Aviation Deep Dive: Overview and preliminary results

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Outline

- Consortium team
- Objectives
- Methodology
- How does new technology get into aircraft?
- What might the aircraft roll-out to 2050 look like?
- What technologies might be in these aircraft?
- What impact on aviation emissions could SAF and new aircraft have?
- What might the SAF ramp up look like?
- Next steps

Consortium team

Alternative fuel characteristics and ramp up

Luca Bertuccioli
Anisha Harris
Lee Roberts

Technology and aircraft performance assessment
Integrated aviation system modelling

Lynnette Dray
Andreas Schafer
Martin Schofield (Ellondee Ltd)

Review of policy, projections, roadmaps and historical evolution

Alex Isard
Cavin Wilson

Objectives

- Join-up analyses of
  - Aircraft technology roll-out
  - Aviation system dynamics and economics
  - Low carbon aviation fuel production ramp-up

- Our guiding questions are: **What might the future aviation system look like?** Considering:
  - Technical and economic realities of aircraft technology roll-out
  - The dynamics and economics of the aviation system as a whole
  - Current and possible policy signals that could drive change

Would the required alternative fuel ramp up be realisable?

Methodology

Technology assessment

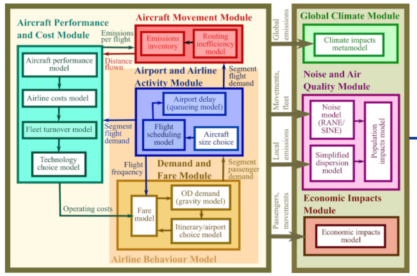
Technology packages

SAF characteristics

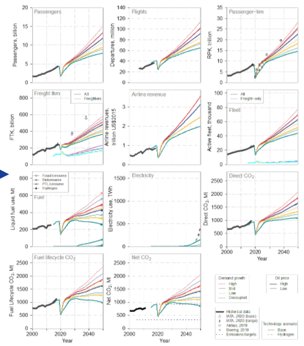
SAF ramp-up

AIM

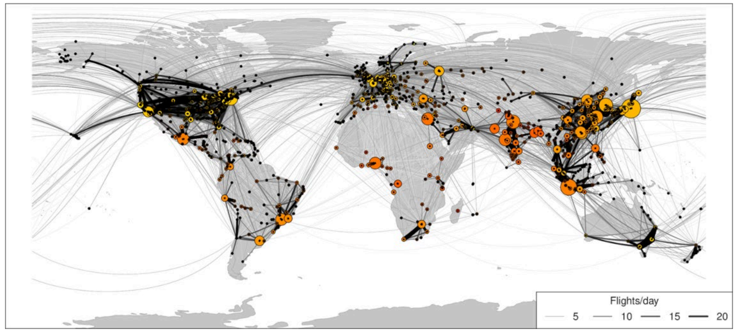
Aircraft Integrated Model



Sample outputs



AIM airport pairs and routes



- AIM inputs: Population, GDP/capita, oil price, policy, technology, etc.
- Models flights between 1169 airports in 878 cities, including modal competition
- Models demand for flights endogenously given the economic, demographic, technology and policy scenario inputs

How does new technology get into operation in aircraft?

How do airlines decide to buy new aircraft?

- Typical aircraft economic life is **20 to 35 years**
- **Revenue generation potential** is balanced vs **acquisition cost** and **operating cost**
  - Acquisition cost: No more expensive than previous generation
  - Operating cost: >10% reduction from previous generation

Airline aircraft purchase considerations

Capability = Revenue	• Seats • Cargo • Range	**Regulation**	• Noise • Emissions
Business case	• Revenue • Operating cost • Pricing	**Availability**	• New build • Spares • Fuels

How do airframers develop new aircraft?

- Takes **5-15 years for basic research** to mature enough for consideration by an airframer
- Airframers bundle coherent technologies to meet expected performance jump between generations
- From there, takes **>5 yrs to develop a new aircraft** and put it into service
- Typical **timeline between aircraft programmes is about 15 years**
- Airframers do not have financial or engineering resources to run parallel development efforts
- So new aircraft in different classes are staggered

What might the roll out of new aircraft look like to 2050?

