

FAA CENTER OF EXCELLENCE FOR ALTERNATIVE JET FUELS & ENVIRONMENT

Impact of Proposed Sustainable Skies Act on Sustainable Aviation Fuel Minimum Selling Price

Project 001

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1. Analysis Overview

- Open-source, harmonized Techno-Economic Analysis (TEA) tools
- Assumptions
- Conversion Pathways and Feedstock Combinations
- Feedstock Limitations

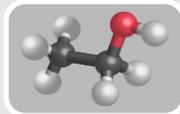
2. Impact of Incentives:

- Incentive Scenarios
- SAF vs. Diesel
- Technology Readiness

3. Take Away Points

1. Factored Techno-Economic Analysis (TEA) methodology
 - Estimates CAPEX requirements to +/- 30%
 - Assumes a mature, nth plant values unless otherwise stated.
 - Geo-specific OPEX variables (electricity, natural gas, feedstock price) set to average USA values
 - Minimum Selling Price (MSP) at the production facility is computed to achieve a real discount rate of 10% and an NPV of zero.
2. The existing diesel BTC was applied to diesel distillates that are produced with the SAF.
3. SAF MSP values are compared to wholesale jet A prices for 2011-2020.
4. The Carbon Intensity (CI) scores are average values from CORSIA, individual sources/facilities will have unique values than will impact incentives and thus MSP.

Conversion Pathways and Feedstock Combinations Considered

Process	Feedstock					
	FOGs	Vegetable Oil	Ag Residue	MSW	Forest Residue	Alcohol
HEFA						
GFT						
ATJ						

HEFA – hydroprocessed esters and fatty acids

GFT – gasification Fischer Tropsch

ATJ – alcohol to jet

FOGs – waste fats, oils and greases

MSW – municipal solid waste

EtOH – corn ethanol

2G EtOH – second generation, cellulosic ethanol

Incentive Assumptions



Incentives Duration

- SAF BTC is applied for 10 years unless otherwise stated
- diesel BTC assumed to be renewed and applied for 10 years for the diesel distillate fraction unless otherwise stated
- RINs are assumed to be available for the life of the plant
- LCFS is assumed to be available for the life of the plant

Incentive Values

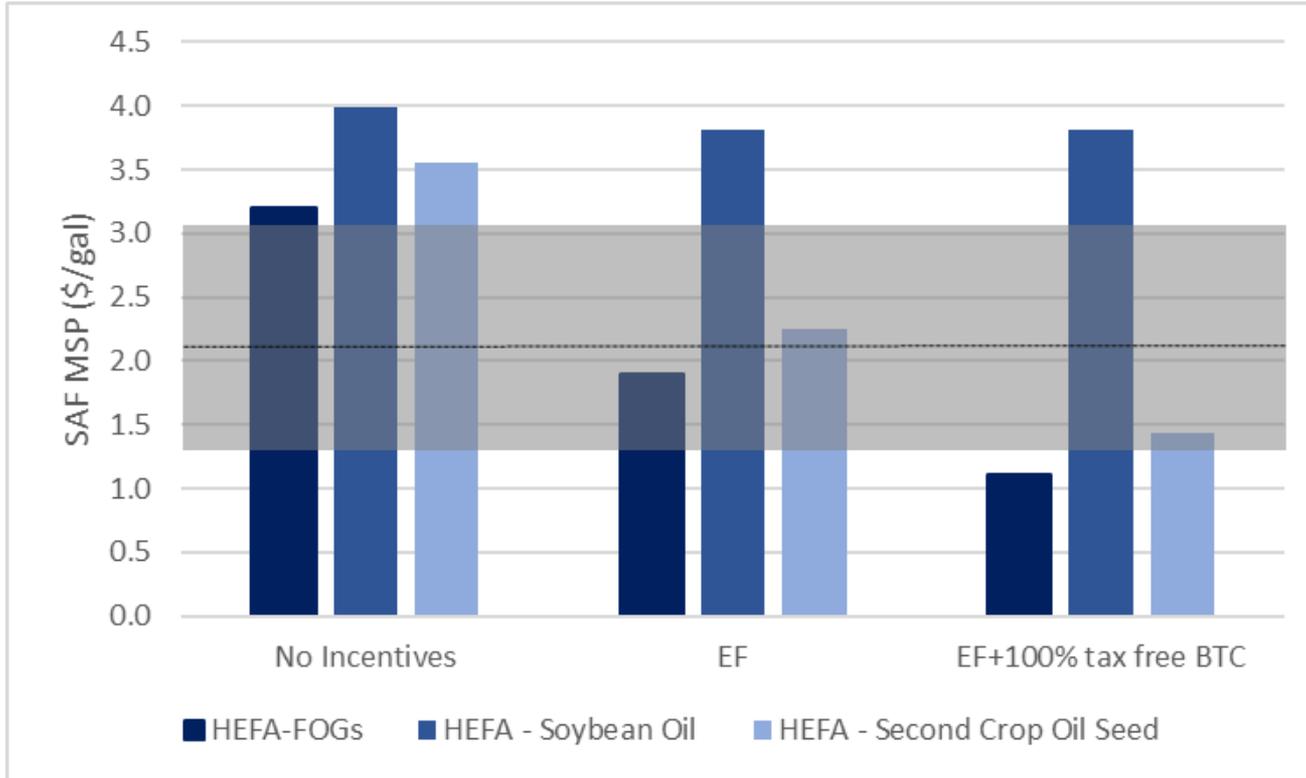
- RINs and LCFS increase by inflation rate
- BTC values do not change over time,
 - diesel = \$1/gal
 - SAF = \$1.5-\$2/gal based on CI score
- RINs are 2014-2021 average
- LCFS – weighted average 2013-2020

