Laboratory for Aviation and the Environment
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Research challenges for assessing the environmental and economic impacts of alternative jet fuel production scale-up

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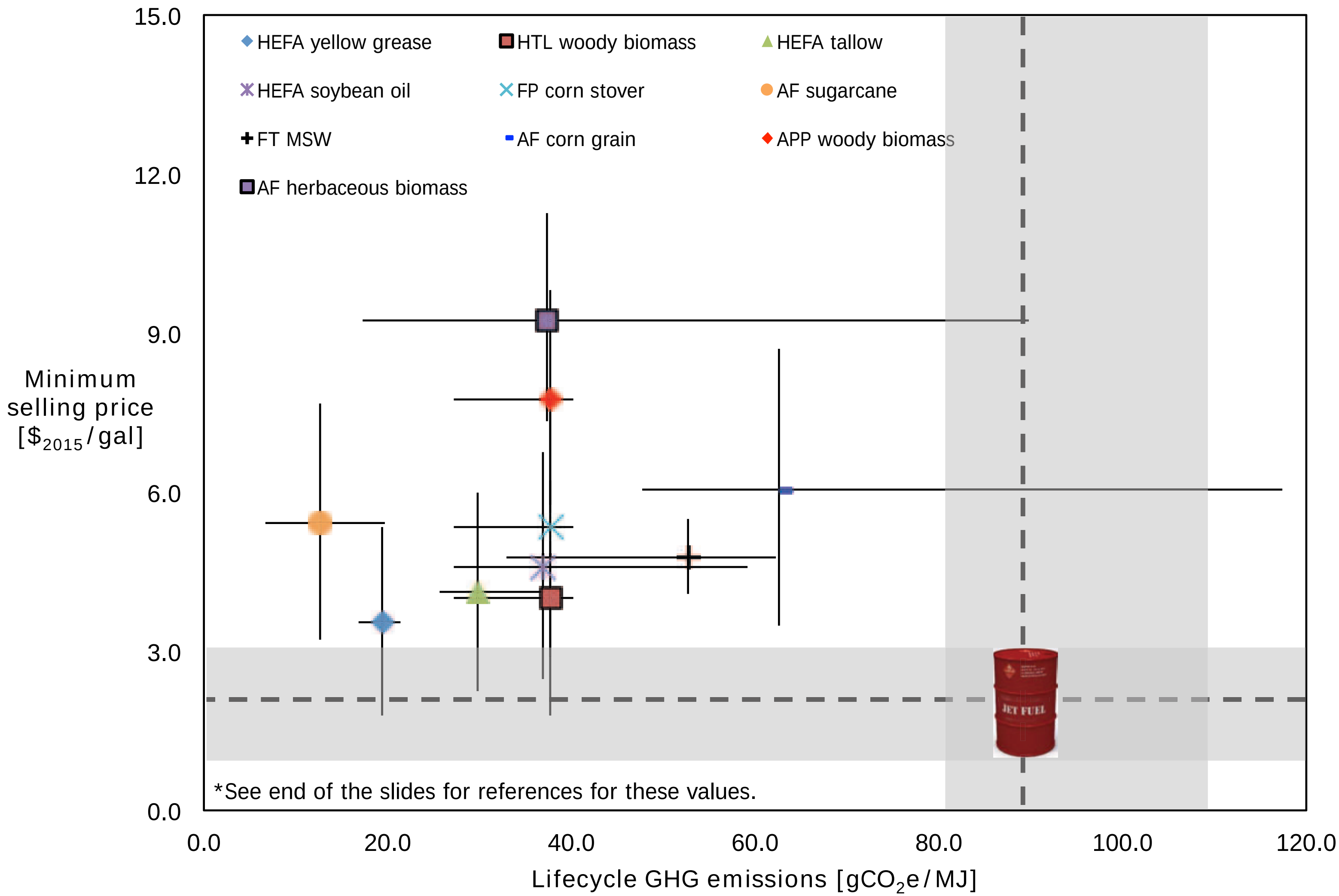
Assessment of AJF technologies

Lifecycle assessment (LCA) - quantifies GHG emissions of full fuel supply chain to estimate net climate change benefit of AJF vs. petroleum-derived jet fuel

Techno-economic assessment (TEA) - quantifies fuel production cost, for comparison to the cost of petroleum-derived jet fuel

Process-based, pathway specific methods of technology assessment

Results of TEA and LCA analyses
(per unit of fuel)

