AJF Deployment Scenarios – ASCENT/ FTOT/ BSM Collaboration

FAA Project Manager: Nathan Brown

Volpe The National Transportation Systems Center

Advancing transportation innovation for the public good

U.S. Department of Transportation
Office of the Secretary of Transportation
John A. Volpe National Transportation Systems Center

Objective

- Analysis focused on two questions:

    1) How much AJF can be produced and how soon?

    2) What is the likely geospatial distribution of feedstock and fuel production and AJF delivery?

Scenario Elements

- Included ASTM-approved pathways: HEFA, FT, and ATJ
  - Experience with AJF production has shown that there is a significant lag prior to commercialization after approval
  - TEA data and product slates from A01 Research
- Feedstocks evaluated (projected to 2030 for FTOT analysis)
  - Waste fats, oils and greases – HEFA
  - Municipal solid waste (MSW) – FT
  - Woody residues – FT or ATJ
  - Agricultural residues – ATJ

Modeling Approach

- ASCENT Research
  - Product slates/efficiency
  - Technoeconomics
  - Feedstock availability scenarios

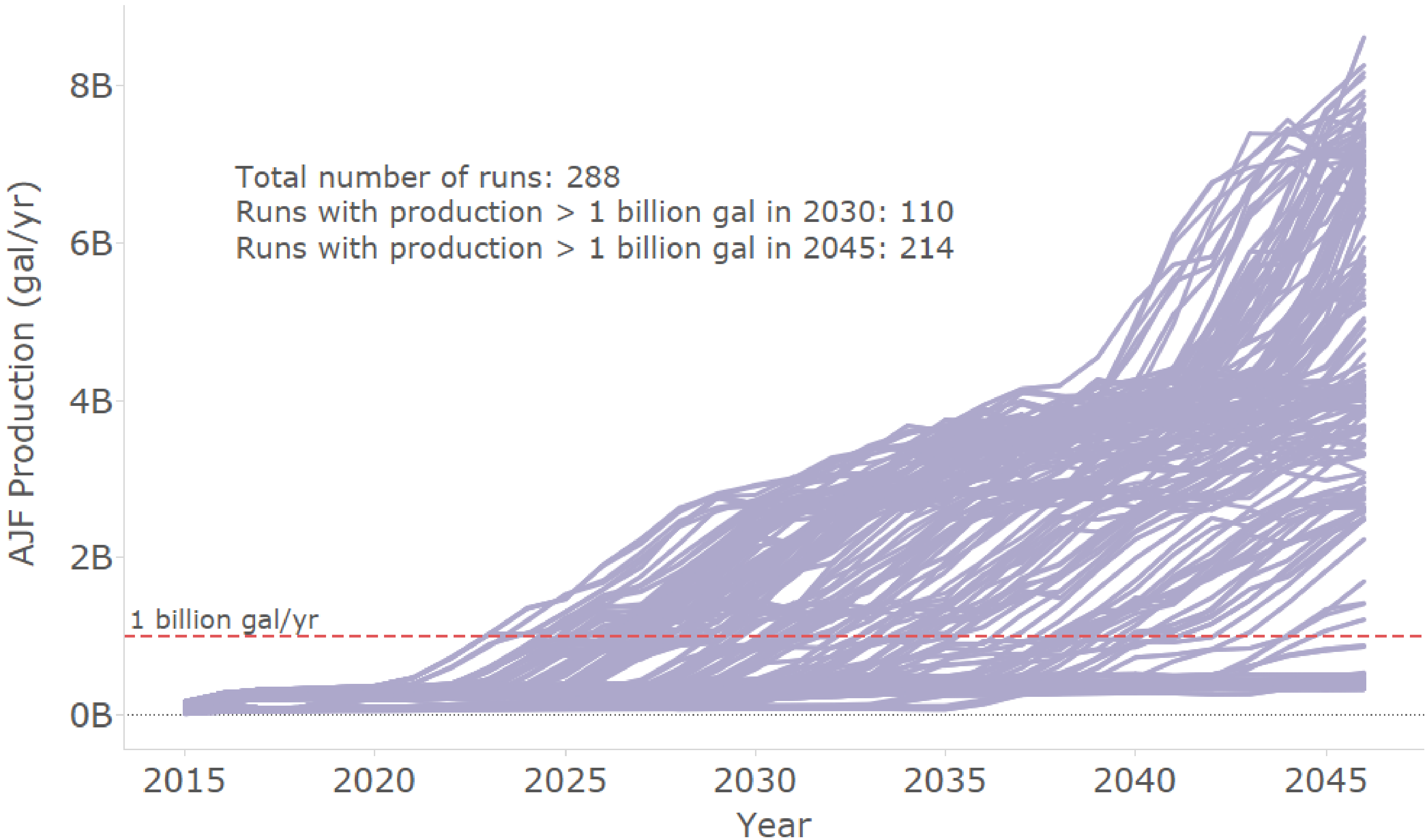
- National Renewable Energy Laboratory (NREL) Biomass Scenario Model (BSM)
  - System dynamics modeling of influence of incentives on deployment trajectories from 2017-2045