Incentive Scenarios



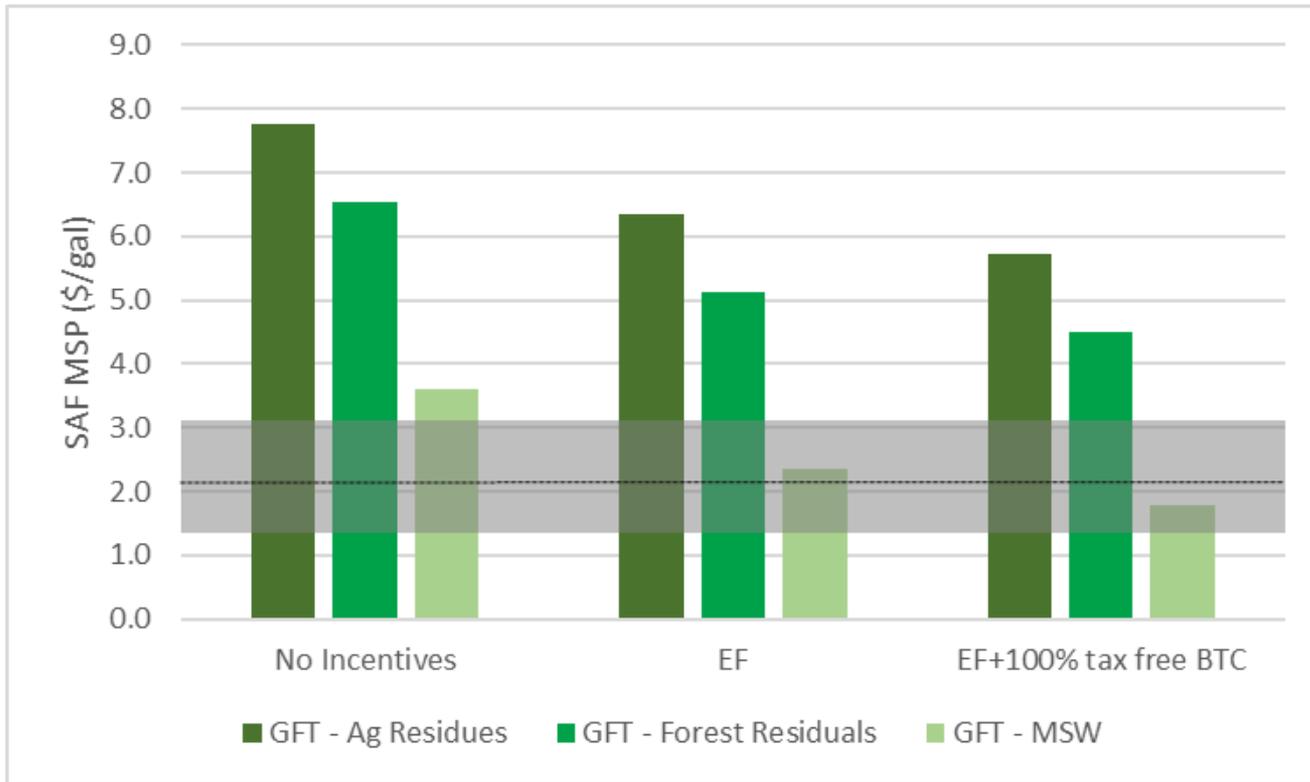
- EF = Existing Federal Incentives = RINs and diesel BTC
 - Assumed base scenario
- EF + proposed SAF BTC (\$1.5-\$2.0/gal tax free)
 - This models a scenario where producers are blenders
- EF + a portion of the proposed SAF BTC, taxable
 - 90%, 80% or 70% taxable is used to model possible BTC sharing that will occur when producers and blenders are separate entities
- EF + proposed SAF BTC with 3 incentive durations
 - 5-years is an estimated amount of the proposed 10-year incentive that a company could receive if they started the process of building a plant today (i.e. 5-year construction time)
 - 10-years is the maximum a company could get if they have a facility that could make SAF now
 - 20-years is the modeled plant life

