ASCENT Project 52

Comparative assessment of electrification strategies for aviation

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Objective:

To evaluate:

(1) the operational and economic feasibility of electrification strategies, and

(2) the life-cycle GHG emissions and their associated impacts, relative to conventional petroleum-powered aircraft.

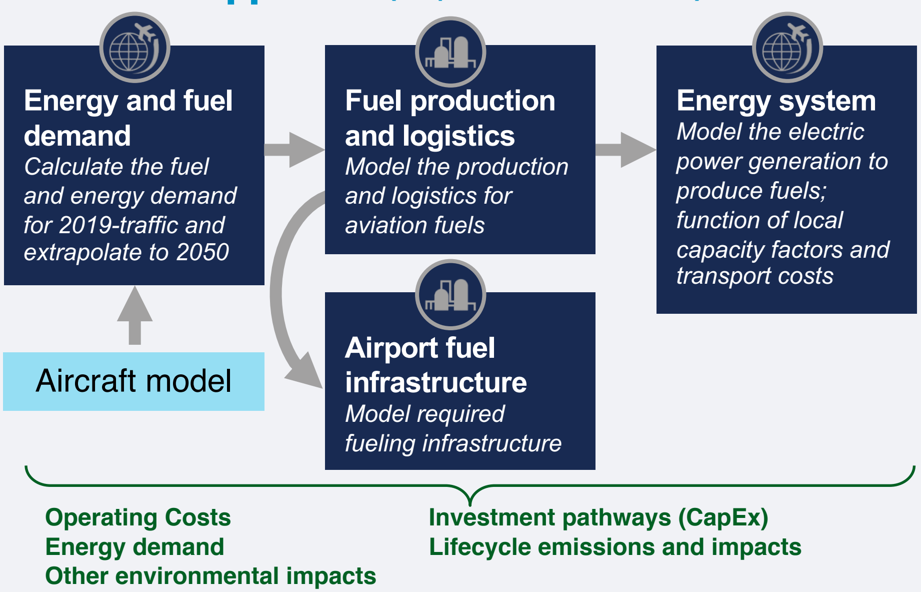
Today's focus:

Comparison of fuel supply chains for PtL and LH2 under current and future assumptions

Project Benefits:

Provide data and guidance on the most promising electrification approaches for aviation

Research Approach (fuel production and distribution):



Major Accomplishments (to date):

For PtL and LH_2 scenarios, we

1. Analyzed expected cost and emission trajectories until 2050
2. Analyzed heterogeneity in costs of PtL and LH_2 production around the globe

Future Work / Schedule:

- Integration of aircraft model to assess feasibility and impacts at the system-level
- Provide integrated economic and environmental assessment
- Compare to other electrification strategies

This research was funded by the U.S. Federal Aviation Administration Office of Environment and Energy through ASCENT, the FAA Center of Excellence for Alternative Jet Fuels and the Environment, project 52 through FAA Award Number 13-C-AJFE-MIT under the supervision of Anna Oldani. Any opinions, findings, conclusions or recommendations expressed in this this material are those of the authors and do not necessarily reflect the views of the FAA.

1 Comparison of expected LH_2 and PtL pathways until 2050

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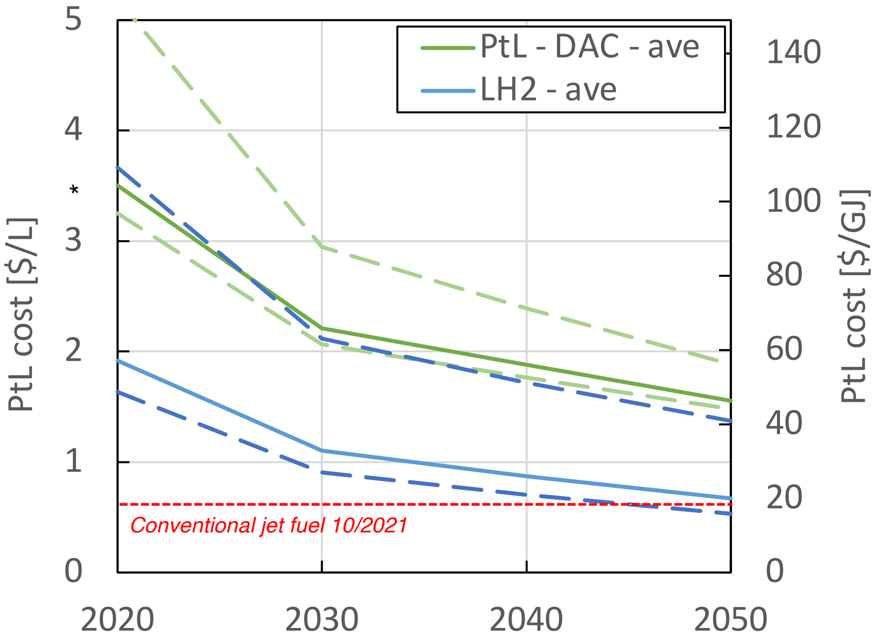
MSP and LCA conducted for "good production locations" under the following assumptions:

