Converting MSW Into Low-Cost, Renewable Jet Fuel

CAAFI Biennial General Meeting & Integrated ASCENT Symposium

Bruno Miller

Managing Director – Fulcrum Fuels

December 4-6, 2018

Fulcrum™ BIOENERGY

Fulcrum: Solving Two Global Challenges

Waste Disposal

Decarbonization of Air Transportation

Fulcrum – MSW to Renewable Fuels

Long-Term Feedstock Supply – Input Costs Locked In

Long-Term Offtake Agreements

Guaranteed Technology Process

Strong Strategic Investor Group

First Project Financed and Under Construction

Standardized Projects – Design, Contracts, Financing

Fulcrum™ BIOENERGY

MSW – A Strategic Feedstock

Changing the way Garbage is Handled and Disposed

- Large Volumes, Ideal Locations
- Established Infrastructure
- Carbon-Rich Feedstock Ideal for Biofuel Production
- Predictable Cost
- No Competing Uses
- Resolves Waste Disposal Problems

Fulcrum BIOENERGY

Proprietary, Proven & Efficient Fuels Process

Feedstock Processing Facility Prepares MSW for Fuels Process

Steam Reforming Gasification System Converts MSW to Synthesis Gas

Fischer-Tropsch Process Converts Synthesis Gas to Syncrude, Jet Fuel and Diesel

Fulcrum's Strategic Partner Model

Feedstock Supply → **Waste to Syncrude** → **Fuel Refining** → **Fuel Logistics** → **Customers**

Waste Connections, Inc. — Connect with the Future

bp

United

ABENGOA

Cathay Pacific

WM — Waste Management

Marubeni

JAL — Japan Airlines

Department of Defense — United States of America

andeavor

World Fuel Services

Fulcrum BioEnergy

Sierra BioFuels Plant
Feedstock Processing Facility

- Feedstock Processing Facility In Operations; Construction Completed on Schedule and on Budget
- Converts 350,000 Tons of Raw Waste into 175,000 Tons of Processed Feedstock per Year
- Waste Processing Capacity up to 120 Tons per Hour

Sierra BioFuels Plant
Biorefinery

- Biorefinery Under Construction
- 175,000 Tons of Processed MSW Feedstock Converted to 11 Million Gallons of Low-Carbon Transportation Fuel Each Year
- Plant Operations Begin in Early 2020



Bruno Miller
Managing Director – Fulcrum Fuels
Fulcrum BioEnergy, Inc.
Office: (925) 224-8246
Mobile: (617) 291-6352
bmiller@fulcrum-bioenergy.com

Fulcrum™ BIOENERGY

RED ROCK BIOFUELS

CAAFI

December 2018

Red Rock Biofuels

Growing Jet and Diesel Fuel Consumption

- **50%** more jet fuel by 2040
- **30%** more diesel fuel by 2040

Transportation Sector Major Source of CO_2 Emissions

- **27%** share of transportation in US Greenhouse Gas Emissions 1990-2015

Government Regulation Targeting High Volumes of Renewable Fuels

- **RFS2 & LCFS** EPA and CARB[1] programs to increase renewable fuel production

Focus on Carbon Emissions in the Aviation Sector

- **CORSIA** framework to start voluntary (2021+) and mandatory (2026+) CO_2 reductions for international aviation

Increasing Demand for Advanced Biofuels

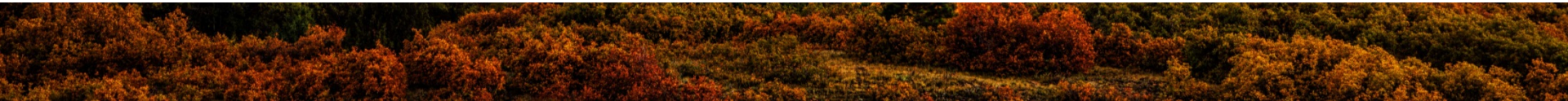
- **288mm** gallons of mandated cellulosic biofuels in 2018
- **CORSIA Goal** carbon neutral growth from 2020 onwards

RED ROCK BIOFUELS ***produces unique products in high demand***

- **15mm** gallons per year of biofuels

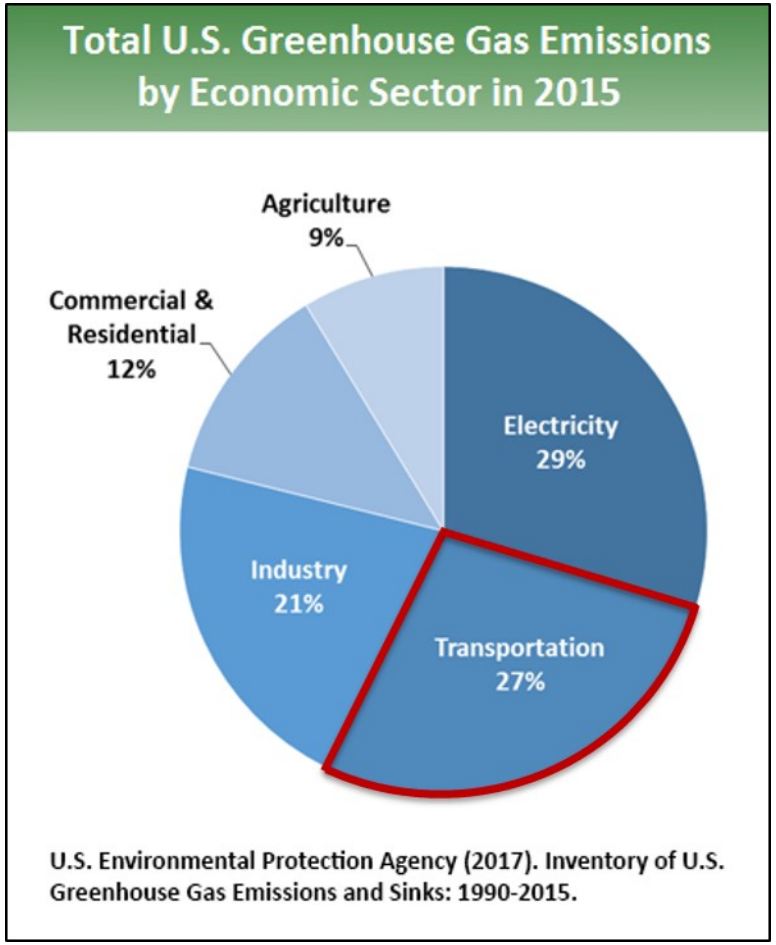
Source: Exxon Mobil 2017 Outlook for Energy, United States Environmental Protection Agency, ICAO.

[1] EPA corresponds to the United States Environmental Protection Agency and CARB to the California Air Resources Board.



