Evaluating Impacts of Sustainable Aviation Fuel Production with CO_2-to-Fuels Technologies on High Renewable Share Power Grids

Jiazi Zhang[1], Weijia Liu[1], Yijin Li[1], Ling Tao[1], Ella Zhou[1], Kwang Hoon Baek[2], Pingping Sun[2], Amgad Elgowainy[2]
[1.] National Renewable Energy Laboratory, Golden, Colorado, USA
[2.] Argonne National Laboratory, Lemont, Illinois, USA

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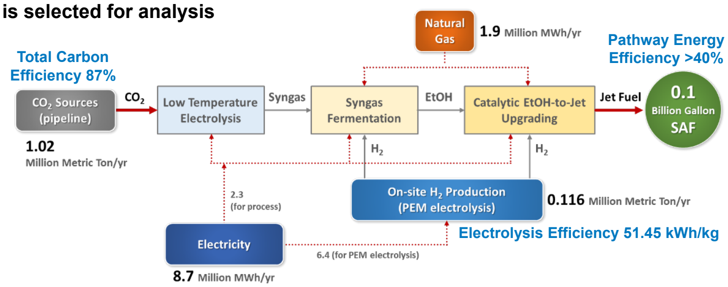
Motivation and Objective

- ❑ The aviation sector, a significant GHG emitter with technical and economic challenges in electrification, presents an opportunity for Sustainable Aviation Fuels (SAF) as a lower carbon alternative to fossil-based jet fuel.
- ❑ This study examines the effects of producing SAF using CO2-to-Fuels technologies on the future U.S. power grid. It focuses on the 2050 SAF production goal and its implications for generation, transmission, and costs.

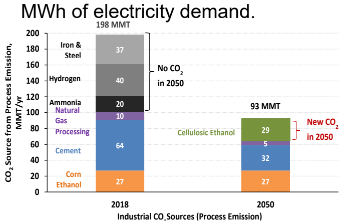
CO_2-to-SAF Pathway and Facility Design

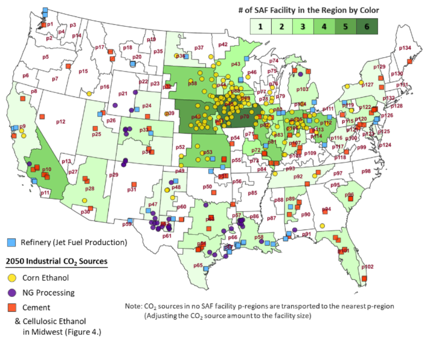
❑ Low temperature electrolysis-syngas fermentation-ethanol to SAF (LTE-SF-ETS) is selected for analysis



❑ **Grid Simulation for 2030 SAF Production**

- To meet this 27% SAF goal, 103 SAF facilities will be distributed near CO2 sources and modeled as inputs to the SAF demand model, requiring 793.2 MWh of electricity demand.





SAF Demand Model in Capacity Expansion Model

- ❑ **ReEDS uses system-wide least cost optimization to estimate future generation and transmission capacity**
- ❑ **SAF production involves:**
  - hydrogen electrolysis consumes electricity to produce hydrogen,
  - jet fuel fermentation and synthesis consume electricity, hydrogen, CO2, and heat to produce SAF,
- ❑ **Demand model constraints are documented→**

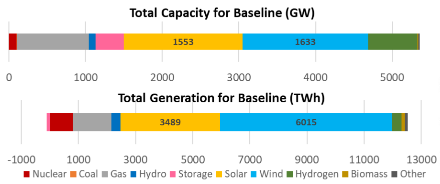
1. Electricity power consumption limit for SAF process & H_2 production
2. Hydrogen intake limit
3. Installed capacity and technical minimum constraint
4. Minimum capacity factor limit
5. SAF target requirement
6. Hydrogen mass flow constant
7. Hydrogen storage injection constraint
8. Hydrogen storage withdraw constraint
9. Storage facility capacity constraint

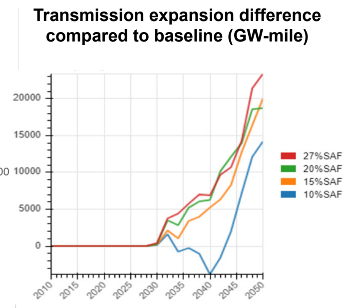
System Model and SAF Scenarios

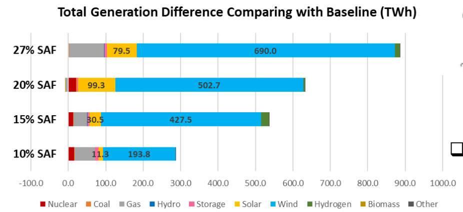
❑ **Four SAF demand scenarios for 2050 are evaluated, each built upon the ReEDS 2050 baseline scenario with different SAF production targets**

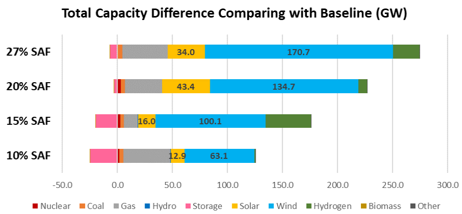
Core Scenarios	SAF Process E_{2050}^{SAF} (TWh/yr)	H_2 Electrolysis (MMT/yr)	H_2 Electrolysis E_{2050}^{SAF} (TWh/yr)	CO_2 Capture and Compression (TWh/yr)
27% SAF	213	11	588	12
20% SAF	158	8	436	9
15% SAF	119	6	327	7
10% SAF	79	4	218	5

Results and Conclusions









❑ **The study concludes that increasing SAF production via CO2-to-Fuels technologies will raise electricity demand, generation and transmission capacities, and system costs, but these impacts are LIKELY manageable and highlight the VALUE OF integrating carbon capture technologies into power system planning for sustainable energy solutions.**

Comparison of baseline and 27% SAF scenarios.

	Baseline	27% SAF	% Change
Electricity Demand (TWh)	12,413.6	13,298.4	+7.13%
Generating Capacity (GW)	5,688.9	6,072.8	+6.74%
New Transmission Buildout (GW-mi)	421,813	445,217	+5.55%
Total System Cost (Bil $)	4,739.9	4885.8	+3.08%

Disclaimer

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