Project 80B: Hydrogen and Power-to-Liquid (PtL) Concepts for Sustainable Aviation Fuel Production

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October 15, 2025

This research was partially funded by the US Federal Aviation Administration Office of Environment and Energy through ASCENT, the FAA Center of Excellence for Alternative Jet Fuels and the Environment, project 80 through FAA Award Number 13-C-AJFE-MIT under the supervision of Ana Gabrielian. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the FAA.

Abstract: Electrification of SAF Production

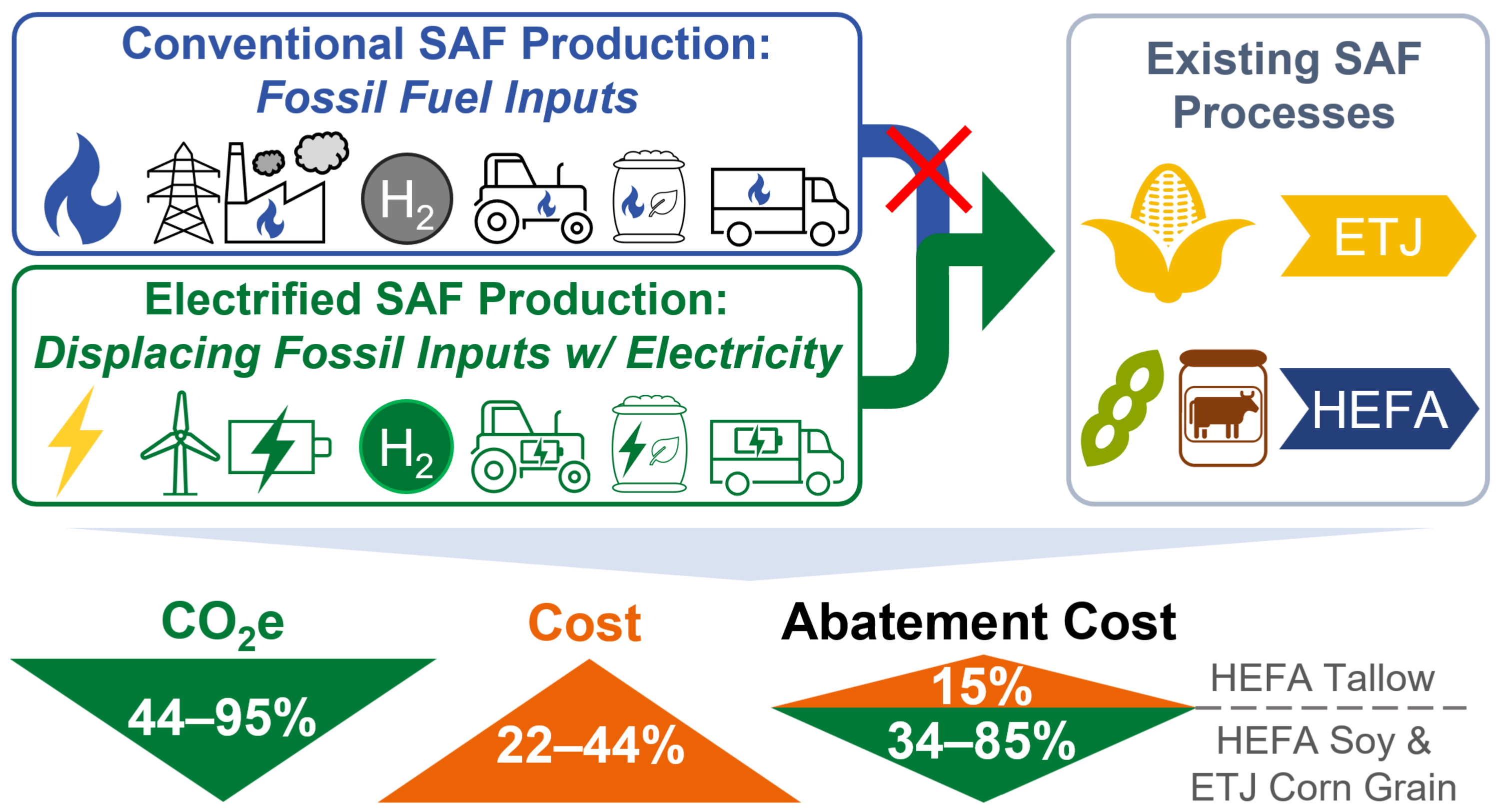

Figure 1: Conventional SAF Electrification reduces GHGs, increases cost, while abatement cost varies by pathway