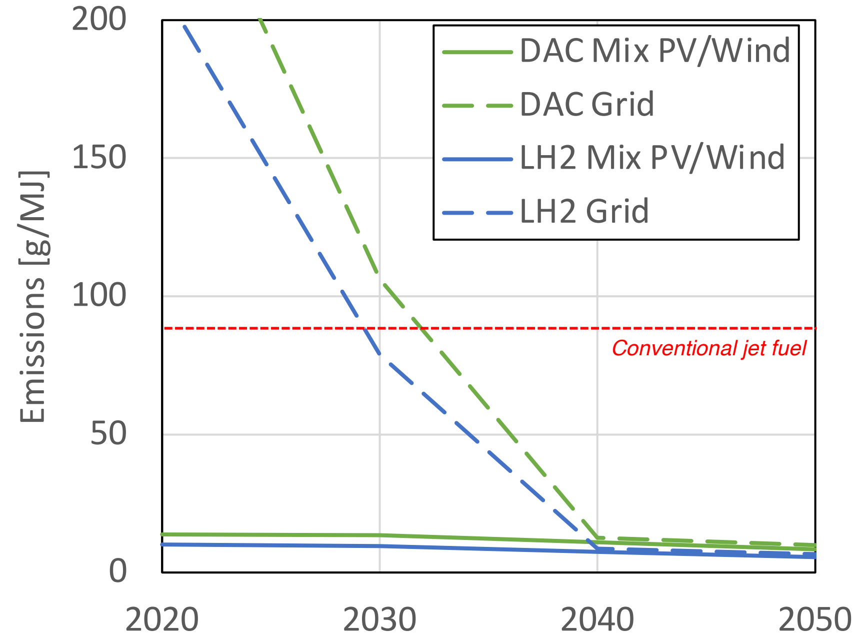
- Significant scale-up of both PtL and LH_2 production (using H_2 made from electrolysis with renewable electricity)
- Embodied emissions of renewable electricity production from wind and solar; grid case based on IEA's NZE 2050
- Optimistic cost development for key technologies (electrolysis, DAC, liquefaction)

MSP



- *LH_2 fuel production is associated with lower costs than PtL on an energy basis*
- *Under optimistic assumptions for 2050, LH_2 could reach the cost of conventional jet fuel today*

Lifecycle GHG emissions (WTW)



