



ICAO

ENVIRONMENT

ICAO STOCKTAKING SEMINAR
TOWARD THE 2050 VISION FOR
SUSTAINABLE AVIATION FUELS



Sustainable Aviation Fuel from Ethanol

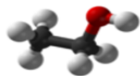
Laurel Harmon

VP Government Relations, LanzaTech

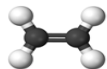




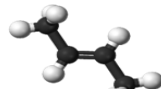
LanzaTech Sustainable Aviation Fuel: ATJ-SPK from Ethanol



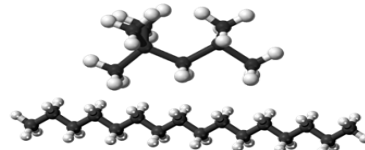
Ethanol



Ethylene



C₄- C₂₄ Olefins



Paraffins and IsoParaffins



DEFENSE ADVANCED
RESEARCH PROJECTS AGENCY



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



RSB
Renewable or
Sustainable Biomaterials
www.rsb.org



BOEING

HSBC



virgin atlantic





Development and Scale Up Timeline

2010-2012: Initial Research and Proof of Concept

- 2010: PNNL
- 2011: DARPA
- 2011: FAA
- 2012: DOE

2011+: Collaboration with Industry Leaders

- Virgin Atlantic
- HSBC
- Boeing
- RSB

2014-2017: Scale up and Fuel Production

- Freedom Pines pilot facility
- 4,000 gallons of jet produced
- DOE demo funding

2016-2018: ASTM

- LanzaTech Research Report on Ethanol Based ATJ-SPK Submitted September 2016
- ASTM SAF Standard including Ethanol as Feedstock for Jet Published April 2018
- Based on LanzaTech data

2018+: Flight Demos and Demonstration Scale Fuel Production

- First Commercial flight on October 2, 2018
- DOE Demonstration Plant



ICAO

ENVIRONMENT

ICAO STOCKTAKING SEMINAR
TOWARD THE 2050 VISION FOR
SUSTAINABLE AVIATION FUELS



- ✓ 4,000 gallons Jet
- ✓ 600 gallons Diesel



Waste Gas Ethanol from RSB Certified Facility
Grain Ethanol

Fuel Property	Jet A Spec	LanzaTech ATJ-SPK	50/50% v with Jet A
Freeze Point, °C	-40 max	-61	-54
Energy Density, MJ/kg	42.8 min	44.4	43.8
Thermal Stability	Baseline	Excellent	Excellent
Viscosity @ -40 °C mm ² /sec	12 max	7.0	9.3
Hydrogen %	13.4 min	15.1	14.5
Aromatics %	8 min, 25 max	Nil	8.8
Sulfur, total mass %	0.30 max	<0.001	0.02