HEFA (Hydroprocessed Esters and Fatty Acids)



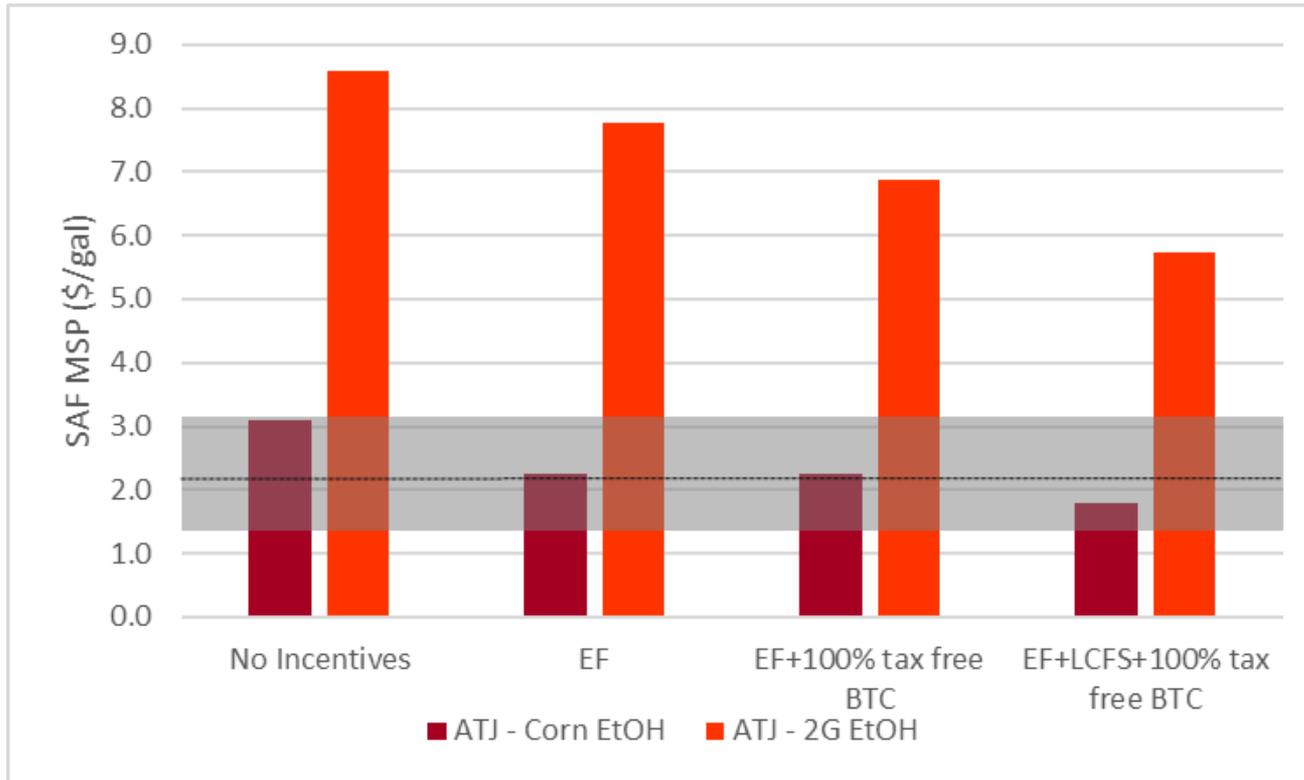
For HEFA, the SAF made with FOGs has an MSP below the average wholesale jet fuel price with the EF incentives, **however, FOGs have limited availability to meet production requirements.** HEFA is likely economical with a second crop oil seed, but long-term financials will need to be convincing for farmers to add a new cropping cycle. Soybean is not viable economically nor does it meet CI reductions.