- Volpe Center Freight and Fuel Transportation Optimization Tool (FTOT)
  - Optimal geospatial patterns of transport and delivery in 2030

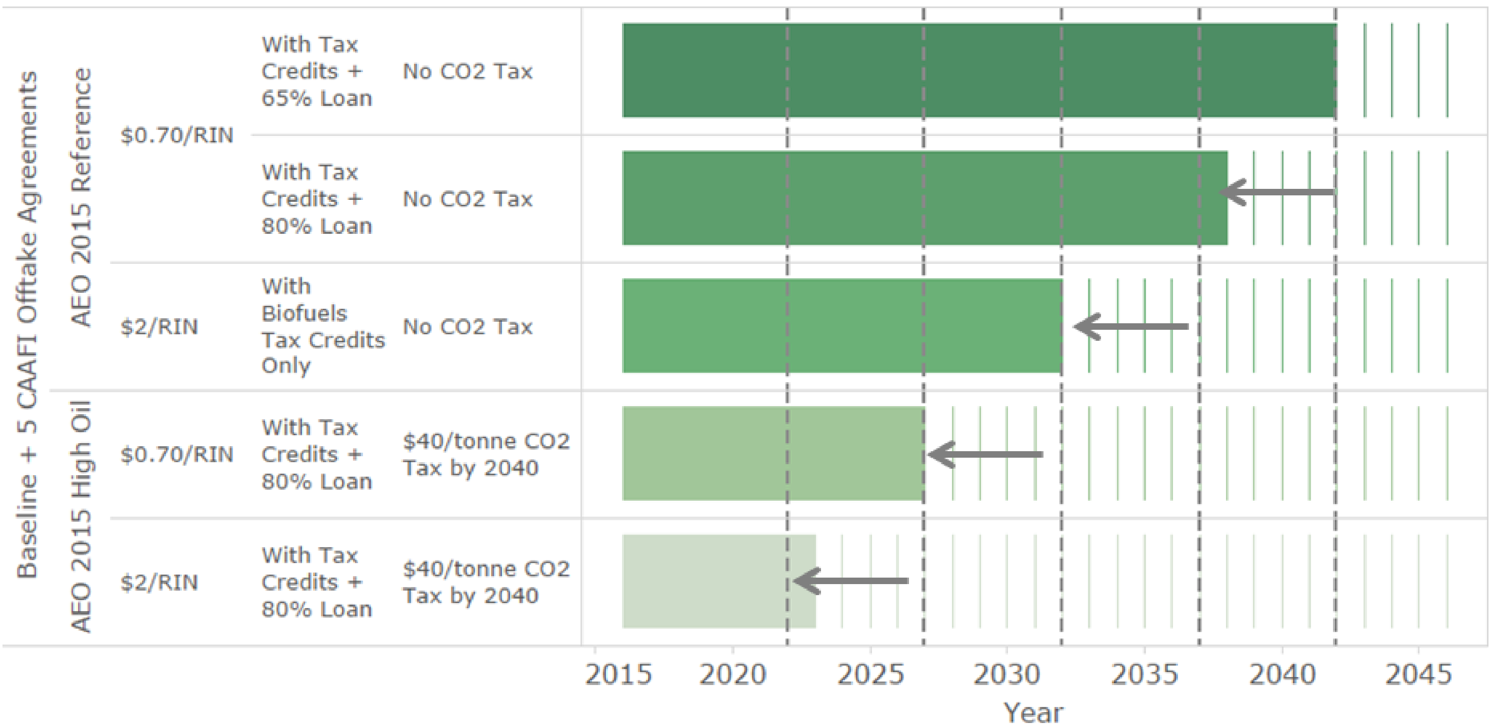
BSM Incentives Scenarios

Factor	Baseline	Variation 1	Variation 2
Production tax credit	Extension for first 1 billion gallons cumulative production ($1/gal for HEFA, ATJ, and FT)	No tax credit	No other variations
Loan guarantee	65% loan guarantee available for first 250 million gallons of cumulative production (e.g., oil to hydrocarbon)	80% loan guarantee available for first 250 million gallons of cumulative production	No loan guarantee
Renewable Identification Number (RIN) prices*	$0.70/RIN	$2/RIN	
CO_2 tax	No CO_2 tax	CO_2 tax starts at $13/tonne and increases to $40/tonne by 2040	CO_2 tax starts at $13/tonne, increases to $140/tonne by 2040
Offtake agreements***	5 CAAFI offtake agreements	No offtake agreements	No other variations
Oil prices	Annual Energy Outlook (AEO) (EIA 2015) 2015 - reference case	AEO 2015 - high oil price case	No other variations

38% of scenarios result in more than one billion gallons in 2030



BSM – Combined incentives required to reach a billion gallons by 2030



ASCENT Feedstock Projections

Feedstock Available in 2030	Data Source	Data Details	Scenario-specific proportion of feedstock available for conversion	
			Low	High
Waste FOG	Adapted from inedible waste animal fat rendering data	Animal inventory per acre of farmland, county level. Only includes inedible FOG.	30%	50%
MSW	Adapted from EPA (2013) and World Bank (2025) per capita values adjusted to 2030	Per capita applied to population, county level. Excludes already recycled, composted, or not convertible	30%	50%
Forest residues	Land Use and Resource Allocation (LURA) modeling	FIA points, aggregated to county level; Average of 20 years based on market.	30%	50%
Crop residues	POLYSYS modeling by University of Tennessee	County level	Avail. @ $50/dry ton	$60/dry ton