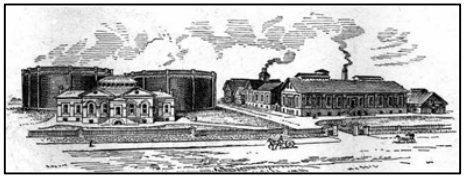
Global Climate Change Imperative

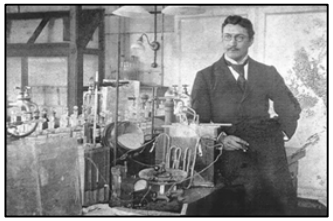
- Transportation sector already major source of CO2 emissions (27%)
- Growing population and standard of living will increase jet & diesel fuel use:
- **30% more diesel fuel by 2040**
- **50% more jet fuel by 2040**



Credit: *International Energy Agency, World Energy Outlook 2016; Exxon Mobil 2017 Outlook; U.S. Environmental Protection Agency*

Process Technology





Gasification
Produce syngas
(CO & H_2)

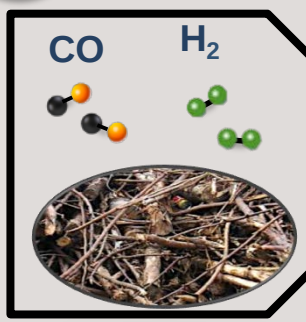
Fischer-Tropsch
Form hydrocarbon chains

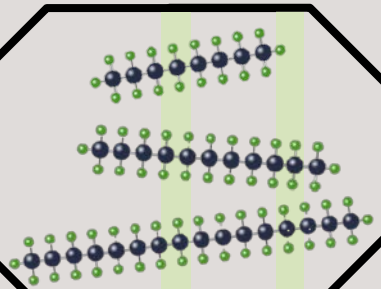
Hydroprocessing
Upgrade into
finished fuels

A

B

C





20% Naphtha

40% Jet

40% Diesel

136,000 bdt/yr Woody Biomass

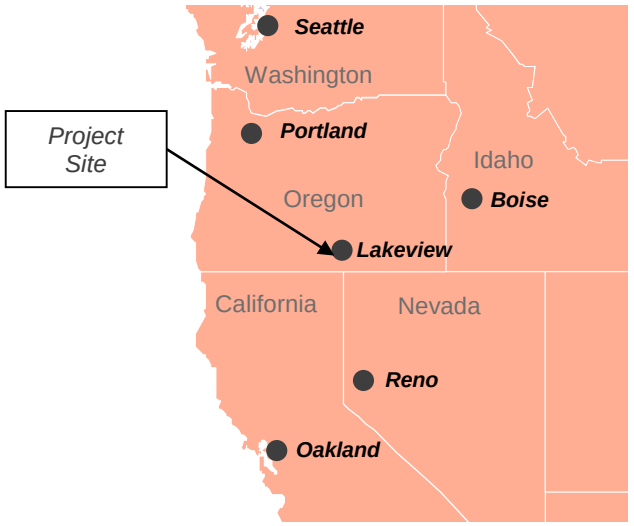
+ temp & pressure

15.1 MGY Renewable, Drop-In Heavy Transport Fuels

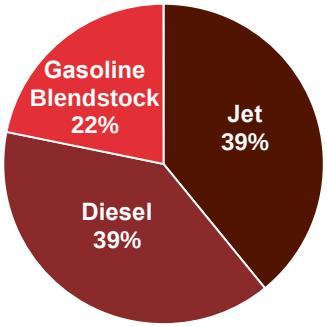
Project Overview

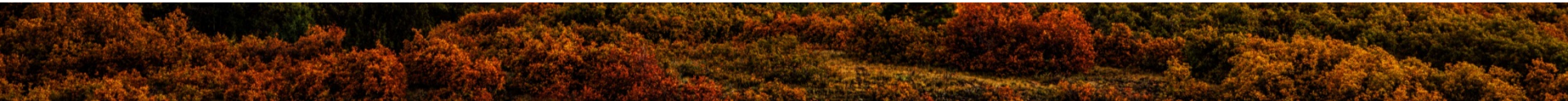
Project and Site	■ Advanced biofuels production facility converting woody biomass into renewable drop-in jet, diesel, and gasoline blendstock fuels — Conversion of **~136,000 BDT/year** of woody biomass into **~15.1mm gallons/year** of renewable cellulosic fuels
Feedstock	■ 70% of annual feedstock requirement under long term contract
Offtake	■ **Jet Fuel**: 100% of jet fuel to be sold to FedEx and Southwest
EPC	■ EPC Contract with IR1 Group LLC
Technology	■ **Gasification and Syngas Clean-Up Unit**: conversion of woody biomass to syngas ■ **Fischer-Tropsch Unit**: cleaned syngas converted into Fischer-Tropsch (FT) waxes and liquids ■ **Upgrading of FT Products**: upgrading of FT Products into finished fuel products

Facility Location



Biofuels Breakdown (by Production Volume)