GFT (Gasification Fischer-Tropsh)



The GFT pathway for SAF requires more than the EF incentives (RINs + diesel BTC) to have the MSP meet the average wholesale jet fuel price for all three feedstock options. Conversion of MSW is the most viable given the BTC.

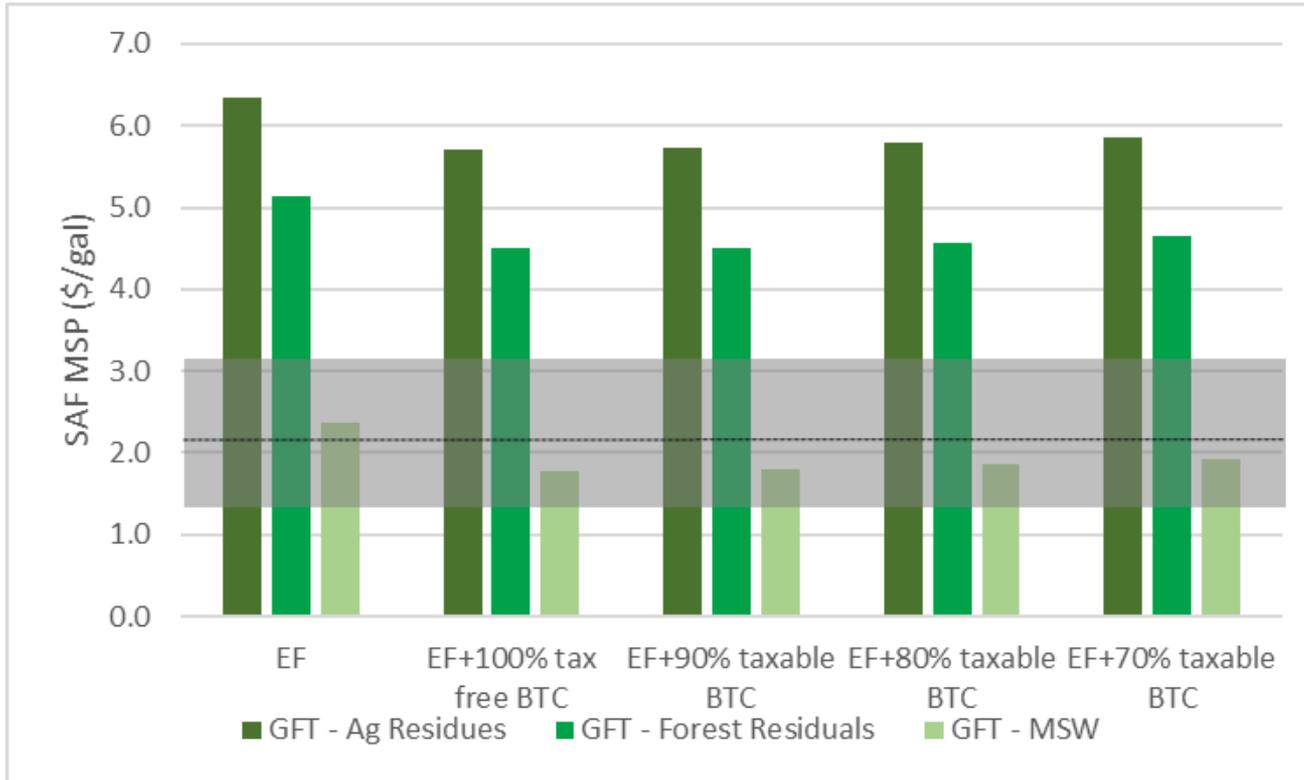
ATJ (Alcohol to Jet)