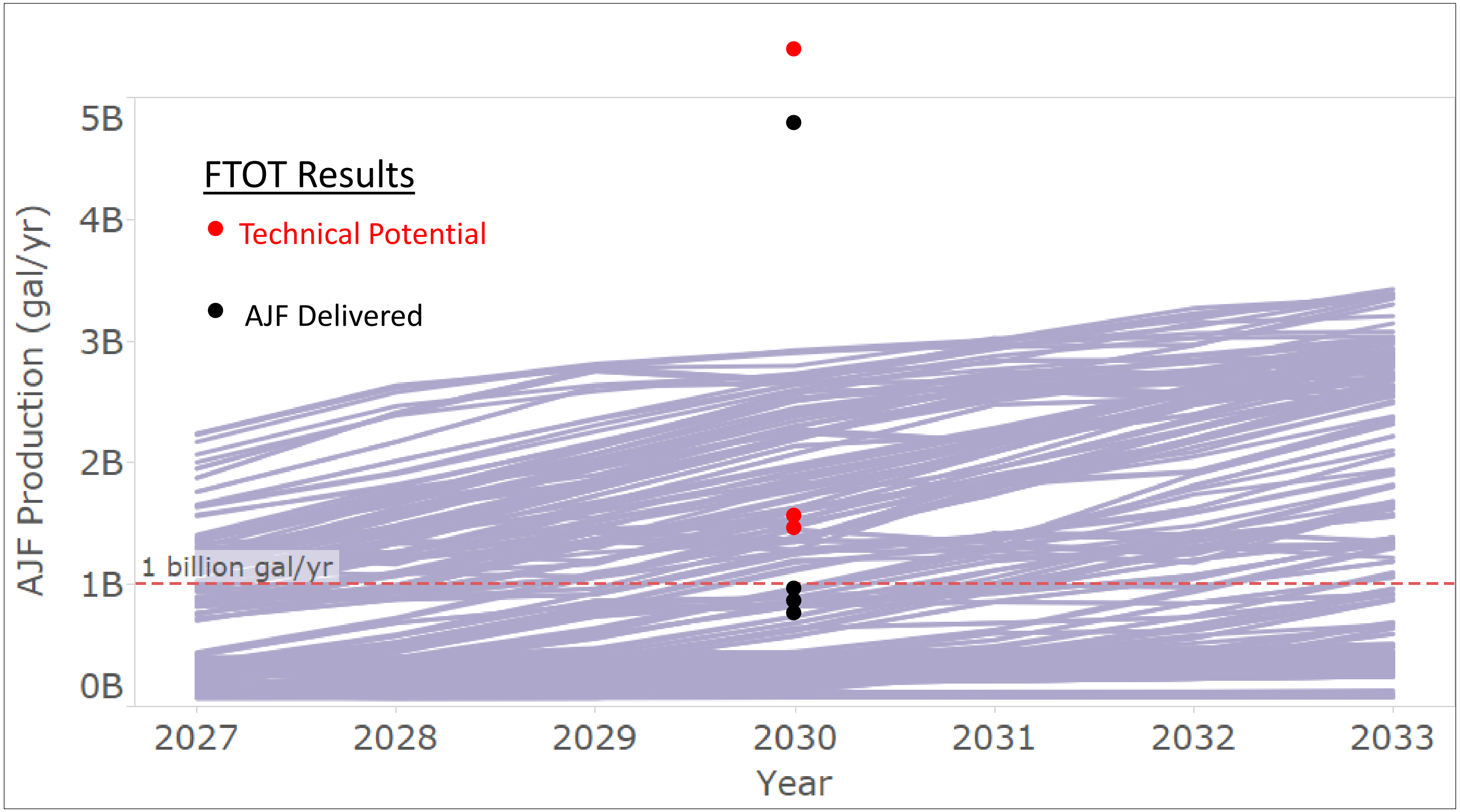
FTOT Feedstock and Incentive Scenarios

Scenario	Feedstock technology match	Jet Fuel Tech. Potential (Bgal)	Incentive ($/gal)
1: Low Feedstock/ low incentive	HEFA – FOG ATJ – crop res. FT – MSW & forest res.	1.47	0.65
2: Low feedstock, mid incentive	HEFA – FOG ATJ – crop res. FT – MSW & forest res.	1.47	1.25
3: Low feedstock, high incentive	HEFA – FOG ATJ – crop res. FT – MSW & forest res.	1.47	2.50
4: Low feedstock, low incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	1.58	0.65
5: Low feedstock, mid incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	1.58	1.25
6: Low feedstock, high incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	1.58	2.50
7: High feedstock, high incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	5.5	2.50