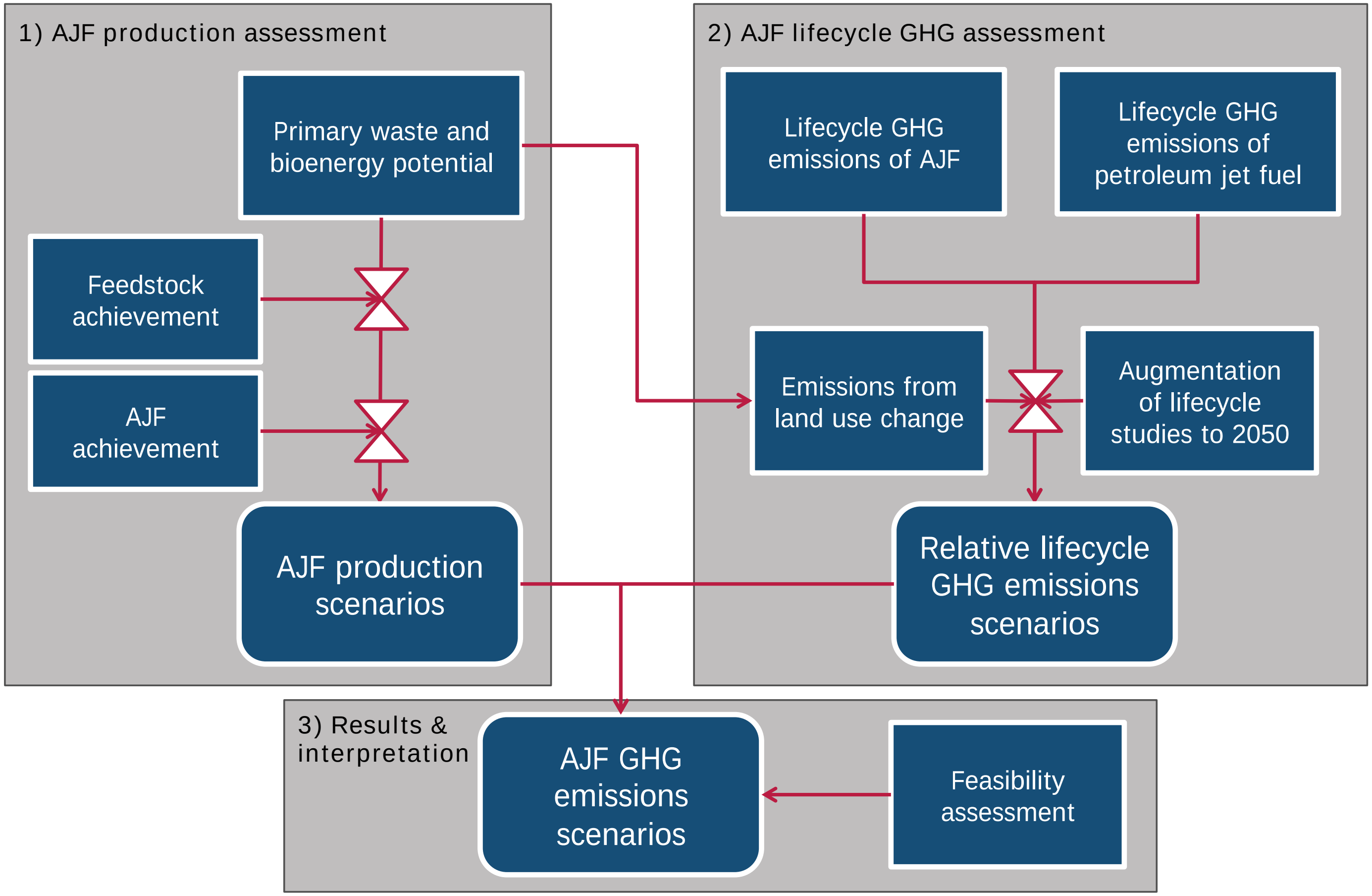


The impacts of large-scale AJF deployment aren't captured.

Preliminary results - do not cite or quote.

Aviation industry GHG reductions from AJF

To what degree can AJF contribute to mitigating GHG emissions from the aviation industry in the near- and long-term?



Aviation industry GHG reductions from AJF

Near-term (2020): **0-2% (0-150k bpd)** global jet fuel demand could be satisfied by AJF → GHG emissions reductions of **0-1.3%**

- Based on AJF production facilities that are planned or under construction
- High end only achievable if green diesel blends are approved for jet engines

Long-term (2050): **0-100% (0-19,000k bpd)** global jet fuel demand could be satisfied by AJF → GHG emissions reductions of **0-63%**

- Based on potential availability of feedstock
- Accounting for LC emissions from AJF supply chain & land use change (LUC)

Preliminary results - do not cite or quote.

Scale-up of AJF production

Reduction in annual aviation GHG emissions in 2050	AJF production capacity in 2050 [Mbpd]	Required growth in AJF production capacity	
		Number of new biorefineries/yr	Capital investment/yr
2%	0.64	10	$1B - $3B
10%	2.8	40	$3B - $14B
17%	4.7	70	$6B - $25B
40%	12.3	170	$15B - $60B
63%	18.7	260	$20B - $90B

Average historical ethanol and biodiesel production	Total annual volumes (Mbpd)	0.22 (1975-2000) to 0.99 (2001-2011)
	Number of new biorefineries/yr	5 (1975-2000) to 60 (2001-2011)
Projection for average annual investment in petroleum refining in 2035		$55B

- In order to achieve **10-20% reductions** in aviation GHG emissions, AJF production capacity **requires significant and continuing investment and growth between now and 2050**
- Ultimately, AJF production capacity would have to be **many times greater than current global biofuel production capacity**

Preliminary results - do not cite or quote.

Potential impacts of AJF production scale-up

Rapid and sustained expansion of AJF production could have impacts not captured by TEA and LCA studies:

- Learning-by-doing of nascent technologies
  [Goldemberg et al. 2004, Newes et al. 2012, Vimmerstedt et al. 2015]
- Land use change (LUC) emissions
- Changes in demand for aviation services
  [Winchester et al. 2015]
- Air quality impacts
  [Speth et al. 2015, Barrett et al. 2012]

Future research on AJF production scale-up

Evaluation of the environmental and economic impacts of AJF scale-up requires:

- Continued characterization of technology performance (process-based analyses), **and**
- Quantification of industry- or system-level impacts

A key challenge is understanding the relationship between the degree of AJF production scale-up, and aggregate impacts.

- Not necessarily linear

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