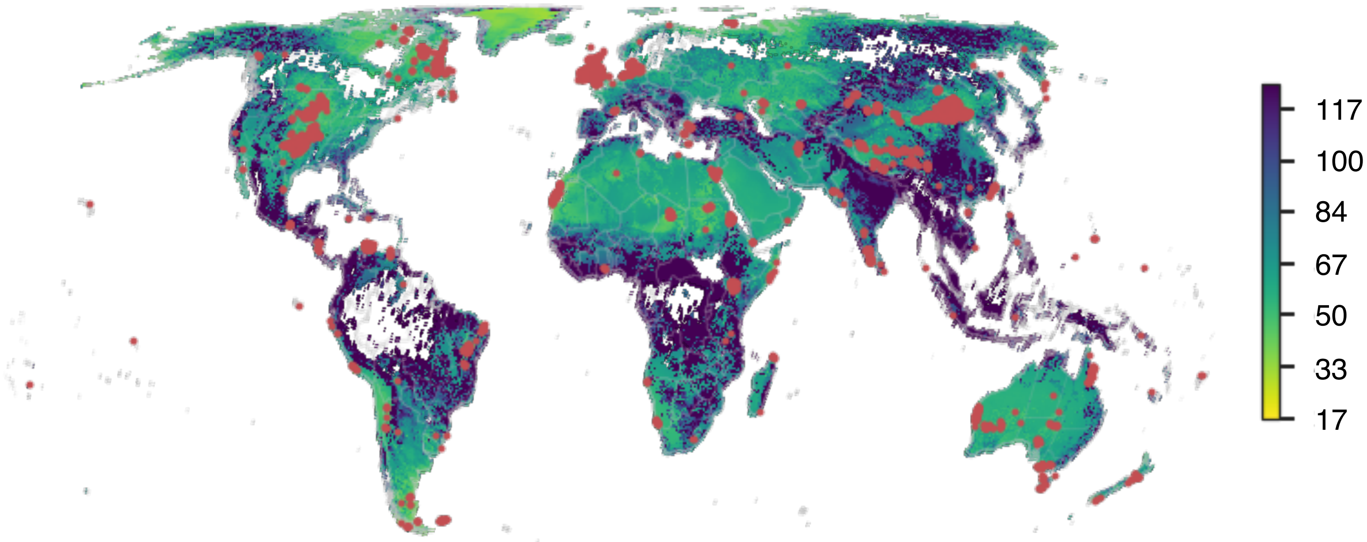
- *LH_2 achieves lower GHG emissions per MJ*
- *Using grid electricity leads to very high GHG emissions of both PtL and LH_2 production until the 2030s (assuming IEA's NZE scenario)*

** LH_2 costs shown in energy equivalent of 1L of Jet Fuel*

2 LH_2 Production for Aviation – Cost variation and power generation

2020 data – future cost reductions expected (see slide 2)

Local Cost of H_2 production, *Year 2020 assumptions*



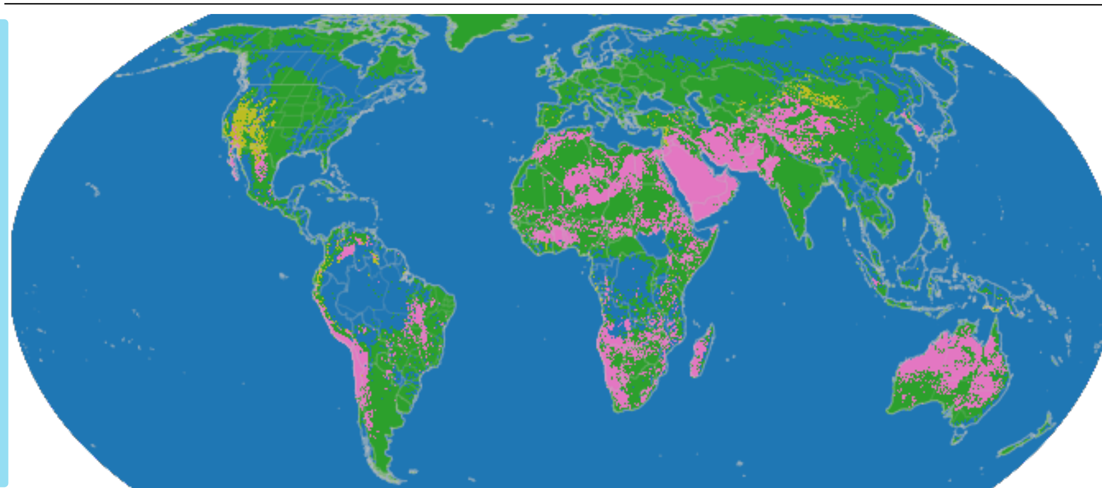
2020 Local Cost of H_2 (LCOH) excluding transport costs (US$/GJ)

Areas for power generation excludes forests, water, urban areas, cropland (for PV)

