SAF Development and Deployment Update

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CAAFI - Public/Private Partnership

A reflection of the 26+B gallons/year U.S. Jet "market pull"

CAAFI Sponsors

An aviation industry coalition established to facilitate and promote the introduction of alternative aviation fuel

Goal is development of non-petroleum, drop-in, jet fuel production with:

- *Equivalent safety & performance*
- *Comparable cost*
- *Environmental improvement*
- *Security of energy supply for aviation*

Synthetic jet fuels, primarily from renewable sources

Enables its diverse stakeholders to build relationships, share and collect data, identify resources, and direct research, development and deployment of alternative jet fuels

www.caafi.org

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Airlines for America™
We Connect the World

SAF Users & SAF Production and Distribution

Finding Best Practices for the SAF Supply Value Chain

- **SAF Users**
- Availability – Secure enough SAF to meet goals
- Affordability – Cost should be reasonable

- **SAF Producers and Distributers**
- Challenges for SAF development
- Near Term Commercialization
- Long Term Commercialization

SAF Production Pathway

Consumption
– Purchasing, Distributing & Flying

Production
– Processing, Converting & Distributing

Feedstocks
– Growing, Harvesting & Aggregating

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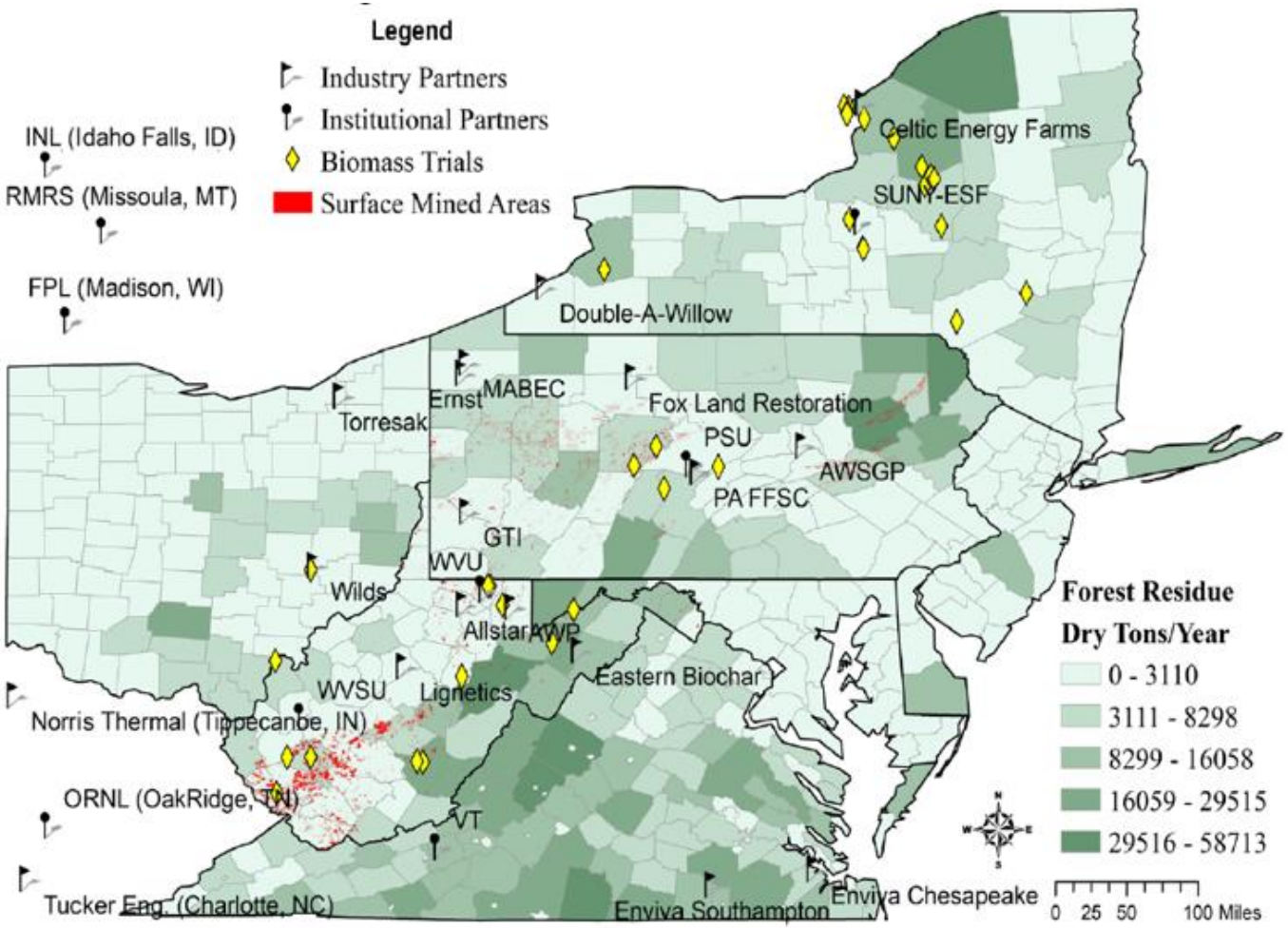
Feedstocks



Bring More Biomass

erSysNet Canada Inc.

