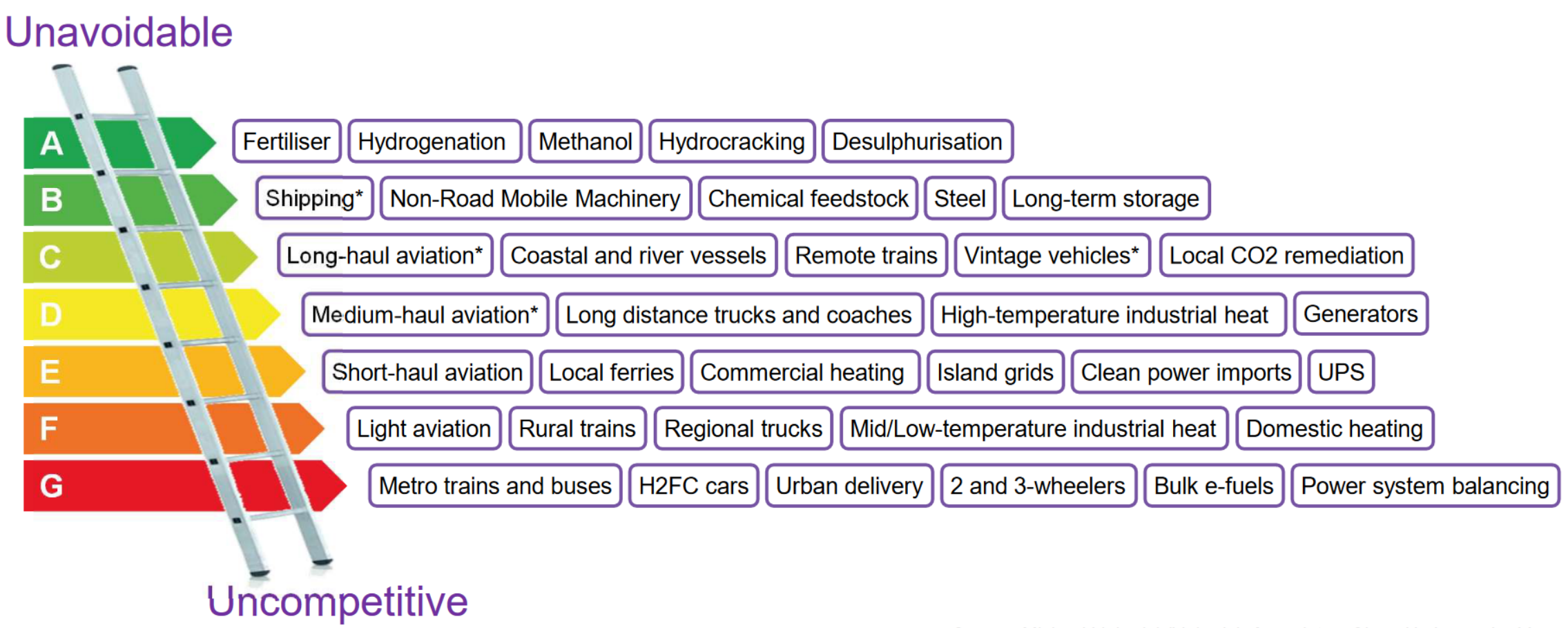

Source: Michael Liebreich/Liebreich Associates, Clean Hydrogen Ladder, Version 4.1, 2021.Concept credit: Adrian Hiel, Energy Cities. CC-BY 3.0

Aviation technology for zero climate impact

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- There’s no silver bullet – all aspects of the aviation system need to be addressed
- It always makes sense to make systems more energy and resource efficient
- SAF needs to be accelerated – it would benefit any gas turbine powered aircraft
- PTL will be required to fully address decarbonization by 2050
- Green hydrogen powered aircraft could eliminate CO2 but formidable technology and economic obstacles need to be overcome
- larger hydrogen powered aircraft will not be available in sufficient numbers to significantly impact CO2 by 2050
- Battery power is only suited to small short-range aircraft
- Aviation will be competing against other sectors for SAF feedstocks and green hydrogen
- Climate change impact of contrails is still poorly understood – more work is required to develop robust solutions