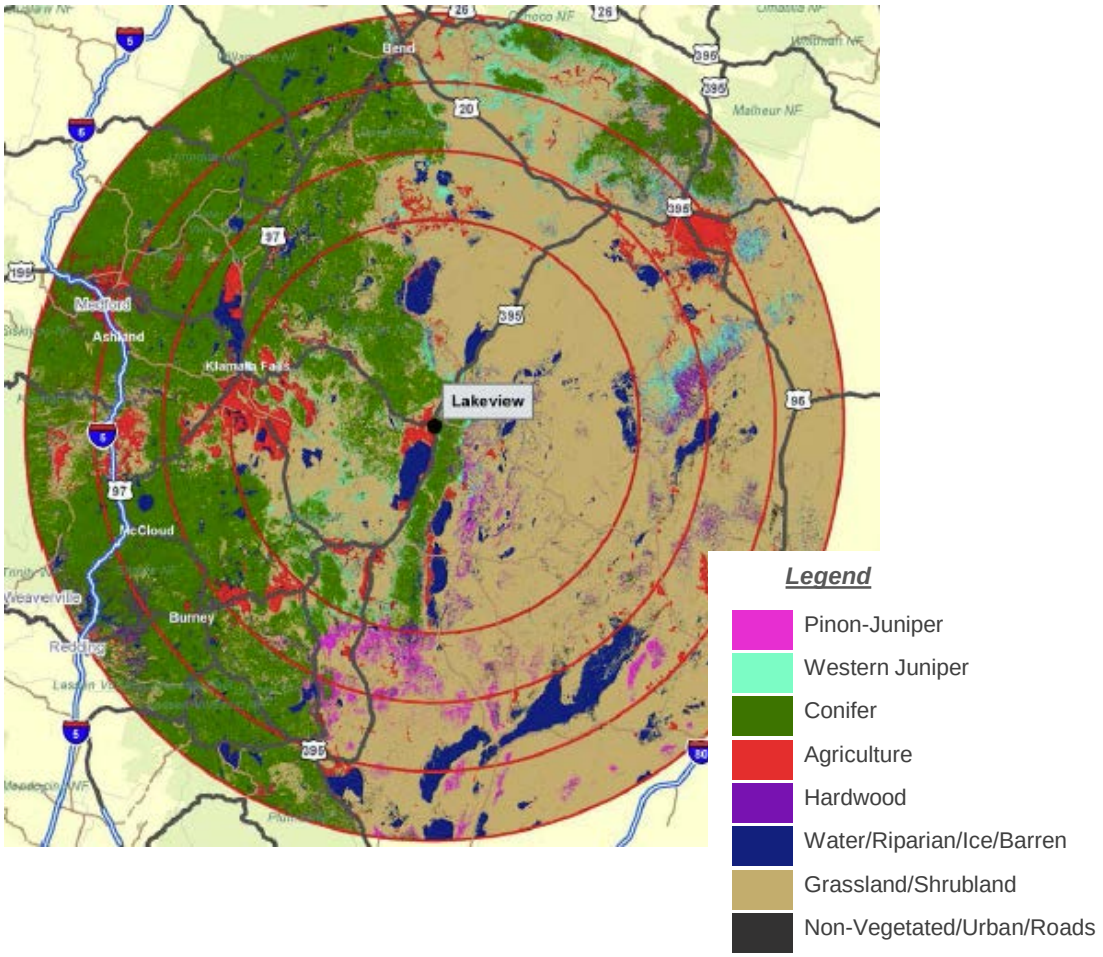


Feedstock

Key Highlights

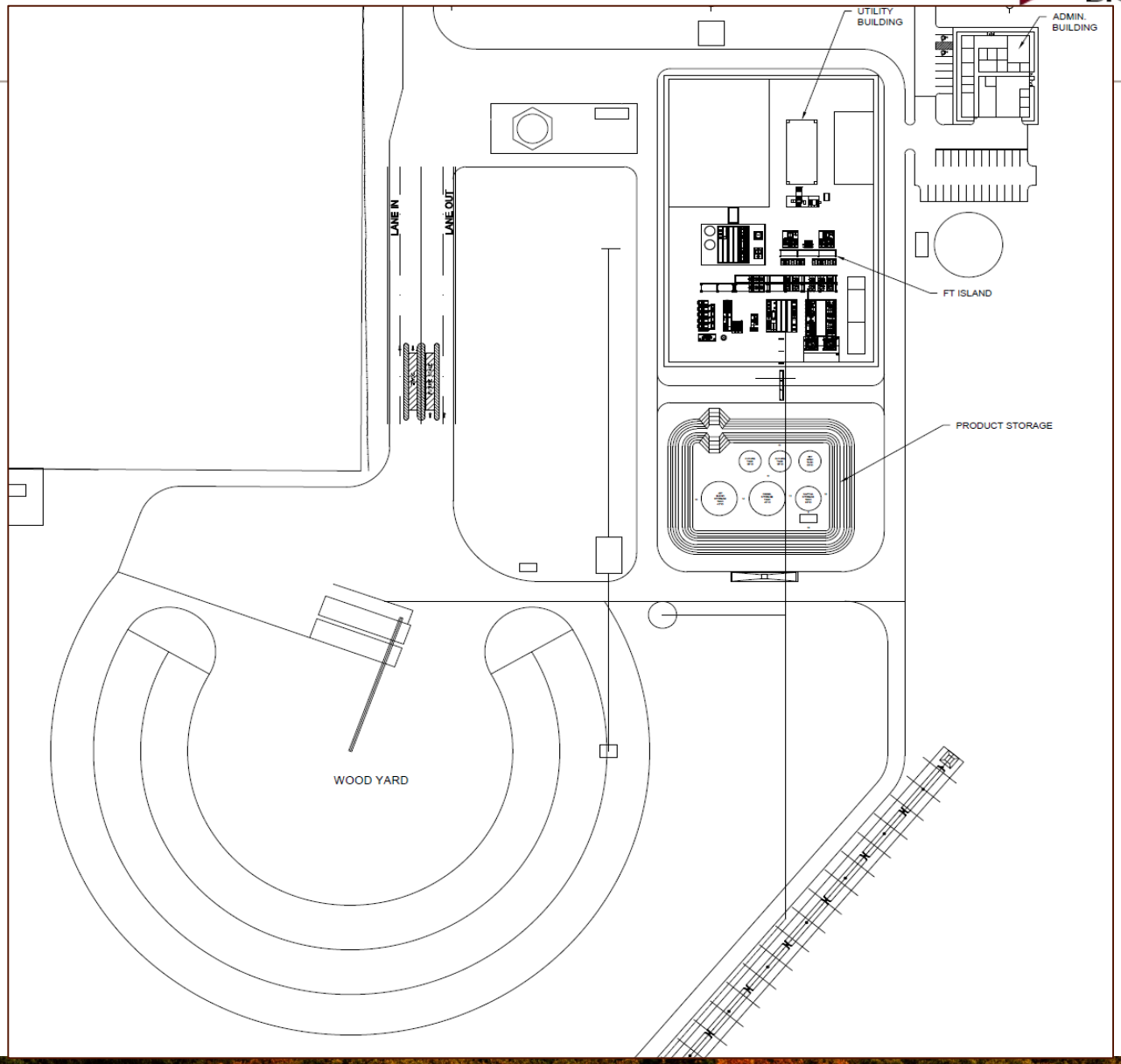
- Facility requires 136,000 BDT of woody biomass per year
  - —Corresponds to ~18% of total waste wood produced within 125 mile radius
- Minimal regional competition for forest biomass material within 125 mile radius