LanzaJet: Taking Off



ASTM INTERNATIONAL



April 1, 2018

D7566 ATJ SPK Annex A5

✓ Ethanol feedstock

✓ Final blend ratio to max 50 %



October 3rd 2018 First Commercial Flight

4 Flights on 92% LanzaJet SPK
>80-90% Lower Contrails and Soot Particles



National Research Council Canada

Conseil national de recherches Canada



ICAO

ENVIRONMENT

ICAO STOCKTAKING SEMINAR
TOWARD THE 2050 VISION FOR
SUSTAINABLE AVIATION FUELS



Path to Economic Volumes



2015
Lab Scale



2016
Pilot Scale

Freedom Pines
Biorefinery 



2020
10M gpy

Freedom Pines
Biorefinery 



2022
30M gpy x3
LanzaJet 



ICAO

ENVIRONMENT

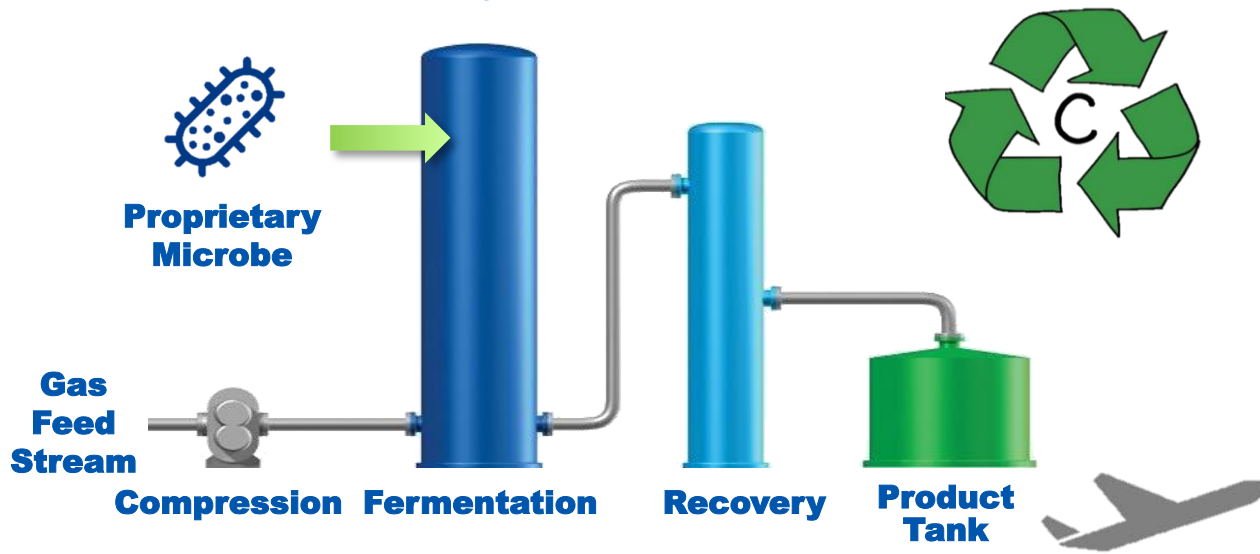
ICAO STOCKTAKING SEMINAR
TOWARD THE 2050 VISION FOR
SUSTAINABLE AVIATION FUELS



Ethanol from Recycled Carbon



**Industrial Off Gas
Biomass, MSW Syngas**



SEKISUI

LanzaTech-Sekisui
MSW → Ethanol
Demonstration
2014-2019





35k MTA
Biomass Syngas





> 6 Million Gallons Ethanol Produced Since Start Up





ICAO

ENVIRONMENT

ICAO STOCKTAKING SEMINAR
TOWARD THE 2050 VISION FOR
SUSTAINABLE AVIATION FUELS



首钢朗泽

Shougang LanzaTech

China
48k MTA



Belgium
62k MTA



Commercialization:
Industrial Off Gases



South Africa
52k MTA

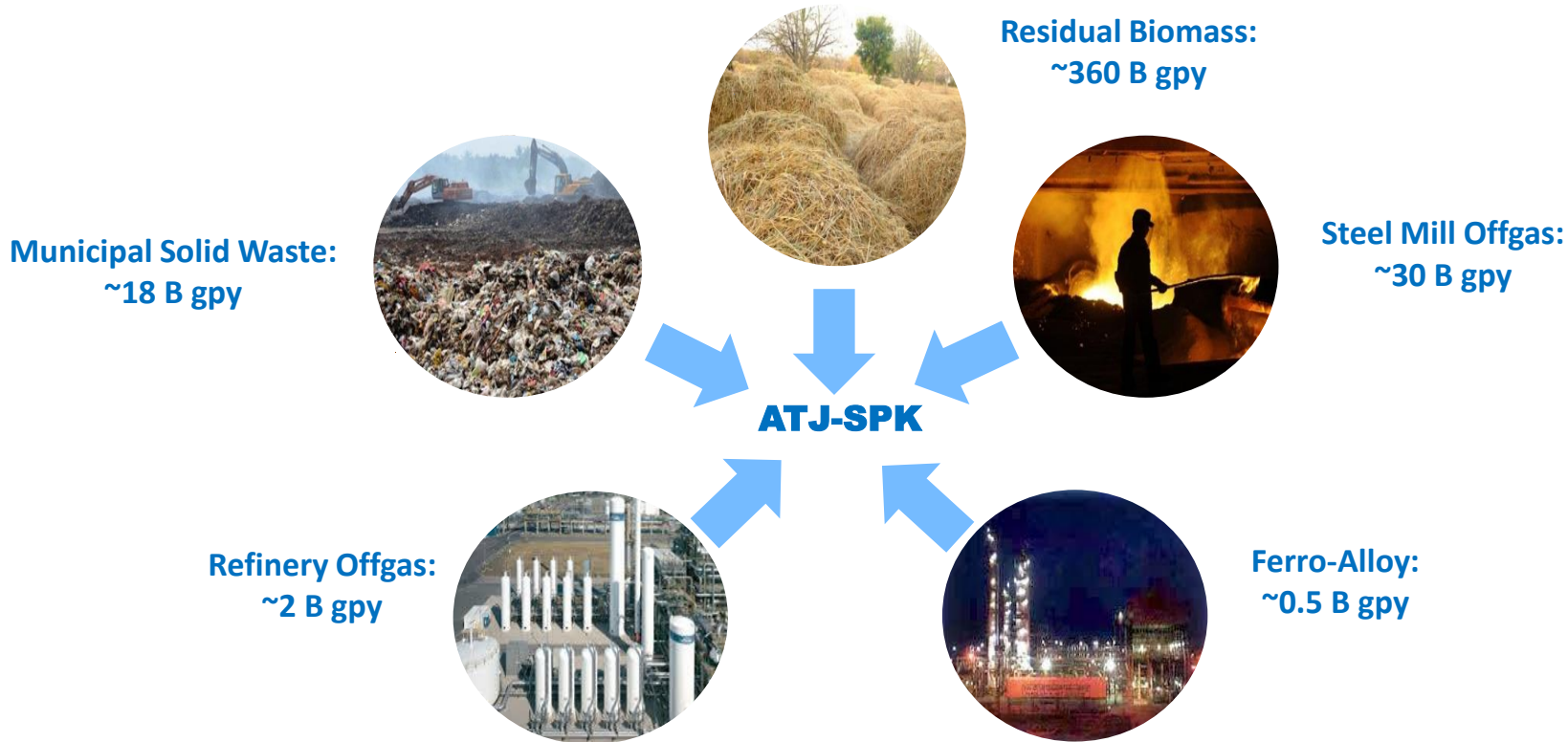


IndianOil

India
34k MTA



Global ATJ-SPK Potential from Wastes and Residues Alone





Building A Sustainable Aviation Fuel (SAF) Sector

➤ Technical Support