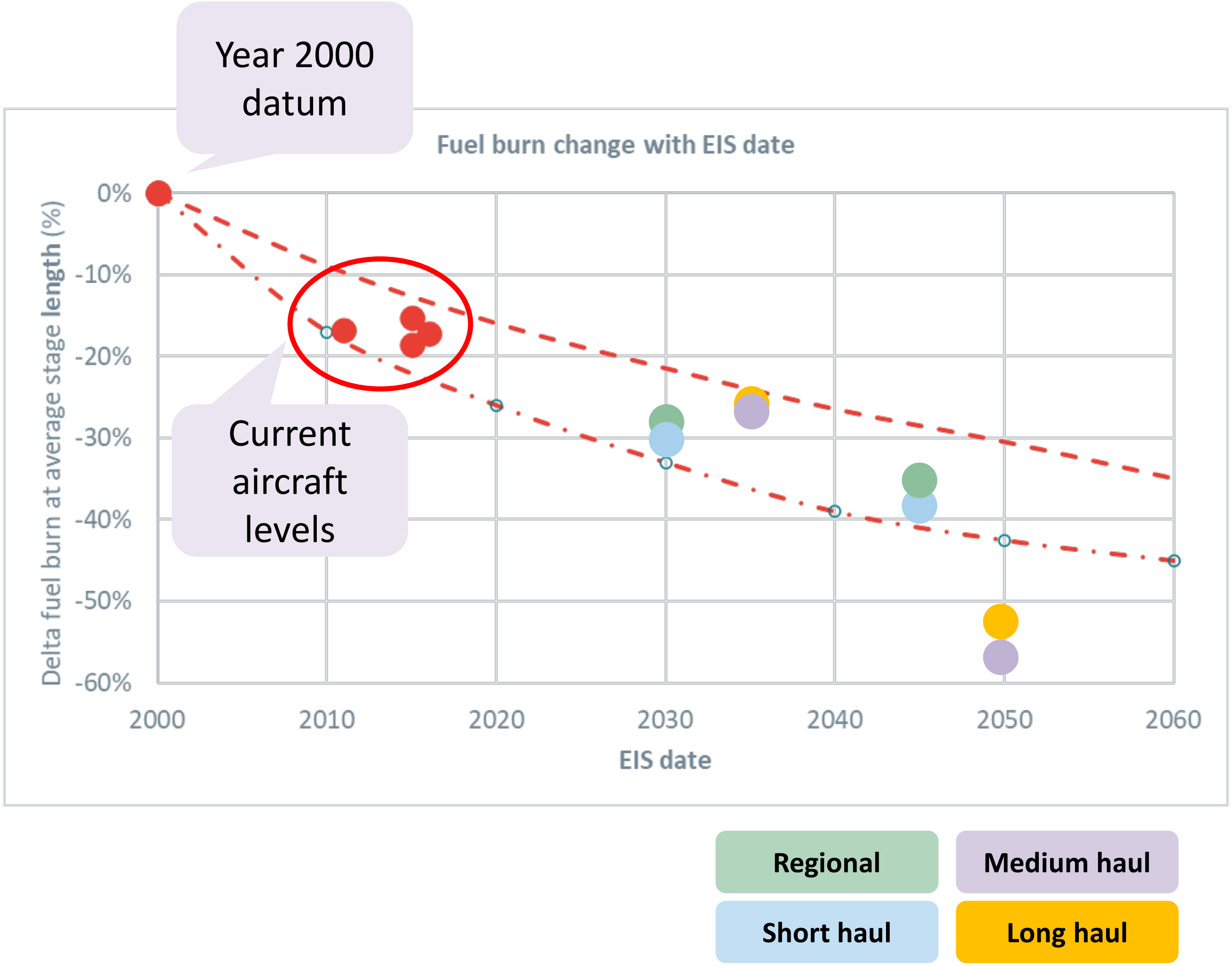
Timeframe of entry into service (EIS) of new aircraft models in two technology scenarios

