Project 52

Comparative assessment of electrification strategies for aviation

System-level assessment of biogenic methane as an aviation fuel

Motivation and Overall Approach

Compatibility w/ existing aircraft — *No in-flight CO_2 emissions*

SAF ← LCH_4? → LH_2

Cost & scalability challenge — *Aircraft & infrastructure challenge*

Currently considered **alternative aviation energy carriers** come with **challenges**.

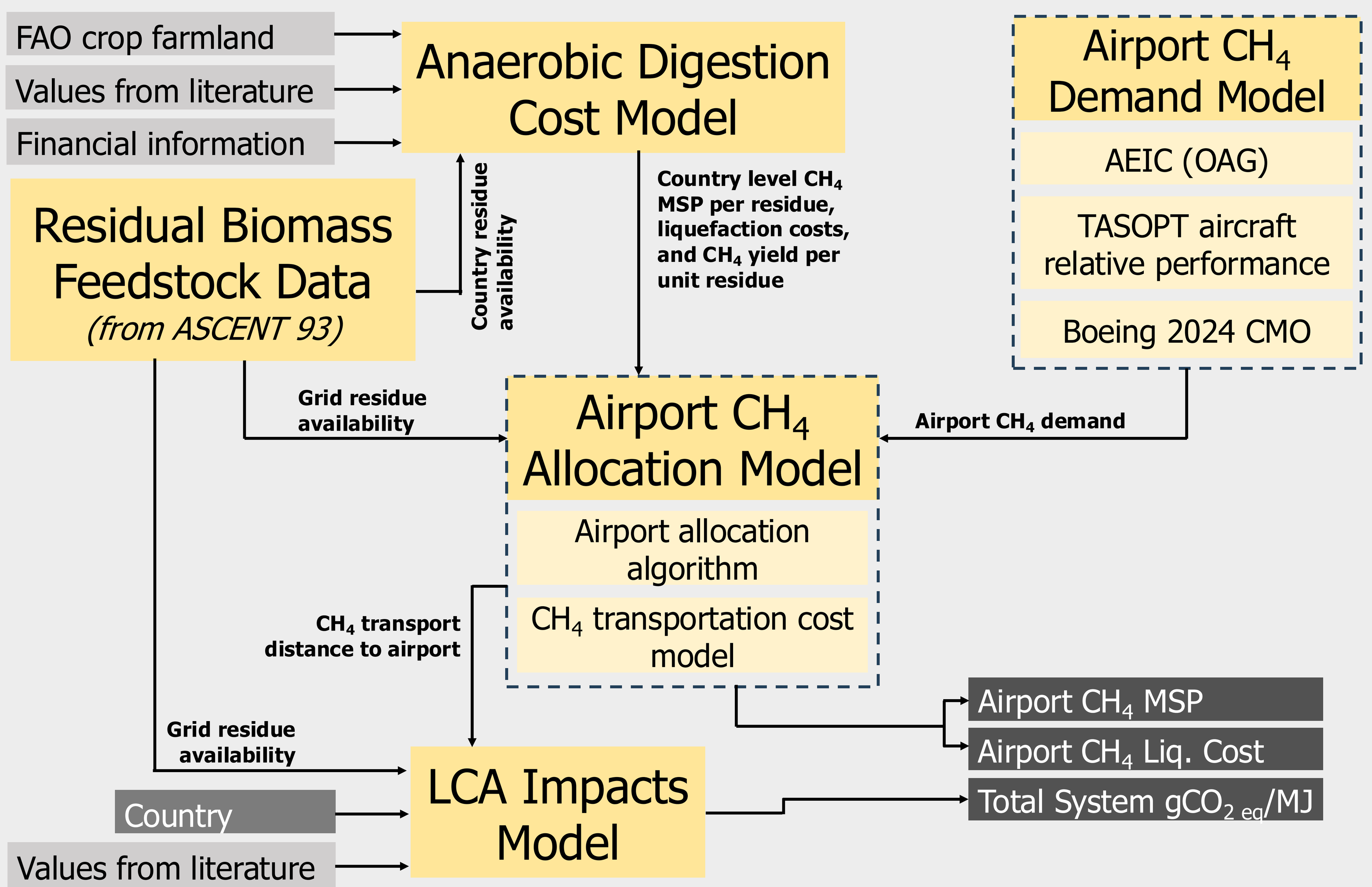
Can LCH_4 on a system level (end-to-end) perform better than SAF and LH_2 in terms of costs, scalability, and impacts?