Feedstock Sourcing Area Characteristics

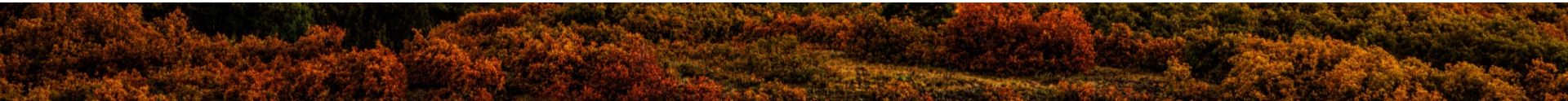


Plant Layout

RED ROCK BIOFUELS

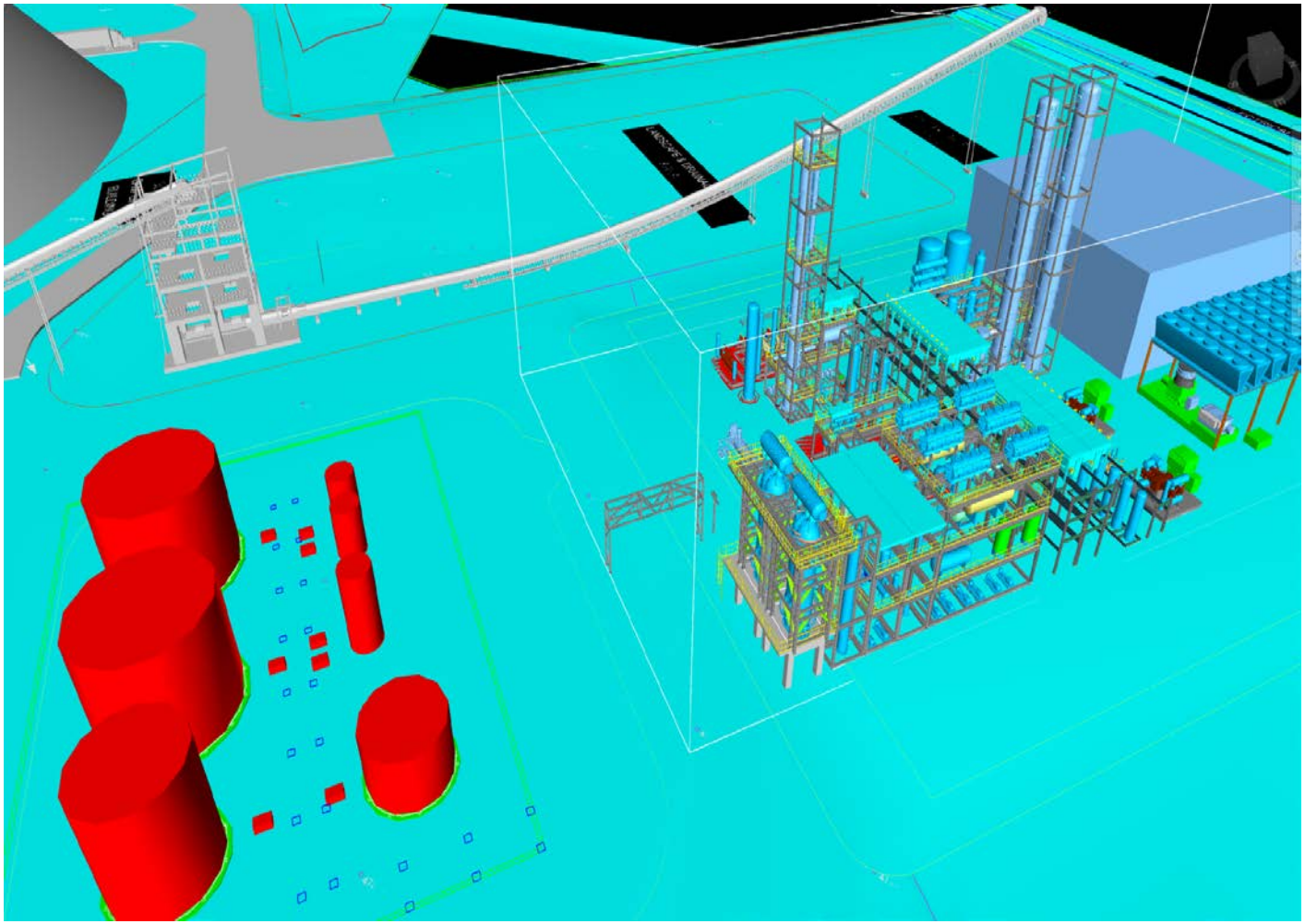


Views of the Site

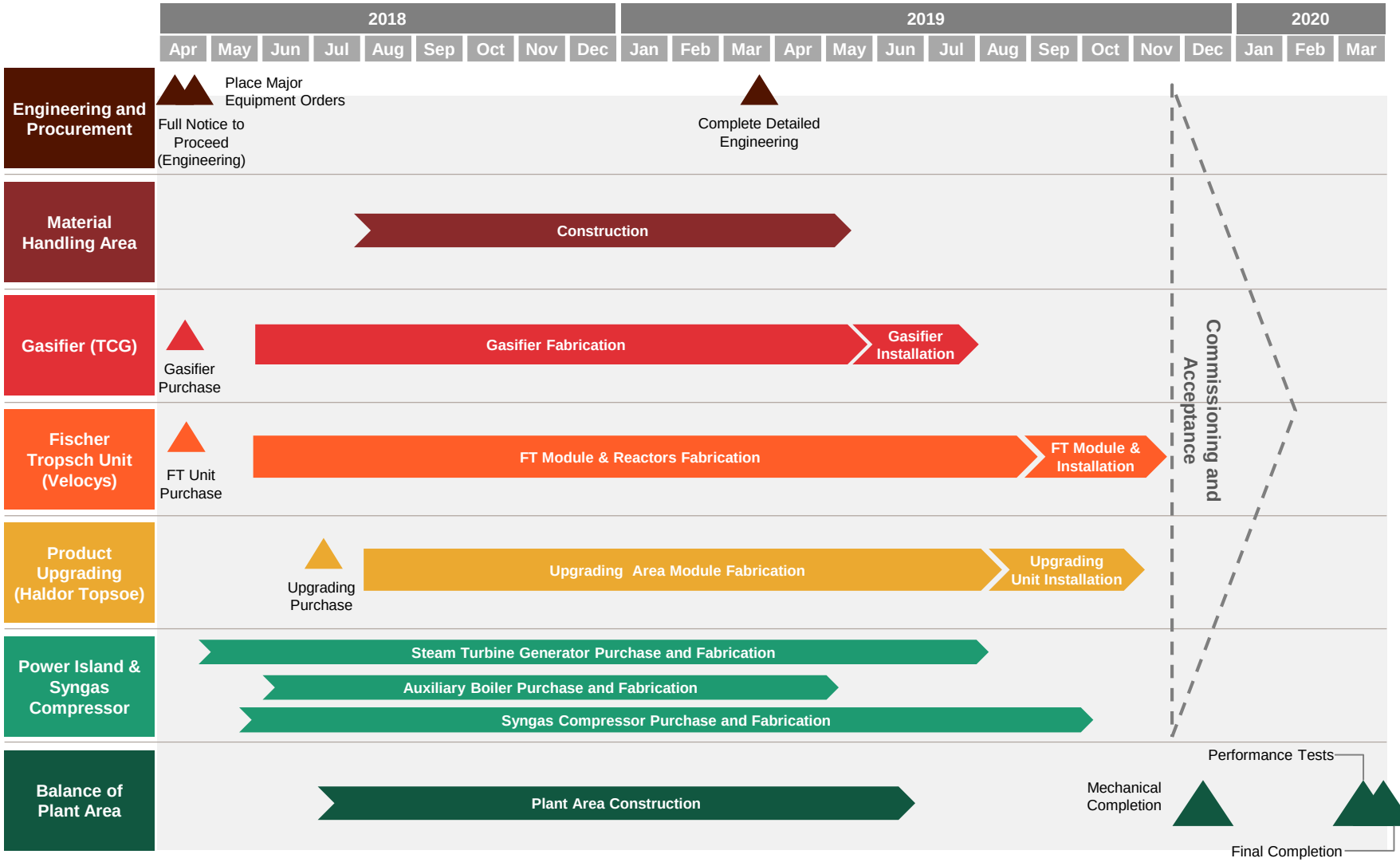


RED ROCK BIOFUELS

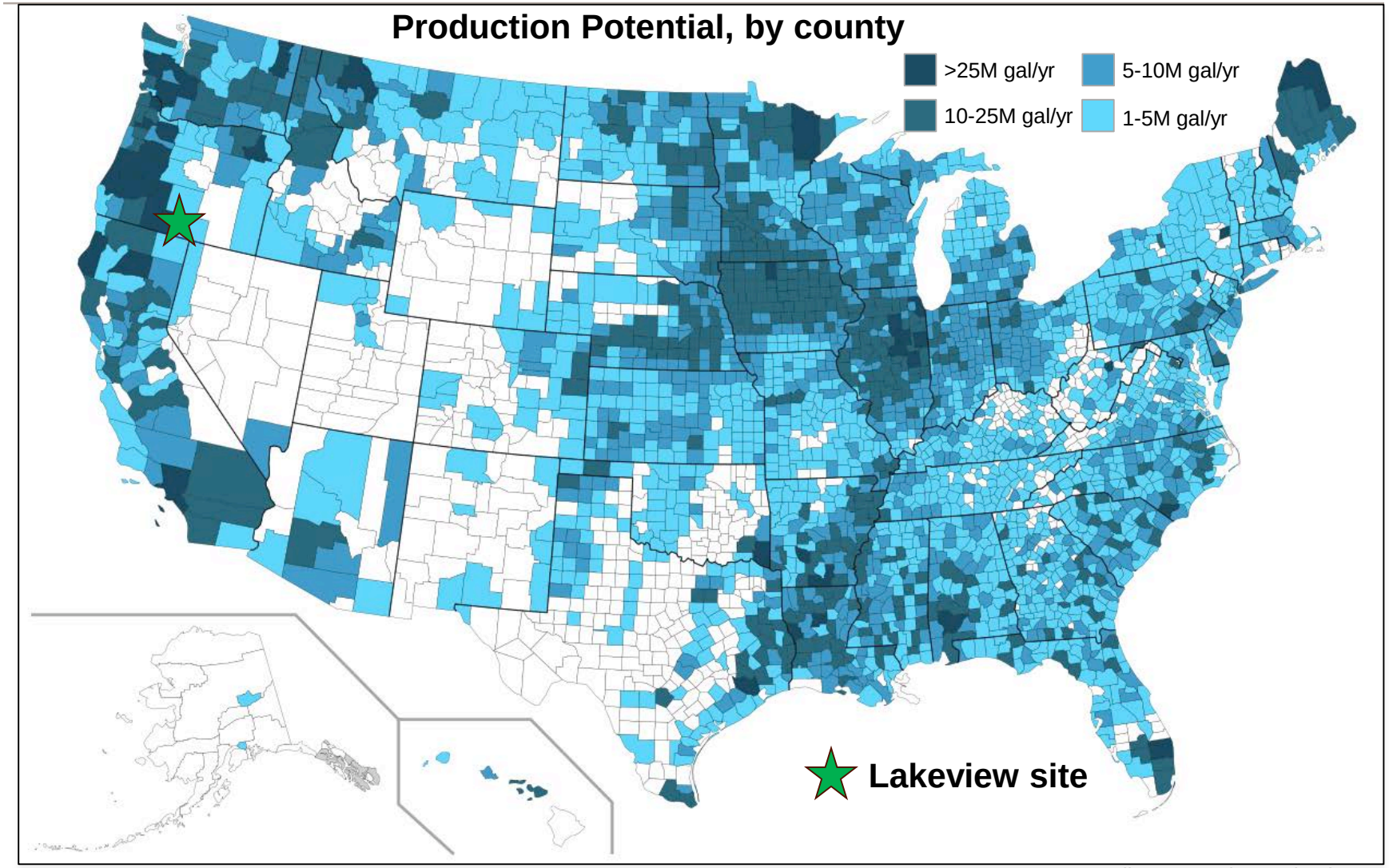
Schematic



Project Schedule

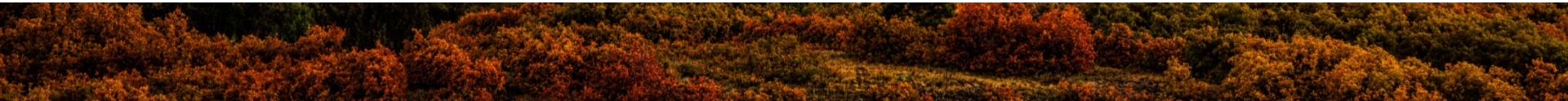


Expansion