Price parity range for wholesale petroleum jet 2011-2020, EIA
 Average SAF price parity with wholesale petroleum jet 2011-2020, EIA

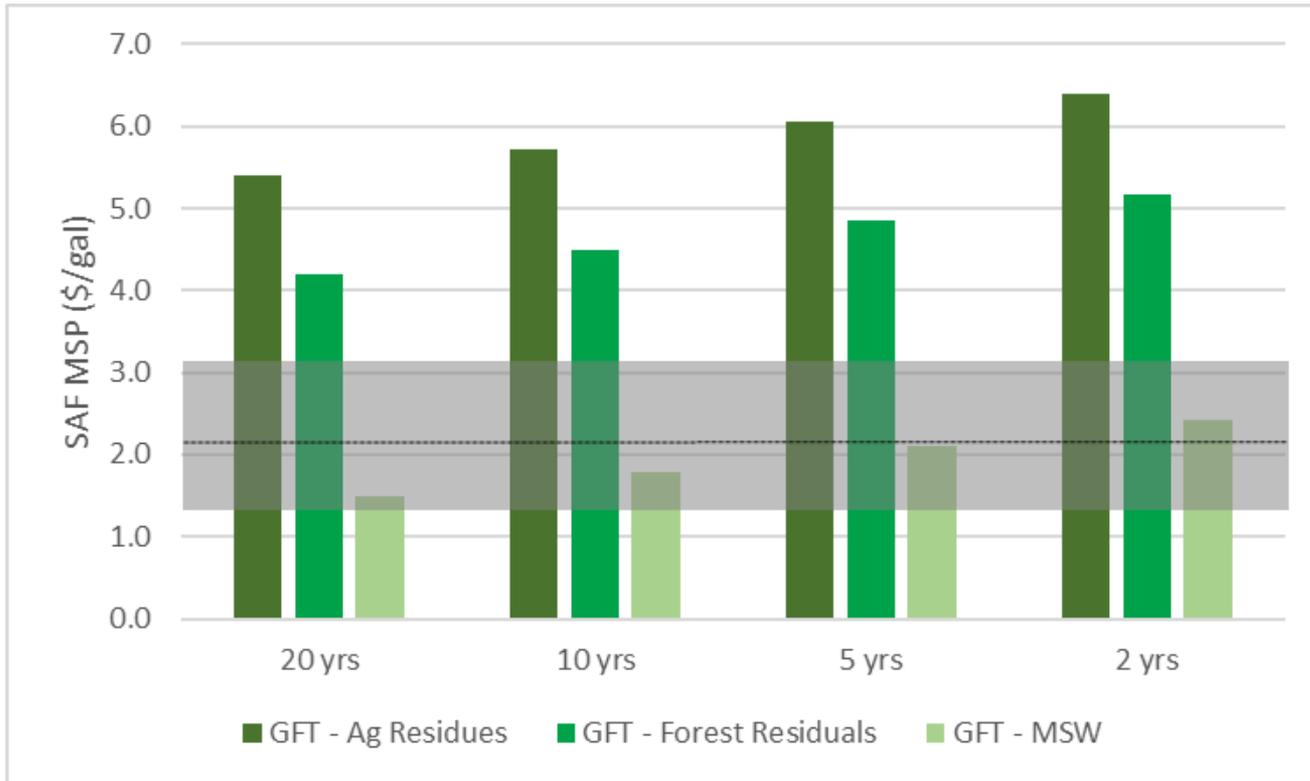
The ATJ pathway for SAF with corn ethanol does not meet the CI reduction requirement for the SAF BTC using the CORSIA CI score. Individual corn ethanol facilities may meet the standard. Second generation ethanol prices reflect low volumes and demand; lower SAF MSP is anticipated over time.

Shared BTC, GFT case study



Sharing the BTC between blender and producer increases MSP by about \$0.15/gal from the 100% tax free scenario to 70% taxable scenario.