- Continued (and expanded) support for stringent technical approval process

➤ Supply Chain Support

- Support for development, collection, transportation, and storage of sustainable feedstocks
- Infrastructure for SAF transportation, storage, blending, and distribution

➤ Technology and Project Support

- R&D grants for technology and feedstock development, sustainability and systems analysis, ...
- Grants and low-cost finance to offset capital costs of scale up (piloting and demonstration)
- Assistance for project development, feasibility studies, environmental approvals, sustainability assessment
- Guaranteed or low-cost debt to reduce capital risk of first commercial plants

➤ Policy Support

- Stable alternative fuel policies that drive SAF demand
- Most SAF technologies can produce gasoline and/or diesel as well as jet (and marine)
- Mandates and incentives that at least level the playing field for SAF



ICAO

ENVIRONMENT

ICAO STOCKTAKING SEMINAR
TOWARD THE 2050 VISION FOR
SUSTAINABLE AVIATION FUELS



ICAO

North American
Central American
and Caribbean
(NACC) Office
Mexico City

South American
(SAM) Office
Lima

ICAO
Headquarters
Montréal

Western and
Central African
(WACAF) Office
Dakar

European and
North Atlantic
(EUR/NAT) Office
Paris

Middle East
(MID) Office
Cairo

Eastern and
Southern African
(ESAF) Office
Nairobi

Asia and Pacific
(APAC) Sub-office
Beijing

Asia and Pacific
(APAC) Office
Bangkok



THANK YOU