Credit: USDA BioSys database, 2015

Thank You



Neste Aviation Solutions

Presented at the CAAFI Biennial General Meeting
"The Producer Pack" – plans for production and expansion

Washington DC, December 4, 2018

NESTE

Discussion points

Neste in brief

Renewable jet fuel

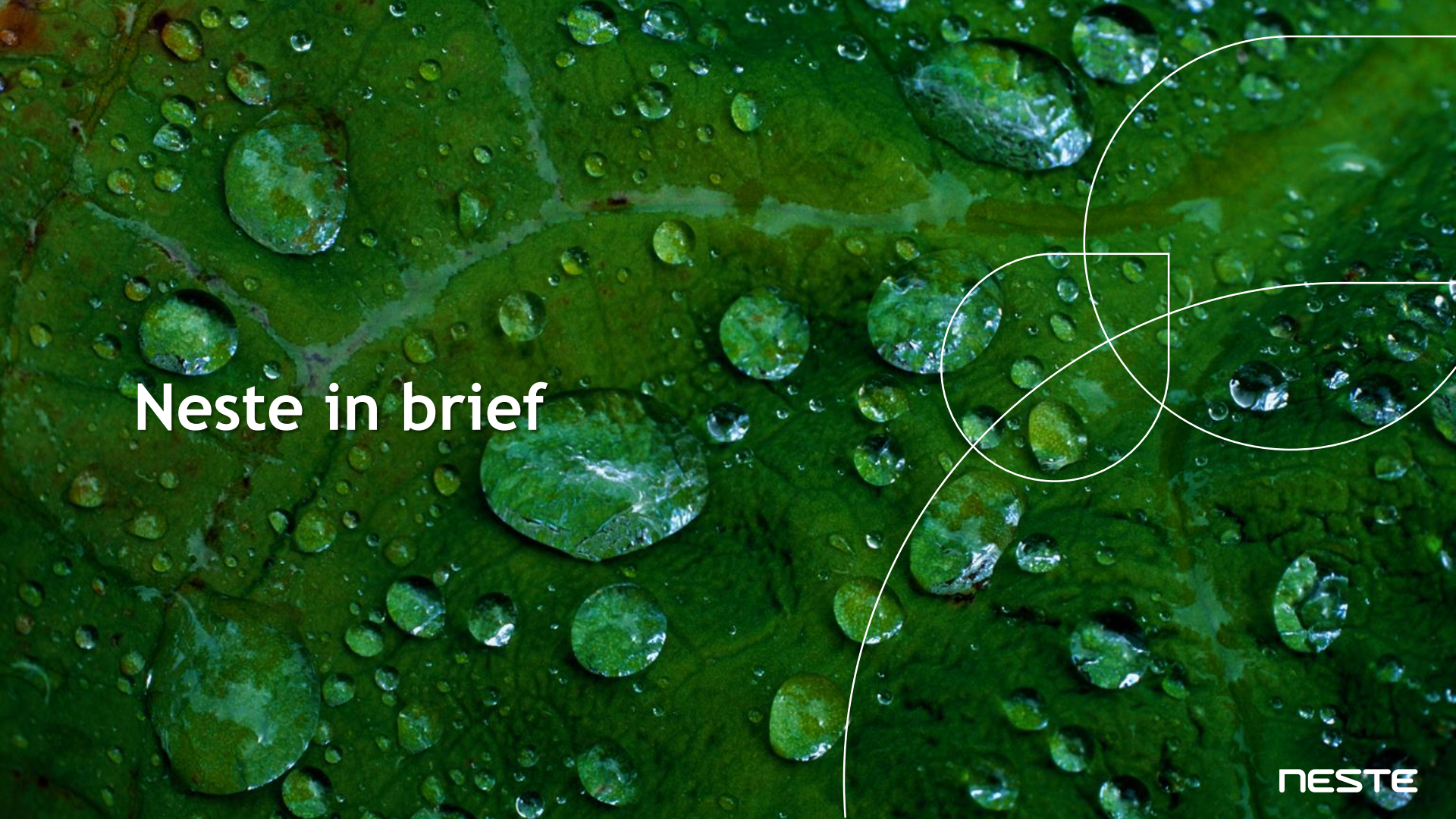
- Go to market approach
- Feedstock and sustainability