FTOT Feedstock and Incentive Scenarios

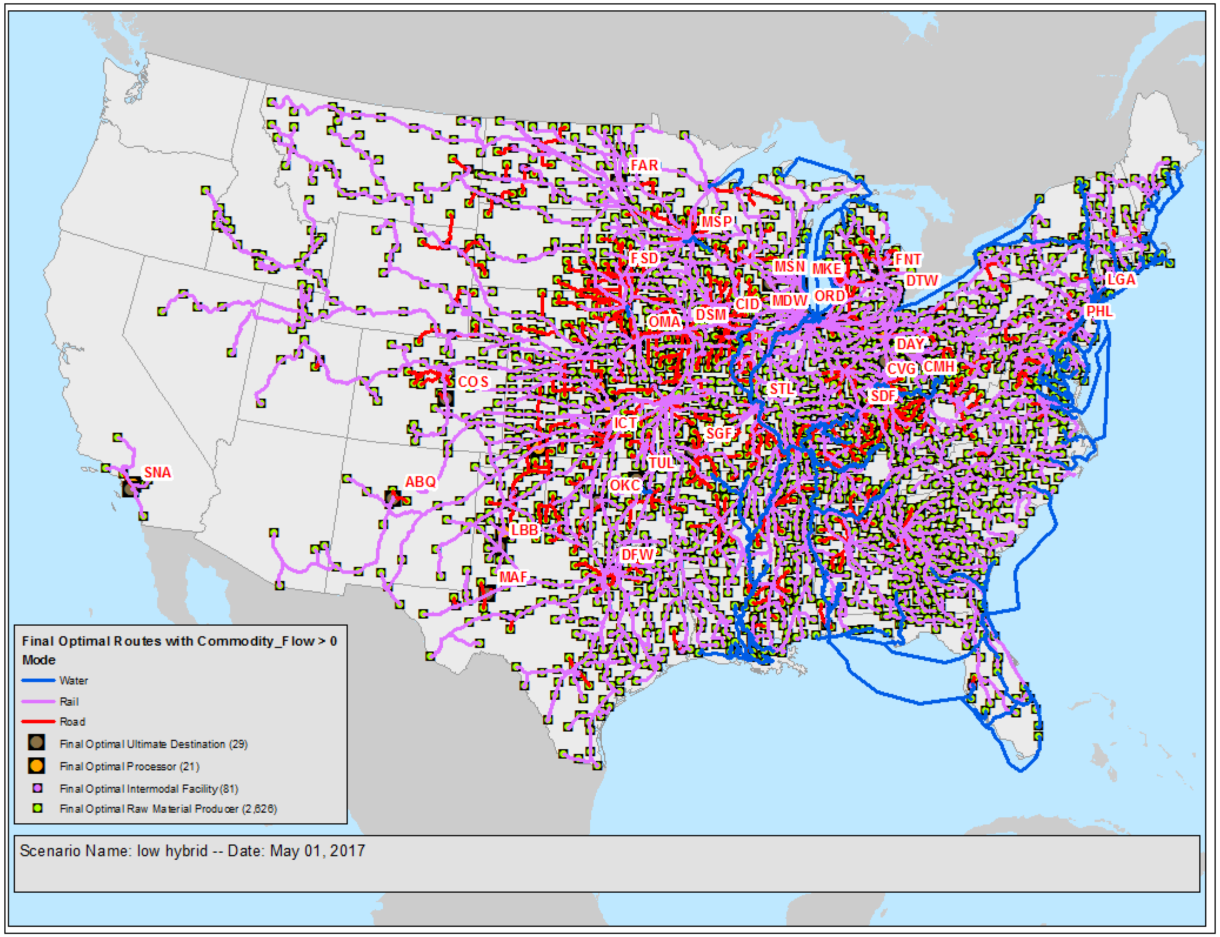
Scenario	Feedstock technology match	Jet Fuel Tech. Potential (Bgal)	Incentive ($/gal)	Feedstocks Used	Number of biorefineries by process	Airports Receiving Delivery	AJF Delivered in 2030 (Bgal)
1: Low Feedstock/ low incentive	HEFA – FOG ATJ – crop res. FT – MSW & forest res.	1.47	0.65	Crop res.	ATJ - 12	26	**0.64**
2: Low feedstock, mid incentive	HEFA – FOG ATJ – crop res. FT – MSW & forest res.	1.47	1.25	Waste FOG, crop res.	HEFA – 2 ATJ - 13	24	**0.73**
3: Low feedstock, high incentive	HEFA – FOG ATJ – crop res. FT – MSW & forest res.	1.47	2.50	Waste FOG, crop res., MSW	HEFA – 2 ATJ – 14 FT – 5	29	**0.92**
4: Low feedstock, low incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	1.58	0.65	crop and forest res.	ATJ - 29	45	**0.84**
5: Low feedstock, mid incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	1.58	1.25	Waste FOG, crop & forest res.	HEFA – 2 ATJ – 27	47	**0.9**
6: Low feedstock, high incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	1.58	2.50	All	HEFA – 3 ATJ - 32 FT - 2	51	**1.0**
7: High feedstock, high incentive	HEFA – FOG ATJ – crop & forest res. FT – MSW	5.5	2.50	All	HEFA – 4 ATJ – 72 FT - 9	119	**4.8**

BSM and FTOT Results Comparison



- FTOT results for low feedstock availability are well within BSM results
- High feedstock availability scenario exceeds BSM results