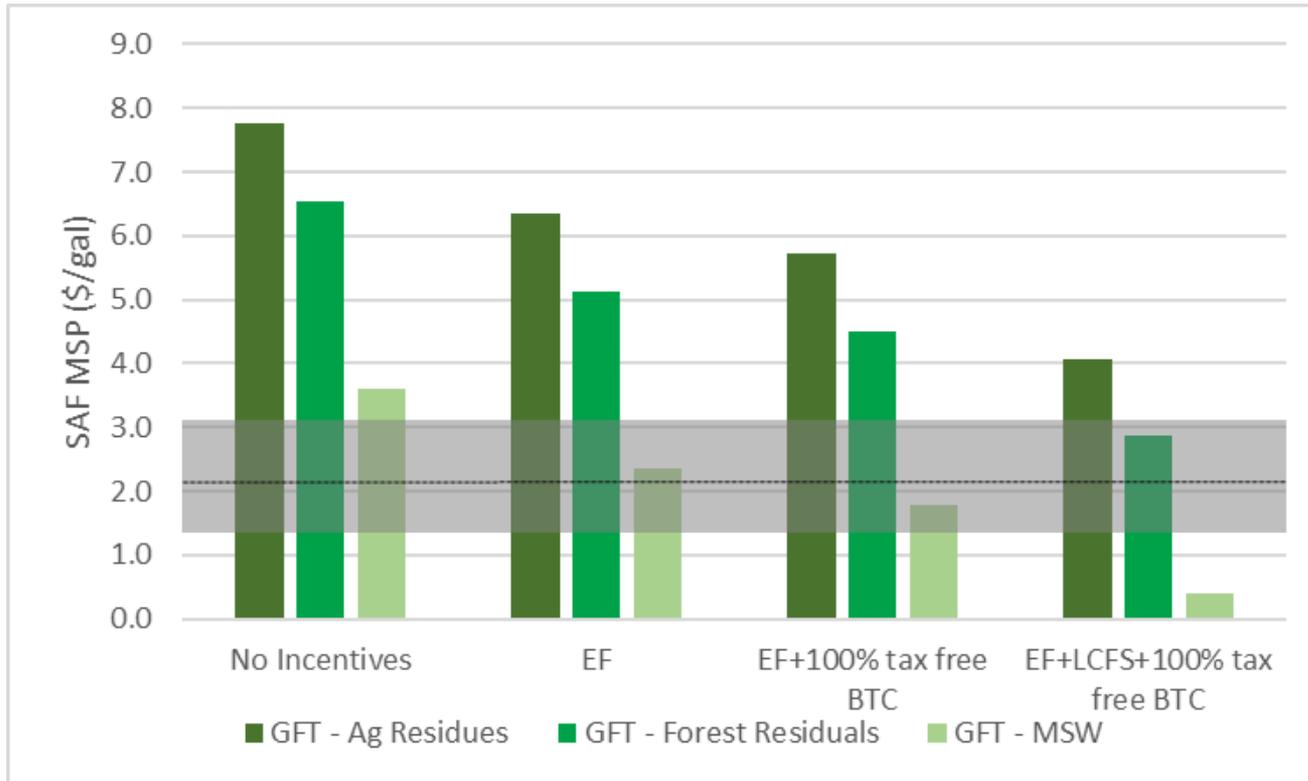
Incentive Duration, GFT case study



Price parity range for wholesale petroleum jet 2011-2020, EIA
Average SAF price parity with wholesale petroleum jet 2011-2020, EIA

The duration of the BTC program significantly influences financials when modeled from 2-year to 20-years. All data includes EF and 100% SAF BTC and diesel BTC for the duration on the x-axis.