- Electrification could replace fossil fuel use in carbon, hydrogen, heat, energy, and material sourcing for SAF production
- Three SAF production pathways analyzed (ETJ corn grain, HEFA soybean, HEFA tallow)
- Implications of electrification (using onshore wind with battery storage): **GHG reduction: 44–95%** | Cost increase: 22–44% | Abatement cost: -85–15%

Introduction: SAF Electrification Spectrum

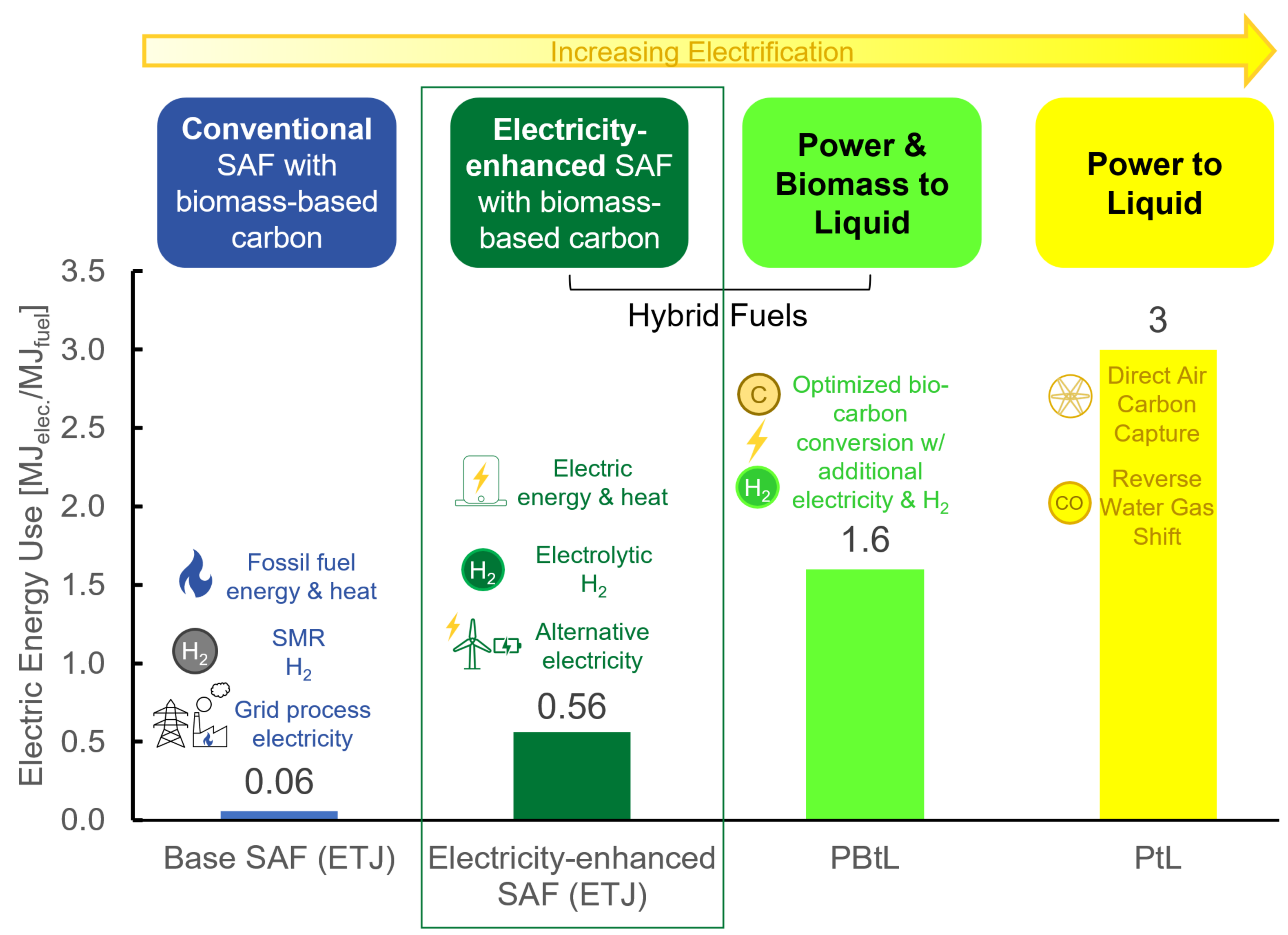

Figure 2: Spectrum of SAF electrification, with increasing electricity use from left to right for base SAF (example: ETJ), electricity-enhanced SAF, PBtL, and PtL.