Optimal power generation, *Year 2020 assumptions*

Optimal Generation Method

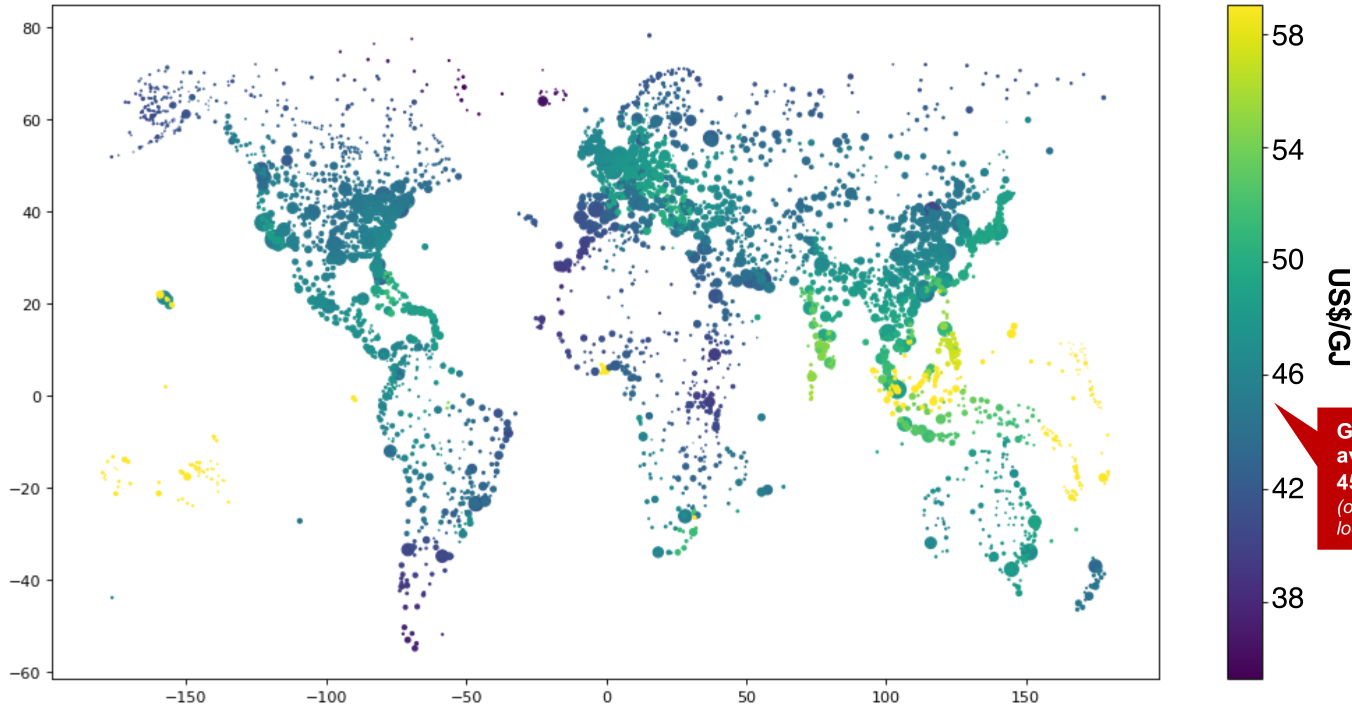
Onshore Wind	PV – Two Axis Tracked
PV – One Axis Tracked	Ocean/Energy production not practical



2 LH_2 Production for Aviation – MSP at Airports

2020 data – future cost reductions expected (see slide 2)

LH_2 MSP by Airport (US$/GJ), *Year 2020 assumptions*



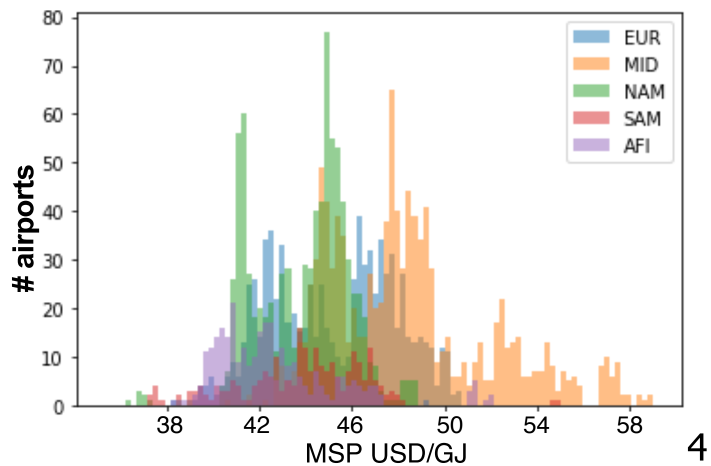
Global average 45 $/GJ *(optimized locations)*