Possible biomass sources in Appalachian Region

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Technologies

Currently there are seven approved pathways through the American Society of Testing and Materials (ASTM)

- Some technologies need a bigger capital outlay
- Some technologies need a bigger operational budget
- Some have a smaller blending rate
- All need specific feedstocks
- All currently need to be blended with fossil-based jet fuel

End Users

Biofuel companies need offtake agreements to help them get financing

- United
- American
- Delta
- Southwest
- Jet Blue
- Amazon
- FedEx
- UPS

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U.S. SAF production forecast
Announced intentions, neat*

- Not comprehensive; CAAFI estimates (based on technology used & public reports) where production slates are not specified. Does not include various small batches produced for testing technology and markets.
- Does not include fractions of substantial Renewable Diesel capacity (existing and in-development) that can be shunted to SAF based on policy support

11 April 2022

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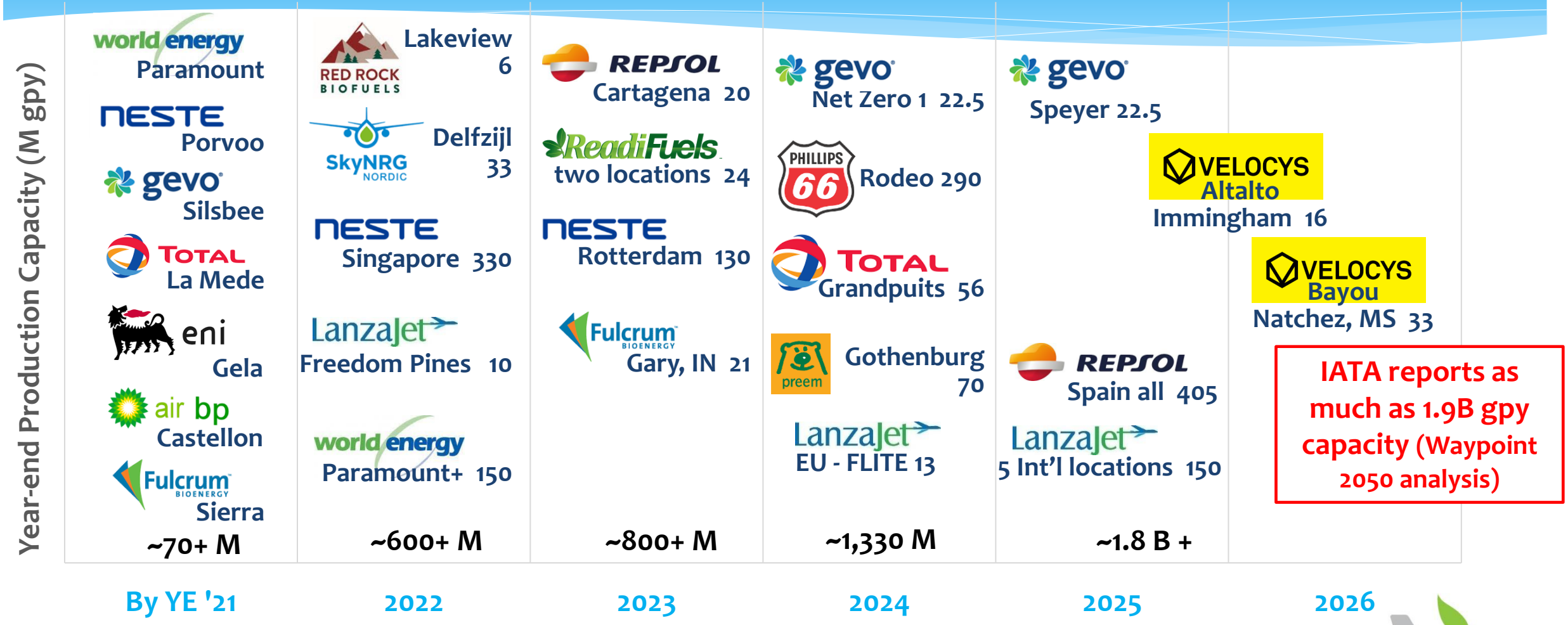
Worldwide SAF production capacity forecast