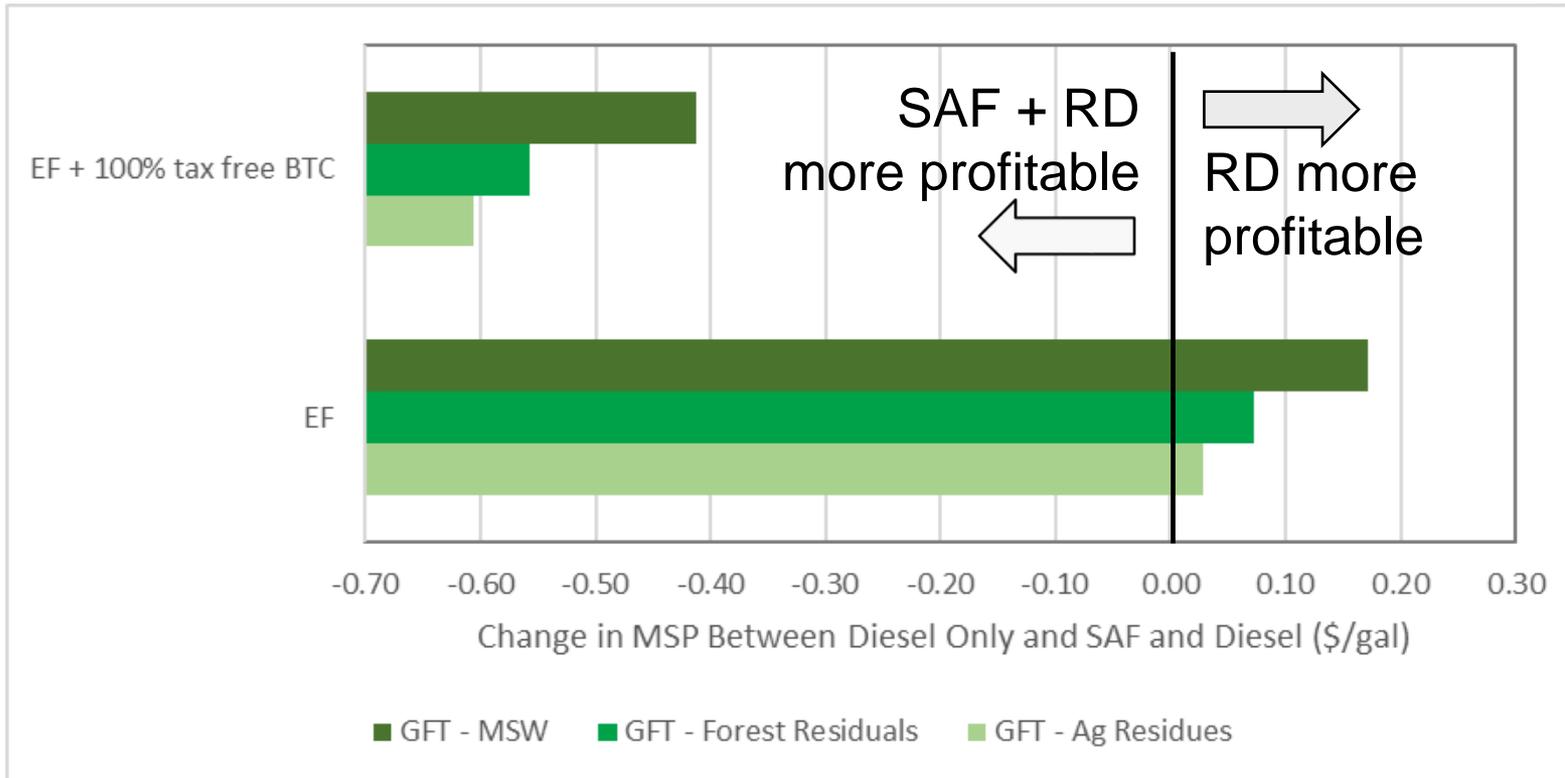
State Incentives, GFT case study



Price parity range for wholesale petroleum jet 2011-2020, EIA
 Average SAF price parity with wholesale petroleum jet 2011-2020, EIA