- Conventional SAF production uses up to 3% of input energy as electricity
- Electrification discussion focused around PtL, which uses 54x more power than conventional SAF (→ 100% of input energy as electricity)
- *Electricity-enhanced SAF* uses 81% less power than PtL by relying on biomass as carbon source and part of hydrogen source
- Other studies, which partially electrify the supply chain, focus on either emissions or costs, or explore less technically mature SAF production pathways (2nd gen EtOH from lignocellulosic feedstock → SAF, syngas → EtOH → SAF)

Methods: Electrification Strategy

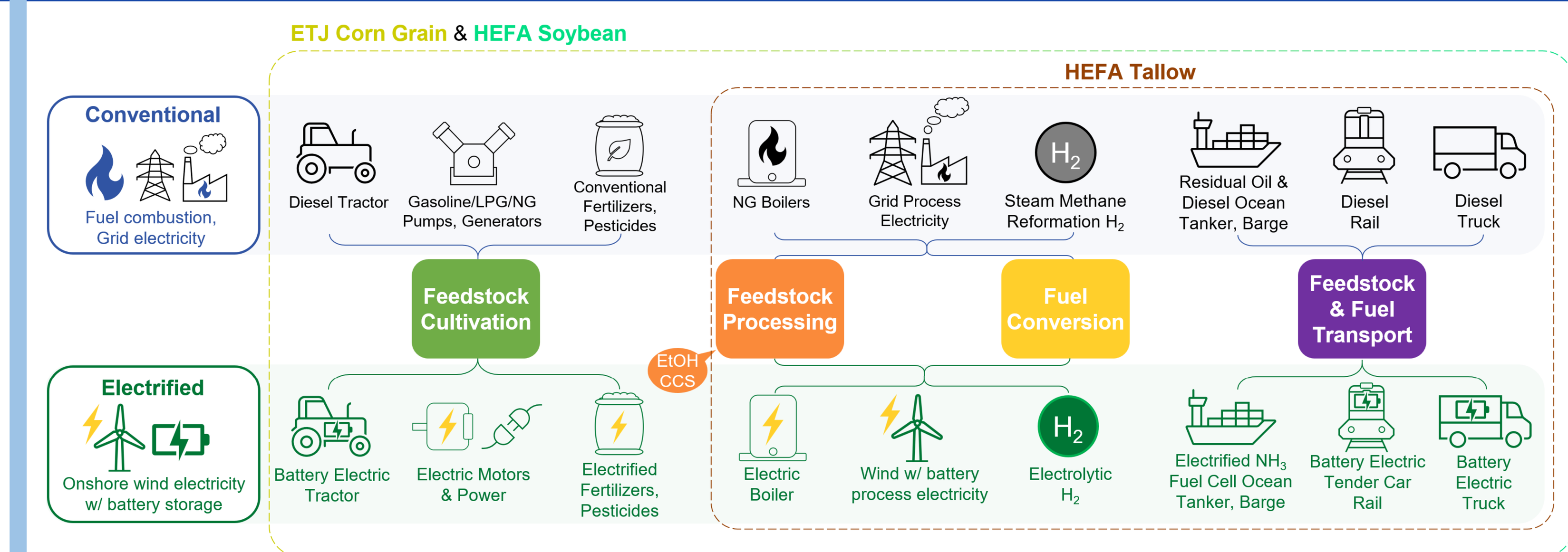

Figure 3: Spectrum of SAF electrification, with increasing electricity use from left to right for base SAF (example: ETJ), electricity-enhanced SAF, PBtL, and PtL.

- **LCA**: Energy allocation (ICAO-GREET), GWP-100 (IPCC AR-5), wind+batt.: $16gCO_2e/kWh$
- **TEA**: DCFROR (WSU), ~1GL/yr plant scale, onshore wind+batt.: $0.053/kWh