For Comparison

- *LH_2 Cost from SMR: ~ $17/GJ*
- *LH_2 Retail Price for Automotive Refuelling in CA:* $110-$130/GJ

ICAO Regional Averages

Africa - $44/GJ
Europe - $45/GJ
Middle East/Asia - $46/GJ
North America - $44/GJ
South America $42/GJ



2 PtL Production for Aviation

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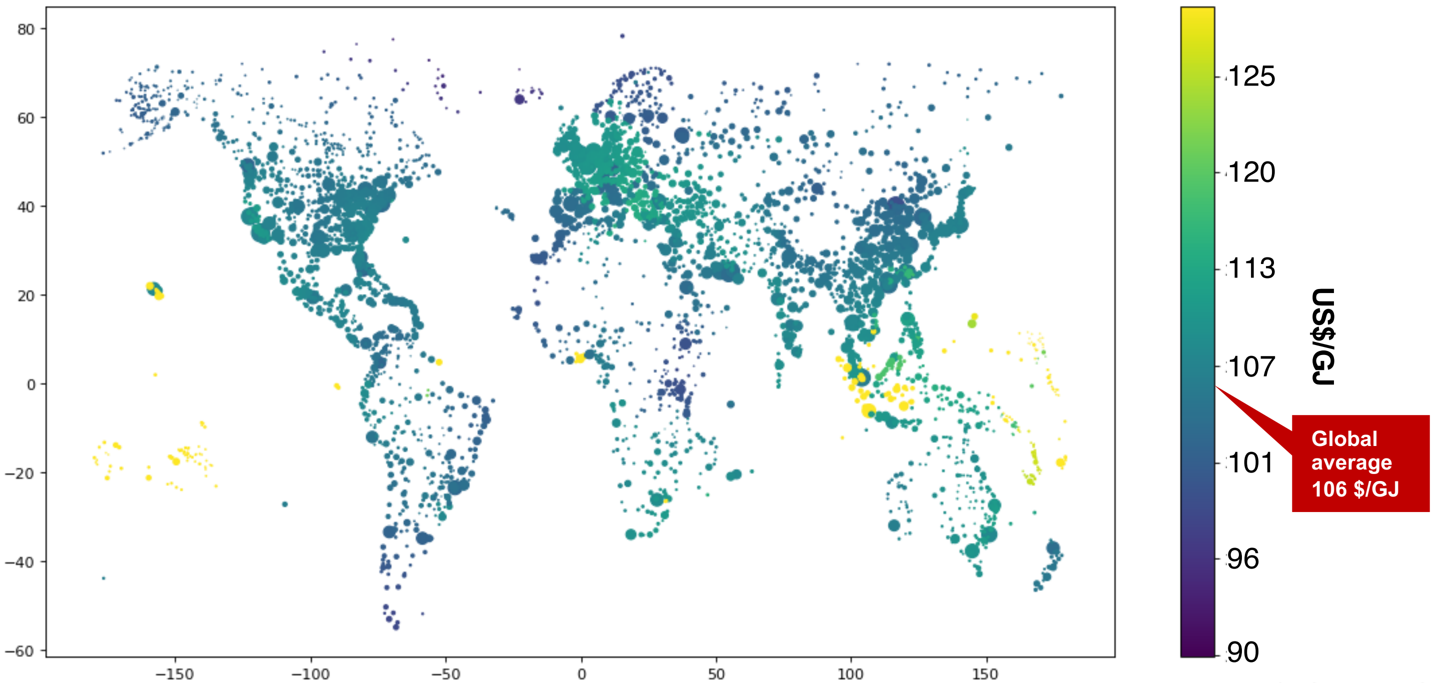
2020 data – future cost reductions expected (see slide 2)

PtL MSP by Airport (US$/GJ), *Year 2020 assumptions*



For Comparison

Current cost of jet fuel: ~20 USD / GJ

ICAO Regional Averages Lower transportation costs for PtL de-emphasizes the tail of MSP distributions
(production can be centralized more easily)