Announced intentions*



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A4A airlines' individual carbon / SAF commitments

Beyond NZC by 2050, and building to 3B gpy SAF by 2030 (commitments as of March 2021)

Alaska Airlines	NZC by 2040; Deal with Microsoft for SAF from SkyNRG/World Energy; SAF supply at SFO from Neste; SAF R&D investments with WSU-PNNL; Work with Carbon Direct
American Airlines	Allocation with Kuehne+Nagel and Deloitte ; 9 M usg SAF supply at SFO from Neste; Science based target by 2035 with SBTi; 10 M offtake from Prometheus
Atlas Air Worldwide	SAF demo work with Exolum/Avikor on Spain – Mexico flight;
Delta	Commits to be first global carbon-neutral airline; Collaboration with corporate customers (Deloitte, Takeda); targeting 10% SAF by 2030
FedEx Express	Achieve NZC by 2040; $2B investment target; $100M on Yale Center for Natural Carbon Capture
Hawaiian Airlines	
jetBlue	NZC by 2040; 10% SAF penetration by 2030; World Energy SAF supply; offtakes with SGPreston
Southwest	Collaboration with NREL on new pathways; MOUs with Marathon & P66 – focus on CA refinery retrofits
United	UA First U.S. Airline to Pledge to Reduce Own Emissions by 50% (vs. 2005) by 2050; 13Sep'18. $40M SAF Investment Fund; 27Oct'19; SAF usage at LAX since 2016
UPS	30% SAF usage by global air fleet by 2035
Air Canada	Midterm goal, -20% from 2019 air ops by 2030. $40M investments in SAF and carbon reductions and removals. [14Mar'21, Leaveless (aircanada.com)]

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Commitments of Greater Ambition

SAF Grand Challenge – U.S. Departments of Agriculture, Transportation, and Energy

- On September 9, 2021, the U.S. government announced a SAF Grand Challenge.
- Goals identified include increased government engagement that will enable the U.S. domestic production of
  - 3 billion gallons of SAF per year by 2030, and
  - 35 billion gallons per year by 2050.
- By reference, total 2019 U.S. jet fuel usage was ~26.7 billion gallons, so the goals represent perhaps 10% usage in 2030 and up to 100% usage in 2050, with the latter goal aligning aviation with the Paris Agreement types of commitments.
- Current SAF consumption – U.S. = 5M gpy (<0.1%) / Global = 25M gpy (<0.1%)
- Realistically, we need to double our SAF consumption each and every year from now until 2030 to reach our goal

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SAF Progress – Technical

* SAF are becoming increasingly technically viable
  * Aviation now knows we can utilize numerous production pathways

    (7 approved, 6 in-process, >15 in pipeline)
  * Enabling use of all major sustainable feedstocks

    (lipids, sugars, lignocellulose, hydrogen & carbon sources, circular-economy byproduct streams)
  * Utilizing thermo-chemical and bio-chemical conversion processes to produce pure hydrocarbons, followed by standard refinery processes
  * Following blending with petro-jet, SAF is drop-in, indistinguishable from petro-jet
  * Some future pathways expected to produce SAF blending components that will need less, or zero, blending
  * Expanding exploration of renewable crude co-processing with refineries
  * Continuing streamlining of qualification – time, $, methods

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Overall industry summary on SAF

SAF are key for meeting industry's commitments on carbon reductions

- Aviation enterprise aligned, representing a 26B gpy US & 97B gpy worldwide opportunity
- Jet fuel demand expected to increase for foreseeable future … 3 - 5% per year (following COVID rebound)
- SAF delivers net GHG reductions of 65-100+%, other environmental services
- Segment knows how to make it; Activities from FRL 1 to 9, with many in "pipeline"
- CAAFI and others are working to foster, catalyze, enable, facilitate, …
- First 6 facilities on-line (5 from lipids), increasing run-rates, multiple offtakers
- Commercial agreements being pursued, fostered by policy and other unique approaches
- Pathways identified for fully synthetic SAF (50% max blend today), enhancing SAF value proposition by enabling deeper net-carbon reductions
- Additional work needed on "appropriate conversion process for targeted feedstocks" enabling affordability

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Summary for the Mid-Atlantic Region

- Need to find good, affordable feedstocks in sufficient quantities
- Based on the feedstock availability, you can then decide on a good technology
  - Even though there are 7 approved pathways, there are at least 6 more at various stages of approval and 15 working towards getting the approval process started
- Need end user offtake agreements
- Policies and incentives can assist in getting a SAF industry going

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SAF: from a diverse set of world-wide feedstocks

Wastes, residues, purpose grown, circular-economy byproducts

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Thank You

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