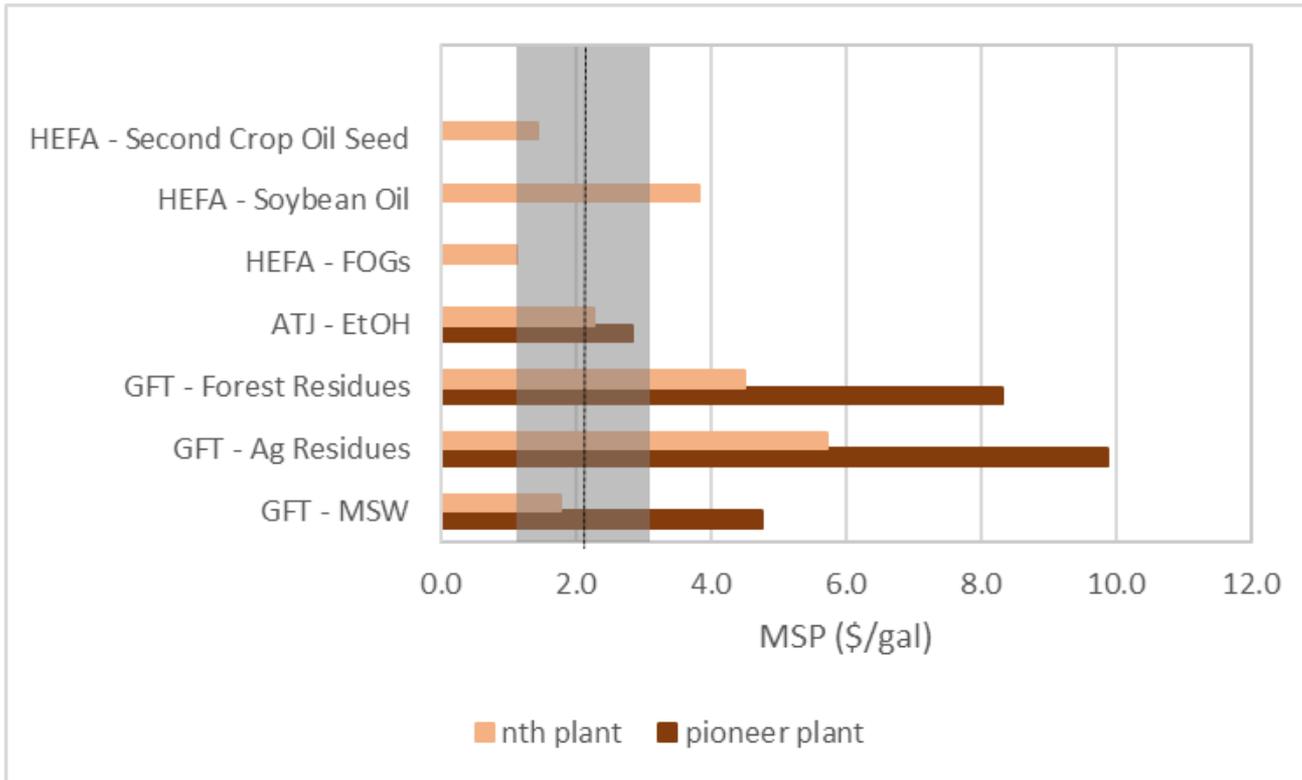
SAF volume will first go to California (LCFS – used in this analysis) and Oregon (CFP – values similar to LCFS) before being sold into markets that have only federal incentive programs. WA could also attract volumes in the future depending on how the new Clean Fuel Standard is implemented. Note: Cap and trade not included in this analysis.

Diesel or SAF, GFT case study



A 100% tax free BTC for SAF would have significant impact on profitability for producing SAF. With only the existing federal incentives, diesel is more profitable. This result is exacerbated for states with incentives that favor diesel (e.g. the cap and trade in CA). For existing RD facilities, additional capital and operating costs will likely be required to produce SAF.

Technology Readiness



Price parity range for wholesale petroleum jet 2011-2020, EIA
 Average SAF price parity with wholesale petroleum jet 2011-2020, EIA

Price parity is more difficult for technologies that are not mature.
 Note: Data is for EF + 100% BTC tax free for 10 yrs.

Take Away Points



- Adding the SAF BTC to existing federal incentives will allow HEFA produced with FOGs and second-crop oilseeds to be competitive with conventional.
- However, FOG availability is insufficient to meet even a fraction of national needs and second-crop oilseed adoption by farmers have yet to be proven.
- With existing incentives, it is more profitable to produce RD only. Adding the SAF BTC would incentivize the shift to producing both SAF + RD.
- Only large producers will have the capital to blend SAF, so smaller producers will likely need to sell neat SAF to blenders, share the value of the BTC, and be taxed on their portion.
- After FOGs are depleted, the SAF BTC will be needed incentivize other technologies with less production history.

Definitions



n^{th} plant – facility that has technology that has been successfully deployed at multiple other locations, aka mature technology.

Pioneer plant - first or near first of a kind facility

SAF – sustainable aviation fuel

MSP – minimum selling price

BTC – blender's tax credit

CI – carbon intensity

LCFS – low carbon fuel standard – California

CFP – clean fuels program - Oregon

RINs – RFS renewable identification numbers

RFS – renewable fuel standard