The Future

- Renewable chemicals and plastics
- Plastics to fuel

Safe Harbor Statement

The following information contains, or may be deemed to contain, “forward-looking statements”. These statements relate to future events or our future financial performance, including, but not limited to, strategic plans, potential growth, planned operational changes, expected capital expenditures, future cash sources and requirements, liquidity and cost savings that involve known and unknown risks, uncertainties and other factors that may cause Neste Corporation’s or its businesses’ actual results, levels of activity, performance or achievements to be materially different from those expressed or implied by any forward looking statements. In some cases, such forward-looking statements can be identified by terminology such as “may,” “will,” “could,” “would,” “should,” “expect,” “plan,” “anticipate,” “intend,” “believe,” “estimate,” “predict,” “potential,” or “continue,” or the negative of those terms or other comparable terminology. By their nature, forward-looking statements involve risks and uncertainties because they relate to events and depend on circumstances that may or may not occur in the future. Future results may vary from the results expressed in, or implied by, the following forward-looking statements, possibly to a material degree. All forward-looking statements made in this presentation based on information presently available to management and Neste Corporation assumes no obligation to update any forward-looking statements. Nothing in this presentation constitutes investment advice and this presentation shall not constitute an offer to sell or the solicitation of an offer to buy any securities or otherwise to engage in any investment activity.


Neste in brief

Neste by numbers

Neste has a strong history of developing, commercializing, and marketing new fuels

1980-2005	2007	2011	2013	2014	2015	2018	2018	Future
Lead-free & sulfur-free fuels	Renewable diesel	Renewable jet fuel	ProDiesel	Futura premium gasoline	Low-sulfur marine fuel	Renewable propane	Renewable chemicals	Green Hub Plastics to fuels







NESTE

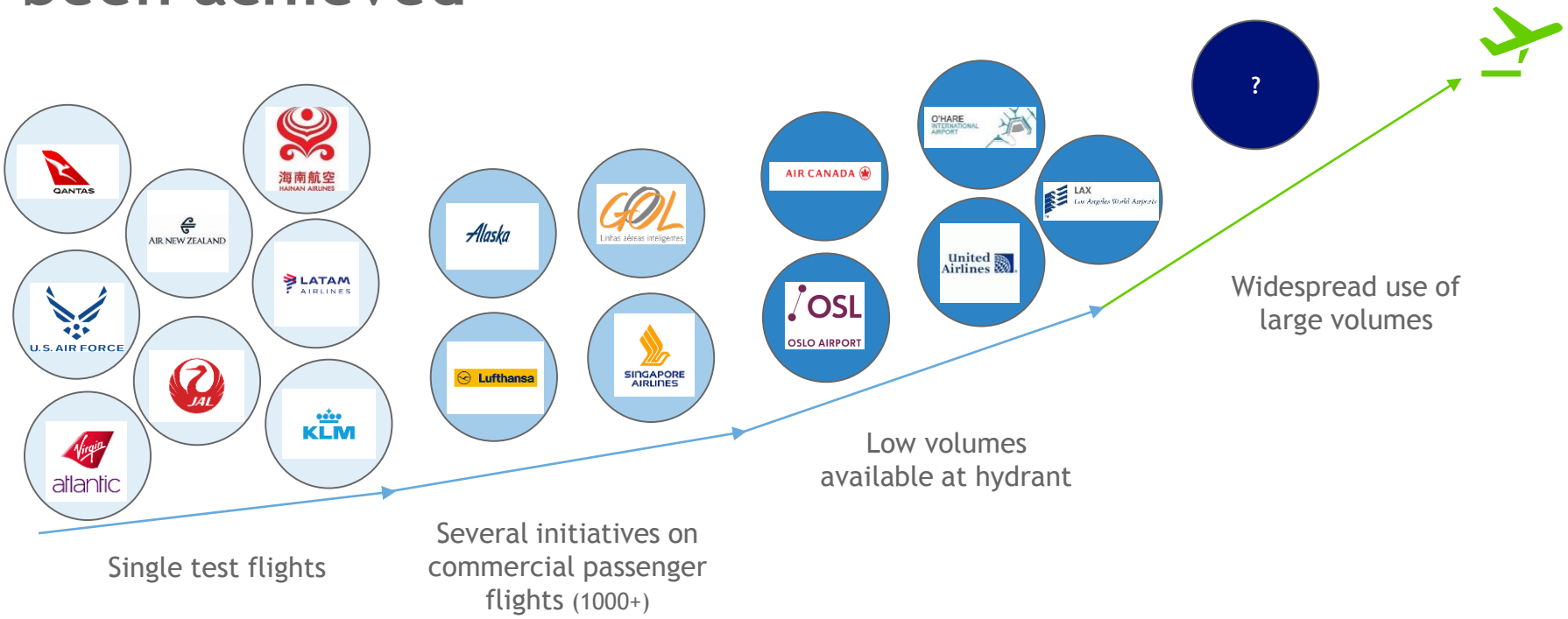
Neste's Renewable products refineries

FID for Singapore expansion for additional 340 million gpy will be made later this month