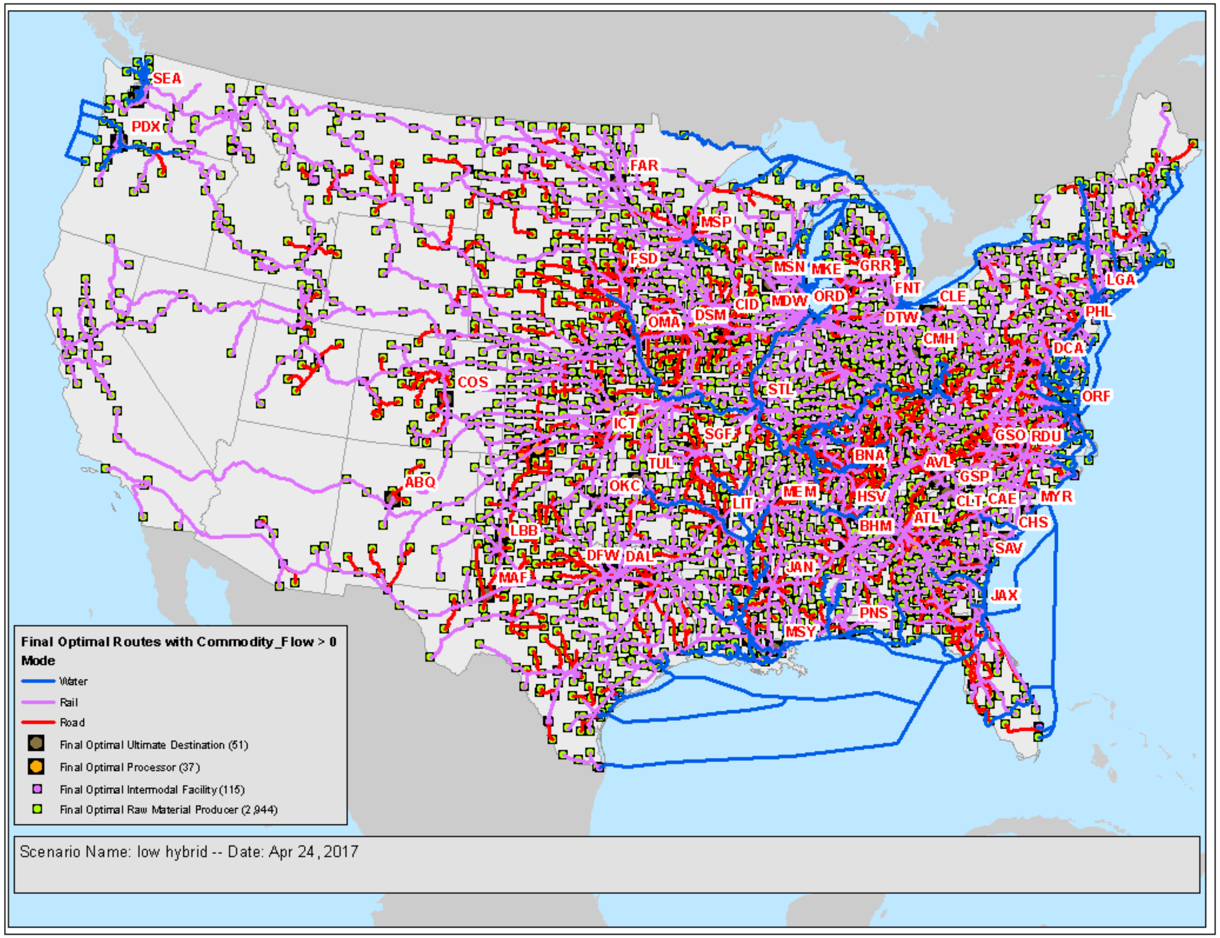
FTOT Geographic Results



- ATJ – crop residues only, FT – MSW, forest residues
- Low incentive → ATJ only
- Mid incentive → ATJ, HEFA
- High incentive → ATJ, HEFA, FT
- Increasing incentive → expanded feedstock draw
- Primary mode - rail. Pipeline largely unavailable near ATJ

Average Transport Cost = $0.69-0.84/gal

FTOT Geographic Results



- ATJ – crop and forest residues, FT – MSW only
- Low incentive →ATJ only
- Mid incentive →ATJ, HEFA
- High incentive →ATJ, HEFA, FT
- Increasing incentive → expanded feedstock draw
- Primary mode - rail. Pipeline largely unavailable near ATJ

More use of CA and Pacific NW feedstocks

Average Transport Cost = $0.66-0.87/gal

Conclusions

- A billion gallons per year of AJF production in 2030 is possible
  - Will require a combination of incentives to achieve a billion gallons or more
  - Waste feedstocks (crop residues) are likely to be drawn from Midwest first if existing ethanol facilities can be repurposed to ATJ
  - Pipeline infrastructure may not be ready for drop-in fuels production in Midwest

- Models can inform each other to improve future analyses
  - FTOT uses *n*th plant/fixed efficiency – BSM could output an estimated efficiency for a particular year based on scenarios and maturation curve
  - BSM uses averaged/generalized transportation costs – FTOT could better inform values
  - Other alignments internally could enhance understanding of the drivers of future industry trajectories

Acknowledgements

- Analysis Team:
    - BSM – Emily Newes, Steve Peterson
    - FTOT – Kristin Lewis, Matthew Pearlson, Emily Lawless, Gary Baker, Alex Oberg, Olivia Gillham, Scott Smith
    - WSU – Mike Wolcott, Kristin Brandt, Dane Camenzind
- Project Managers:
    - Nate Brown, FAA
    - Alicia Lindauer (current) and Zia Haq, DOE
- Thanks to:
    - Burt English, Univ. of TN Knoxville (POLYSYS crop residue modeling)
    - Greg Lata, Oregon State Univ. (LURA modeling)