To answer the question, we need to quantify:

a) The impact on **aircraft design and performance**
b) Geospatial **availability** of **feedstocks**
c) Feedstock conversion **yields**
d) Projected **fuel costs** and transportation costs
e) **System-level impacts**, such as emissions associated with production, transportation and use, including slip

Methodology

Model Structure



Model Levers:
- Residue scenario (pessimistic, mean, optimistic)
- 2022 or 2050 aviation fuel demand
- CH_4 aircraft market (# seats, range)
- Airport allocation algorithm
- CH_4 transportation mode

Financial Information:
- Cost of debt
- Central bank policy rate
- US inflation rate
- ILO (labour)
- US labour index
- Equity risk premium
- $\beta_{Levered}$
- 10Y government bond yields
- Exchange rates

Future iterations of the model, will include geospatial modeling of H_2 MSP for methanation and CO_2 from anaerobic digestion

Preliminary Results

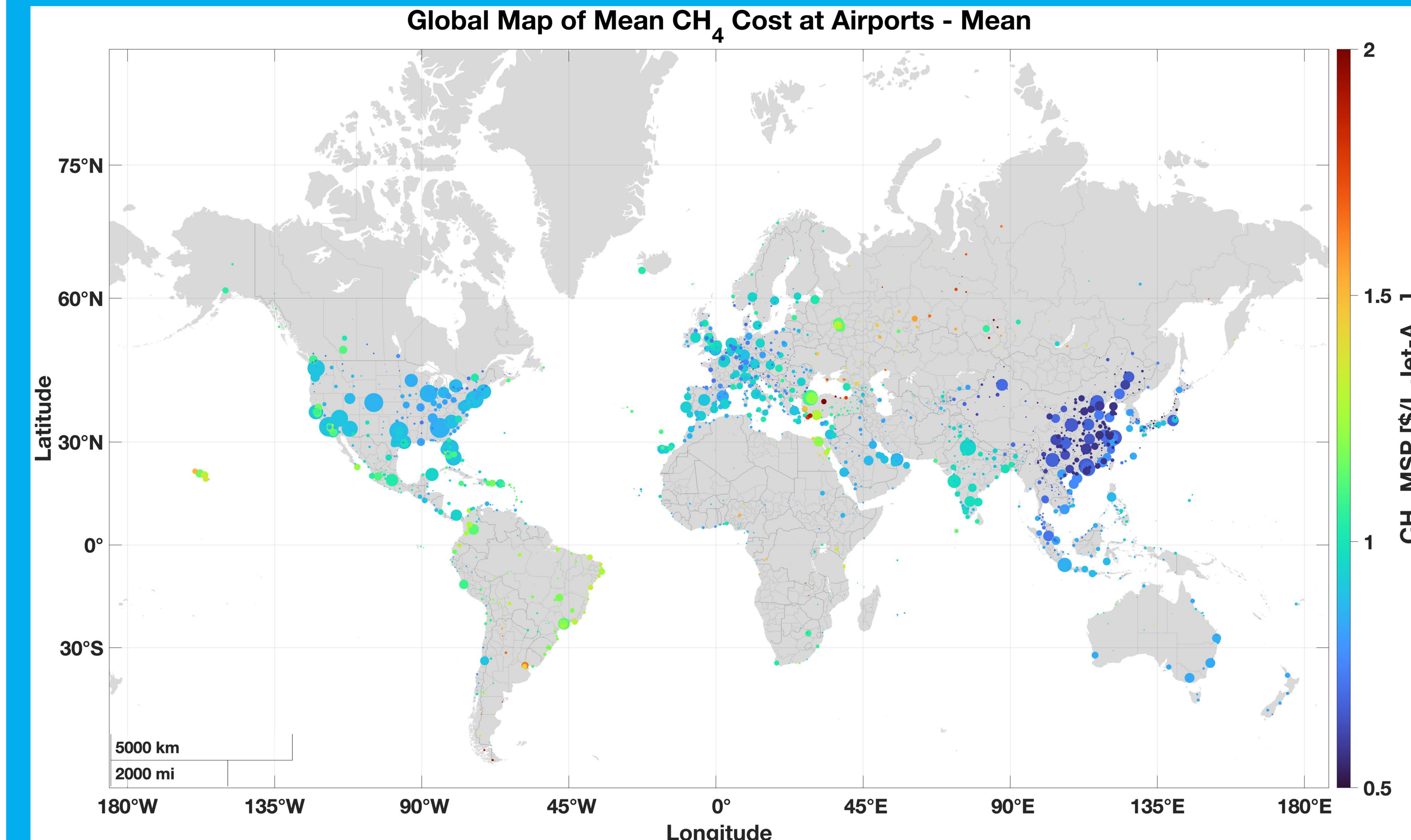


Figure 1: At pump minimum sell price of LCH_4 at airports

Fuel allocation strategy:
- Staged in **four rounds**, from local (400 km radius) to global (20,000 km radius)

Assumptions:
- Using the **mean** global residue availability **scenario** as determined by A93; **16** out of 172 **feedstocks** used
- CH_4 exclusively from **anaerobic digestion**
- Airport level **fuel demand** is derived from **OAG 2022** flight schedule for **100-6500 nmi** and **120-290 seat** market
- Fuel demand scaled compared to LCH_4 aircraft relative performance to Jet-A
- **Excluding** LCH_4 sources where total costs **exceed $10/L Jet-$A_{eq}$**

Result:
- Weighted average global **MSP $0.89/L Jet-$A_{eq}$**