NESTE

Renewable Jet Fuel: A solution for sustainable aviation

Despite numerous test programs and commercial launch, widespread continuous use of RJF has not been achieved



Creating value through delighting customers of different stakeholders

AIRLINES

- RJF has higher fuel energy density (by mass)
- RJF has better thermal stability
- Meet GHG reduction targets
- Recognition as a model corporate citizen
- Drive new value proposition & associated revenues
- Legitimacy for growth

AIRPORTS

- Helps fight climate change
- Meet GHG reduction targets - e.g. Airport Carbon Accreditation
- Improved air quality
- Recognition as a model corporate citizen

GOVERNMENT

- Improved air quality & living standards
- Meet global GHG reduction targets
- Enhance energy diversification
- Support R&D of renewable jet fuel and the development of more efficient supply chains

FUEL PRODUCERS

- Enhanced product portfolio, energy diversification and value proposition to customers

LOCAL COMMUNITY

- Improved air quality
- Local responsibility
- Engaged and happy community
- Contribution to fight climate change

PASSENGERS

- Ability to make an impact for change
- Lower carbon footprint
- Brand loyalty and brand ambassadors
- Recognition as a responsible citizen

CORPORATIONS

- Meet corporate social responsibility goals
- Enhance marketing and PR value
- Reduce business travel footprint
- Attract employees who are demanding sustainable behaviour

Neste cooperation with leading aviation brands

2011

Lufthansa

HEFA used in 1,187 scheduled flights

2014

BOEING

Testing begins on the HFP HEFA for a new RJF specification

2016

Lufthansa

KLM SAS

Oslo Gardermoen becomes the world's first airport to offer HEFA to all flights

2018

American Airlines

Alaska ups

Multiple collaboration agreements with airlines

2018

DFW SFO

Multiple agreements with airports and others to explore Green Hub and supply chain

2018

air bp

Collaboration to support supply chain development

NESTE

Feedstock Sourcing and Certification

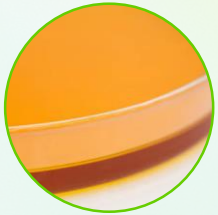
Broad range of renewable raw materials

Animal fat from food industry waste

Fish fat from fish processing waste

Vegetable oil processing waste and residues
(e.g. PFAD, PES, SBEO)

Used cooking oil



Technical corn oil

Crude palm oil

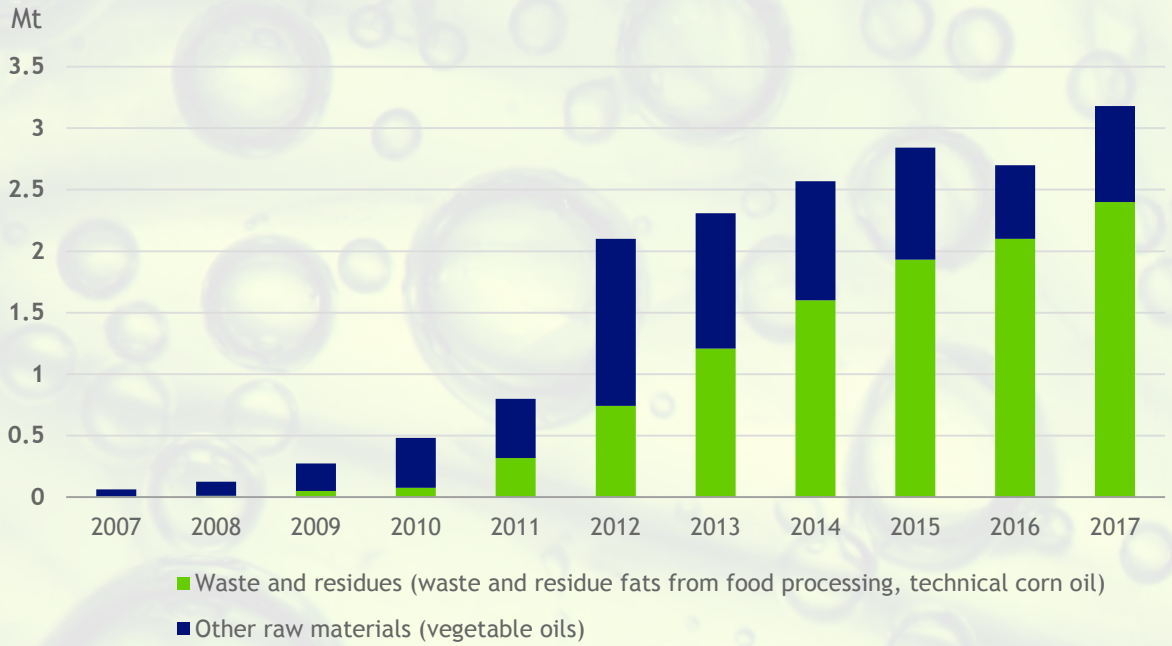
Rapeseed oil

Soybean oil

Camelina oil

Jatropha oil

Waste and residue usage continues to increase



Focus on non-cultivated materials:

- We have technical capability to use all waste and residue
- Current share of w&r is close to 80%
- We continue to research the use of lower quality materials
- R&D spend is approximately 40 million euro per year