Results: LCA Value, MSP, Abatement Costs

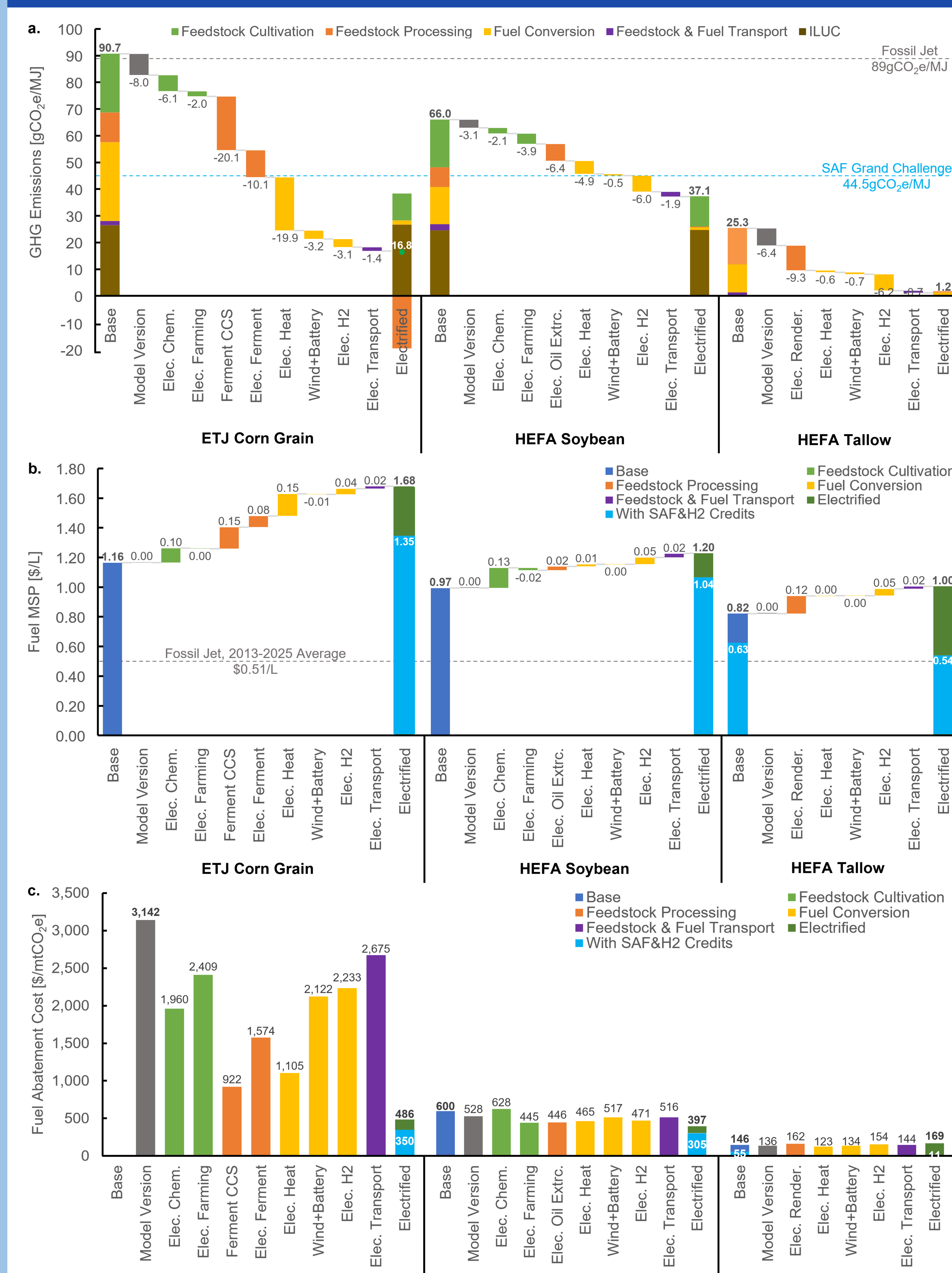

Figure 4: a) LCA value b) costs c) abatement costs of SAF electrification

Results: Sensitivity to Electricity Source

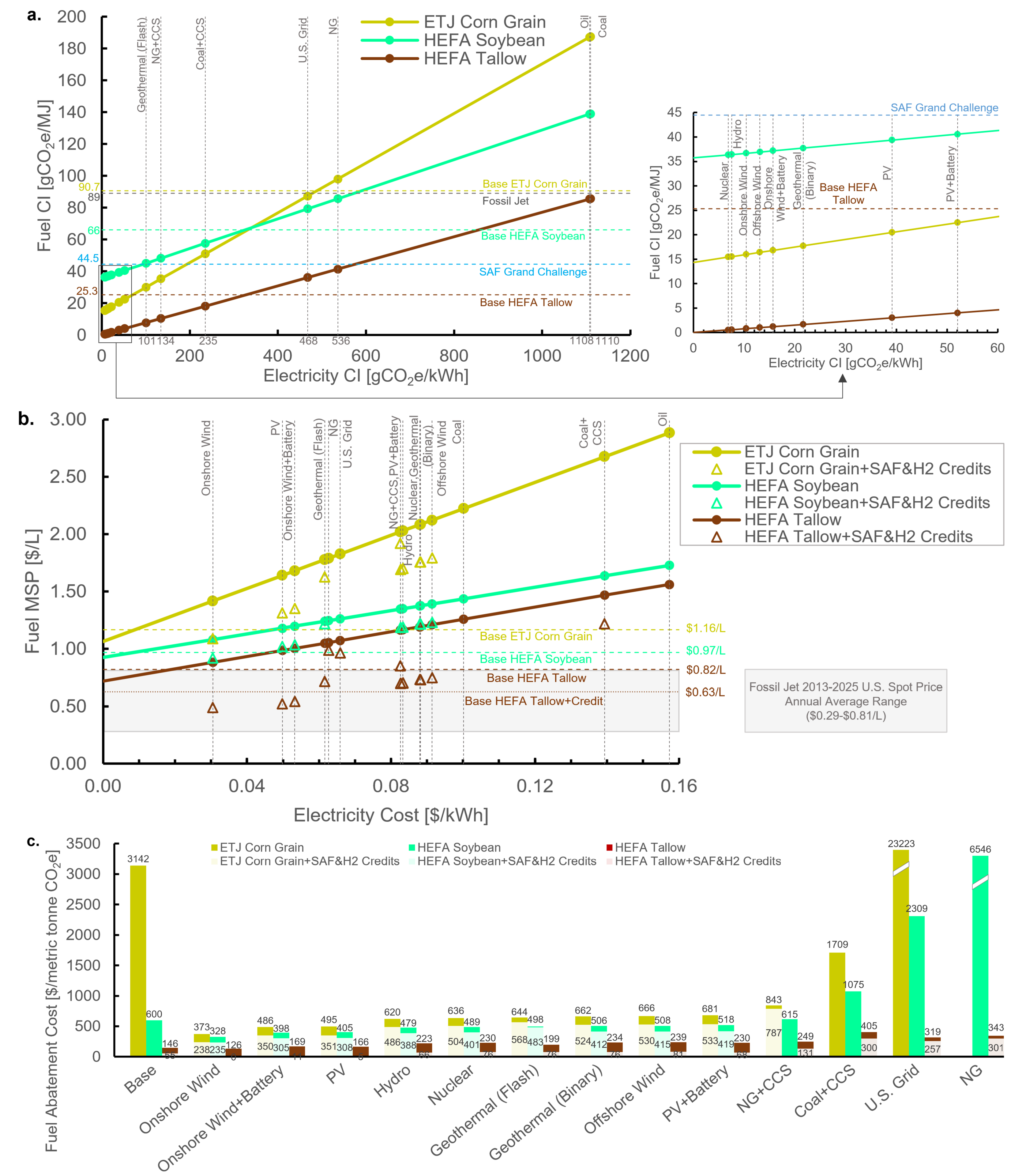

Figure 5: Sensitivity to power source of a) LCA value b) costs c) abatement costs of SAF electrification

LCA

- ETJ Corn: 82% GHG reduction from ETJ corn grain baseline. 97.5% capture of biogenic CO_2 from EtOH fermentation, and lower energy intensity by using 99.9% efficient electric heat instead of 80% efficient NG heat provide >60% of reductions.
- HEFA soybean: 44% GHG reduction from HEFA soybean baseline. Higher H_2 use → larger reduction using electrolysis
- *ILUC and N_2O emissions* for soybean (N fixation) and corn remain
- HEFA tallow: 95% GHG reduction from HEFA tallow baseline. Feedstock is by-product of animal slaughtering, no ILUC emissions → lower residual emissions compared to HEFA soybean and ETJ corn grain

TEA

- **Most effective decarbonization strategies are also the most expensive** (5.3¢/kWh for wind powered resistance heat, 1.8¢/kWh NG heat)
- Credits mitigate electrification cost impact to 7% (HEFA soy), 16% (ETJ corn grain), -14% (tallow)

Abatement Cost

- Largest GHG reduction strategies provide the largest reductions in abatement cost
- Not every step results in an abatement cost reduction for HEFA, due to high cost and low GHG savings (soybean fertilizer) or low base CI (HEFA tallow)

Sensitivities

- **Onshore wind (with or w/o battery) and PV provide largest GHG reductions at lowest cost**
- With credits, electrified HEFA tallow is within fossil jet cost range using low carbon power
- Fossil power sources with CCS only reduces abatement cost for ETJ corn grain