	2020	2025	2030	2035	2040	2045	2050	...
SAF	Current		Regional Short haul	Medium haul Long haul		Regional Short haul	Medium haul Long haul	
SAF + H2	Current			Regional Short haul	Medium haul Long haul		Regional Short haul	Medium haul Long haul

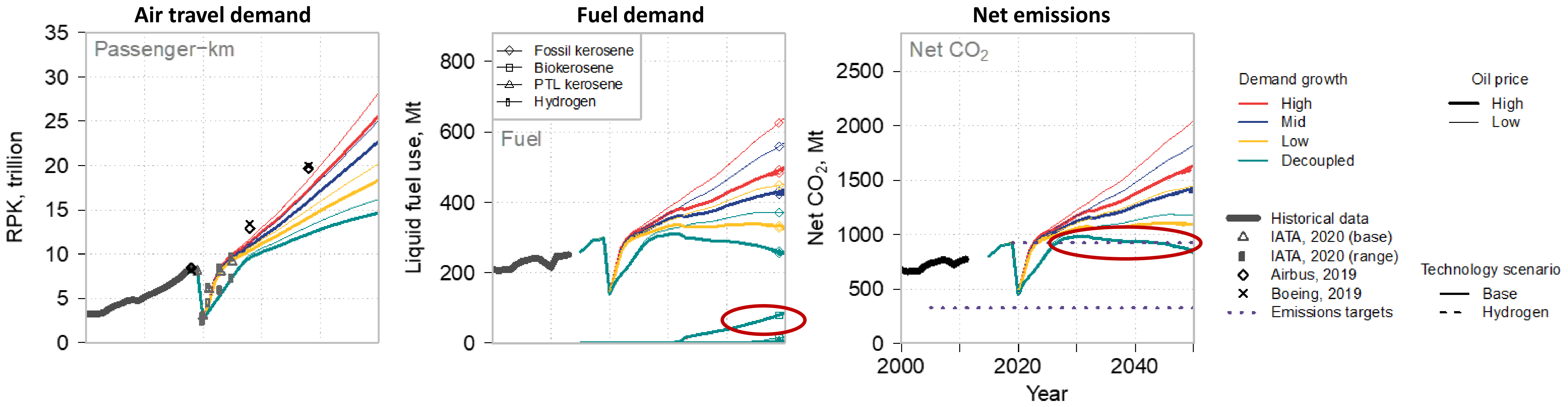
- Aircraft aggregated into 4 families that capture >95% of flights and fuel burn
- One of our technology scenarios considers only drop-in SAF, the other also includes hydrogen
- Introduction of hydrogen delays EIS of new aircraft by 5 years
- After EIS, new models gradually enter fleet as older aircraft are retired
- **Effectively only one new generation of each aircraft family will be operational between now and 2050**

What technologies might be in these aircraft?

- Aircraft technologies
  - High and ultra high aspect ratio wings
  - Ultra high bypass ratio engines
  - Composites
  - Flying wing for long and medium haul 2050
  - Reduced design cruise speed
  - Liquid hydrogen fuel (delays EIS by 5 years)
- Operational options
  - Air traffic management improvements (formation fying, continuous climb and descent, optimum track, reduced hold times)
- Ground operation options
  - Reduced taxi times