NESTE

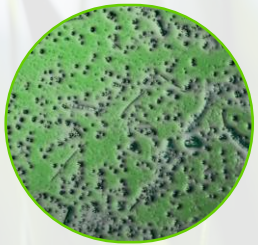
Expanding our feedstock portfolio

Short term

Waste animal fats, waste oils, residue and side streams

Long term

microbial oil



algae oil

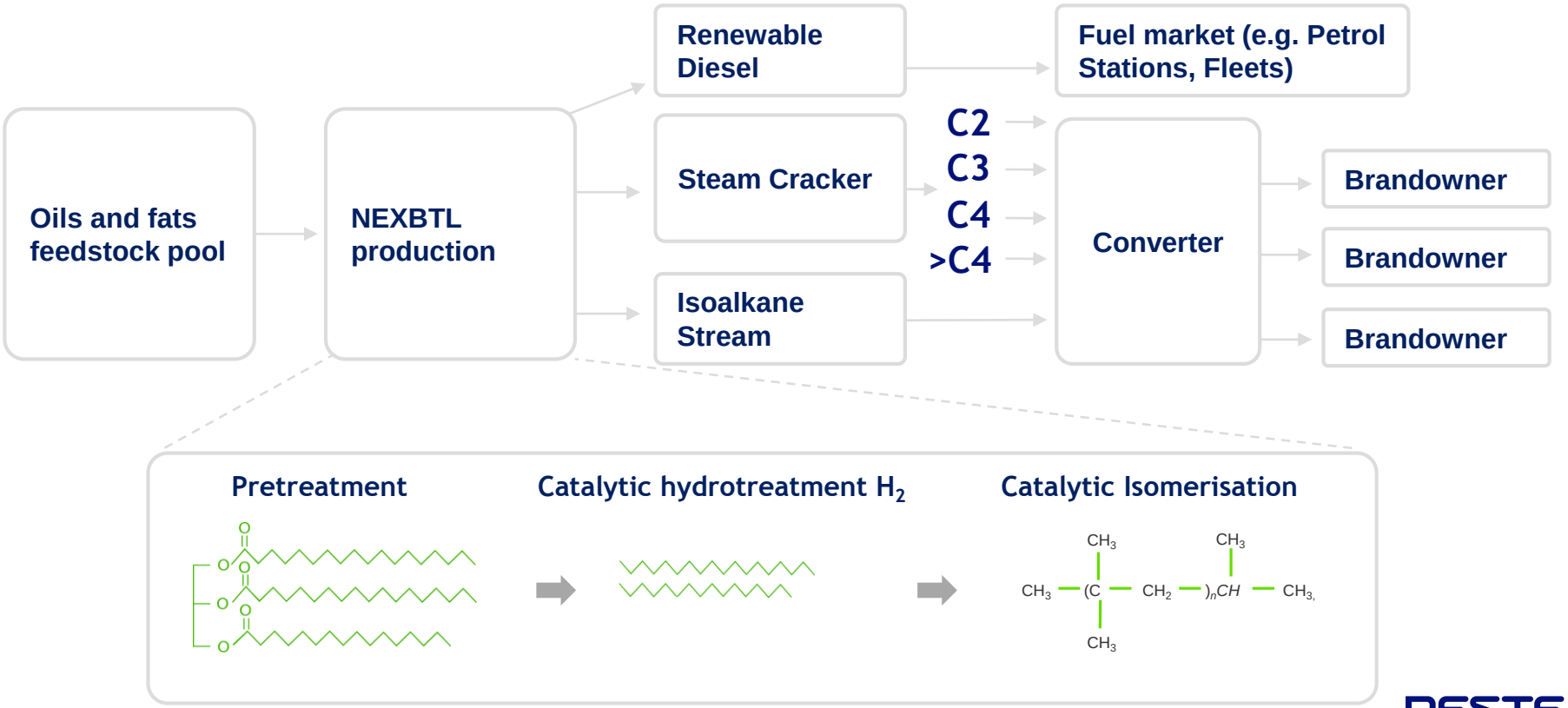
thermo-chemical pathways

plastic liquefaction


All renewable raw materials sustainably produced
All of the renewable raw materials used by Neste are traced back to the plantations or production plants
Our contracts include strict sustainability requirements, e.g. human rights, forests, carbon-rich areas covered
Taking leadership in sustainability practices is essential to growing acceptability of renewable feedstocks

Renewable Chemicals

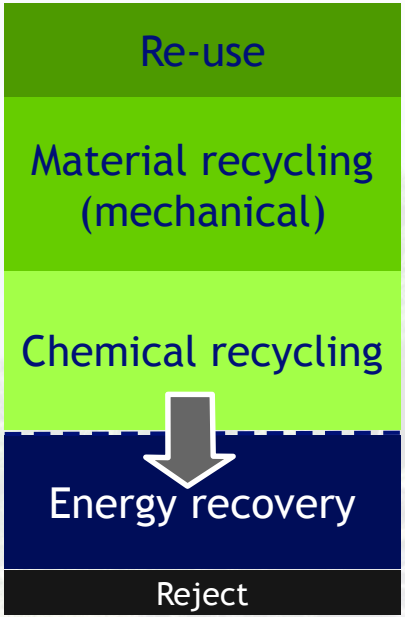
Neste's Approach to Bio-Based Chemicals




Closing the loop for
Plastics through
chemical recycling
NESTE

Creating a higher value alternative for incineration and complementing mechanical recycling

Improved collection and sorting creates increasing amount of plastic material that is too poor in quality for mechanical recycling, but too high value to just incinerate



Used for same purpose

Mechanically sorted and re-granulated for use in new products

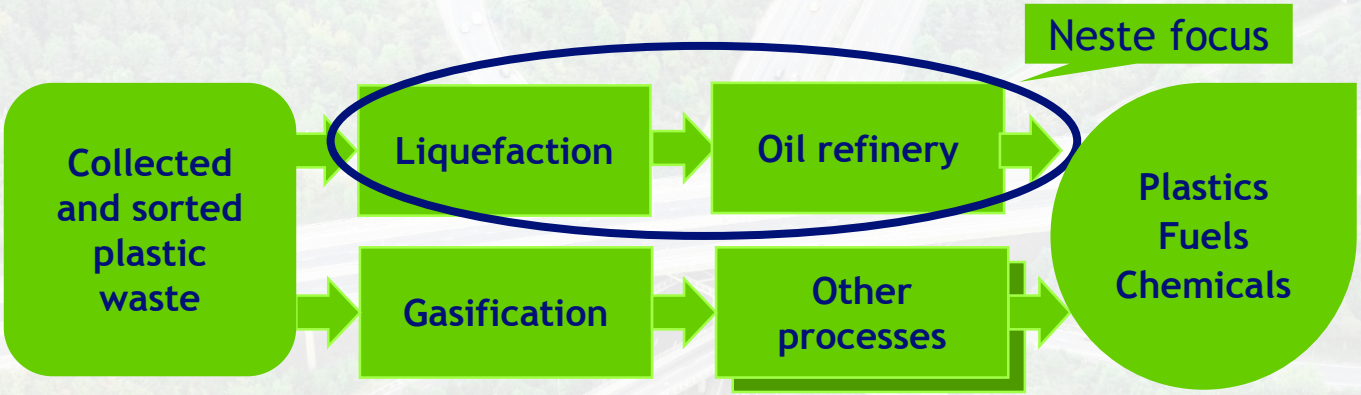
Used as feedstock in the chemical industry to make plastics and petroleum products

To be counted to recycling targets

Converted to electricity and/or heat by incineration

No use, landfilled

Neste focus on chemical recycling



- Chemical recycling of plastics and end-of-life tires means converting them by liquefaction or gasification to feedstock for the chemical industry
- This feedstock can be used to replace crude oil in production of fuels, lubricants, bitumen, solvents, and plastics

NESTE

Concluding remarks

- Renewable jet fuel must be part of the solution to make air travel more sustainable
- Neste has long had the capability to produce RJF and has now committed to supply the market on a permanent basis
- Neste is collaborating with airlines, airports, and other stakeholders around the world to promote the use renewable jet fuel
- Neste will continue to increase total renewable fuels capacity, and specifically increase RJF production and sales
- Renewable plastics and plastics to waste fuel will further help to decarbonize aviation in the future – but will need supportive policy to grow

Safe travels - and remember to lower your own environmental footprint!

Neville Fernandes
Neville.Fernandes@neste.com
(713) 584 5244

NESTEMY.COM
DECARBONIZINGAVIATION.COM