- The **MSP ranges from $0.48/L Jet-$A_{eq}$** at CGO, China, **to $3.94/L Jet-$A_{eq}$** at DYR, Russia. Seven airports, out of 2080, have MSP over $2.00/L Jet-$A_{eq}$

Key Takeaways:

- In the **pessimistic** global residue availability **scenario**, with methane only via anaerobic digestion, the global **narrowbody LCH_4 fuel demand cannot be met**
  - Approximately 4.8% of the North, and Central America fuel demand could not be supplied despite allowing them to access all remaining biogenic methane globally
- Depending on the global residue availability scenario the average **MSP** is in the range of **$0.82-$1.15/L Jet-A_{eq}**
  - MSP comparable to HEFA-based SAF [1]

[1] International Civil Aviation Organization. *SAF rules of thumb*. Retrieved September 25, 2025, from https://www.icao.int/SAF/saf-rules-of-thumb

Table 1: Model key results for different global residue availability scenarios, assuming only anaerobic digestion, including cost of liquefaction

Scenario	Fuel Demand Met	Global W-Avg. MSP	Top 100 W-Avg. MSP
Pessimistic	98.4%	$1.23/L Jet-$A_{eq}$	$1.22/L Jet-$A_{eq}$
Mean	100%	$0.89/L Jet-$A_{eq}$	$0.84/L Jet-$A_{eq}$
Optimistic	100%	$0.82/L Jet-$A_{eq}$	$0.77/L Jet-$A_{eq}$

Future Work

- **Complete the system level analysis for narrowbody market**
- **Evaluate global cost distribution of methanation via H_2 from renewable electricity sources.** Current implementation has scenario unique assumptions; it does not capture global variations
- **Estimate the financial assumptions for *all* countries.** Current implementation has data for 115 unique countries and territories

Bjarni Örn Kristinsson
Investigators: (PI) F. Allroggen, (Co-PI) R. Speth, (Co-I) N. Keogh
Massachusetts Institute of Technology
Project manager: B. Habibzadeh, FAA
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