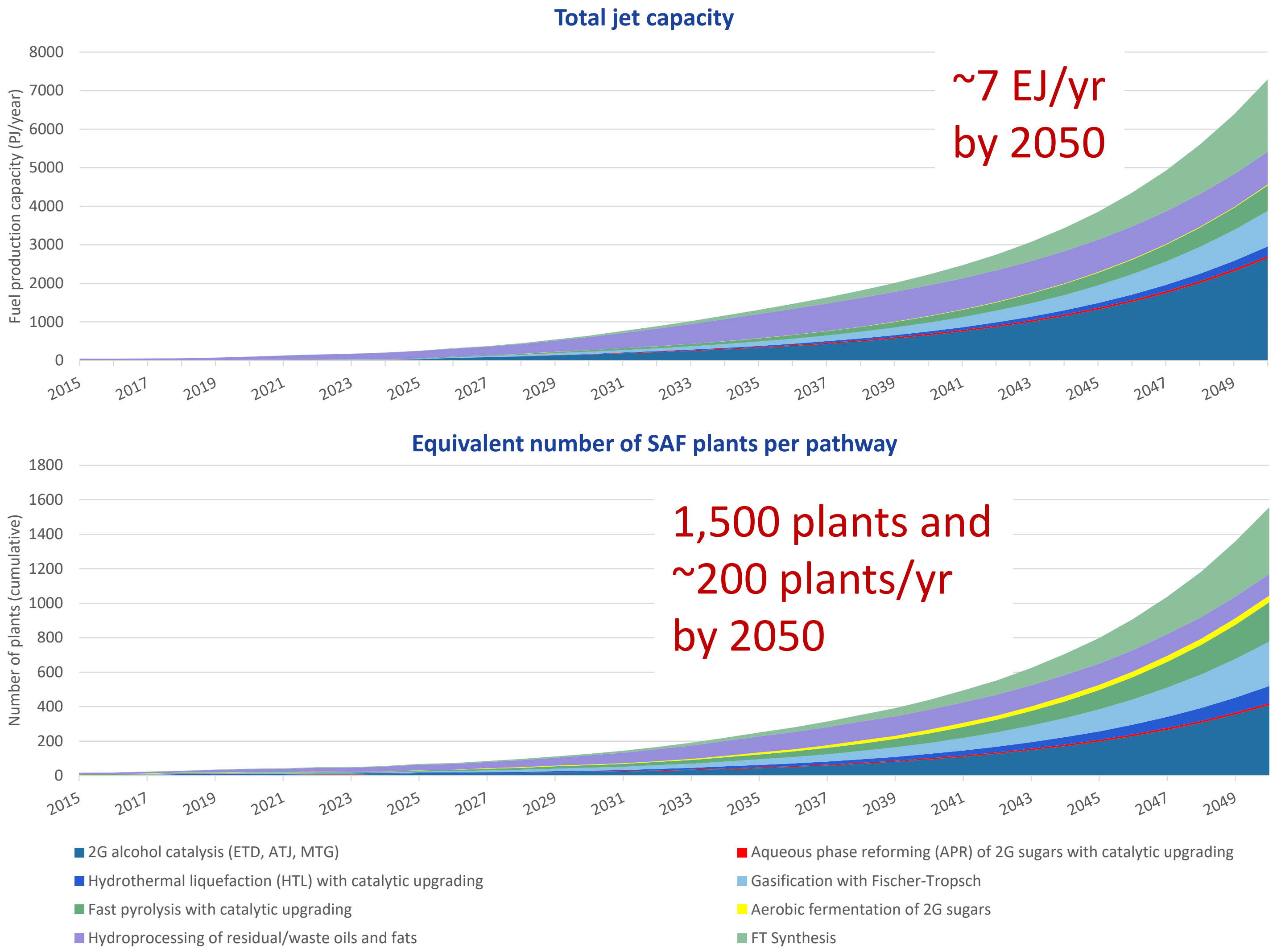
Preliminary results suggest bold policy signals are required to drive SAF uptake but even then industry targets are not met



- **Preliminary** results from the Global Carbon Price scenario that imposes 150 USD/tCO2e from 2025
- Demand for air travel increases in all scenarios
- Only with high oil prices is there significant uptake of SAF and only in the **lowest demand scenario** is carbon neutral growth achieved

Preliminary SAF production ramp up that results in 1,500 plants by 2050 is only sufficient to meet about a third of jet fuel demand

- Preliminary SAF production ramp up is sufficient to meet ReFuel EU target globally
- This only satisfies about a third of jet fuel demand in 2050
- Even this volume is not taken up in the GCP scenario and requires stronger policy drivers



Next steps

- Refine analysis: Care needs to be taken to ensure consistency between fuel ramp-up and uptake

- Develop additional scenarios that are closer to aspirational targets
  - Carbon neutral growth to 2050 for a central demand scenario
  - 100% SAF or 100% SAF + H2 by 2050

- Explore implications of the required SAF plant roll-out trajectories