
BETTER TOGETHER: UNDERSTANDING BIODIESEL AND RENEWABLE DIESEL USE IN HEATING AND TRANSPORTATION



DIVERSE, ENERGY-DENSE FUELS



Biodiesel and renewable diesel are produced from **agricultural by-products**, wastes and residues such as:

- Soybean, canola and other plant oils
- Corn oil
- Rendered animal fats
- Winter oilseed cover crops
- Used cooking oil



SELECT LIST OF FEEDSTOCKS FOR BIOMASS-BASED DIESEL UNDER U.S. RENEWABLE FUEL STANDARD



Distillers Corn Oil



Animal Fats

Est. 9+ billion pounds of soy oil use



Soybean Oil



Camelina



Canola Oil (biodiesel only)



Used Cooking Oil/Yellow Grease

BIODIESEL AND RENEWABLE DIESEL

Renewable Diesel

Produced through *hydrotreating*, a process similar to a traditional refinery operation.

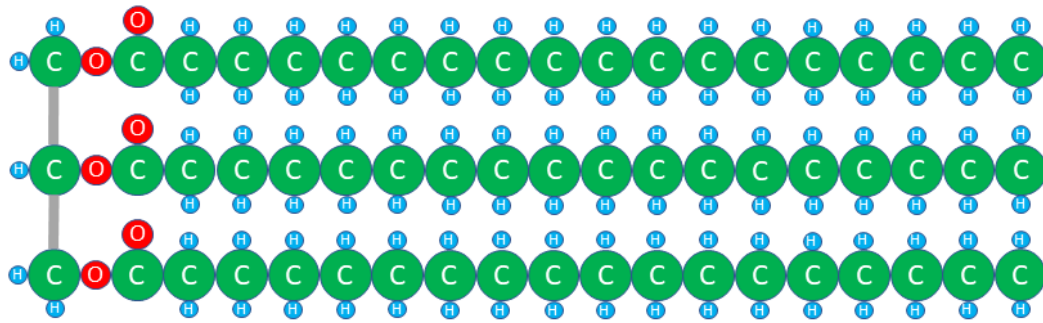
This high-heat, high-pressure process produces a fuel that has similar chemically properties of conventional diesel.

Biodiesel

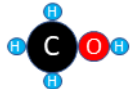
Typically produced through transesterification, a simpler process that reacts a fat or oil with a small amount of alcohol (typically methanol) to produce a diesel like fuel.

THE BIODIESEL PROCESS

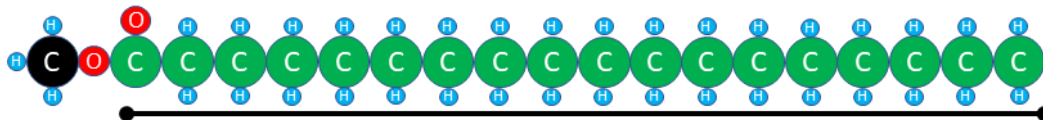
C-18 Triglyceride – Steric Acid



Fossil Methanol (alcohol) X 3

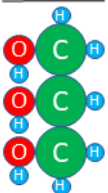


Biodiesel – C18 Steric Acid Methyl Ester X 3



18 Biogenic Carbon

Glycerol



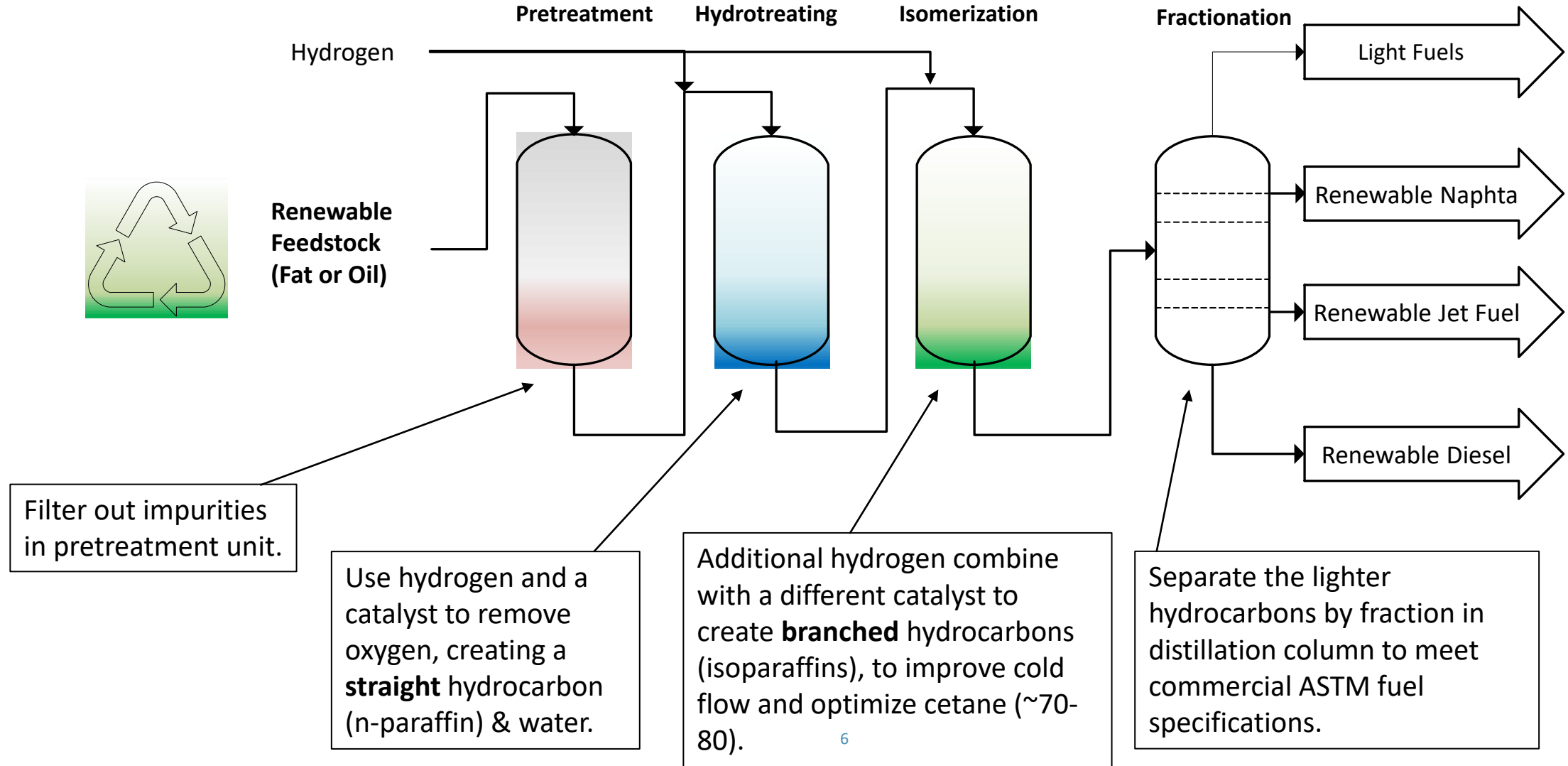
C-18 + methanol
=biodiesel & Glycerin

Legend:

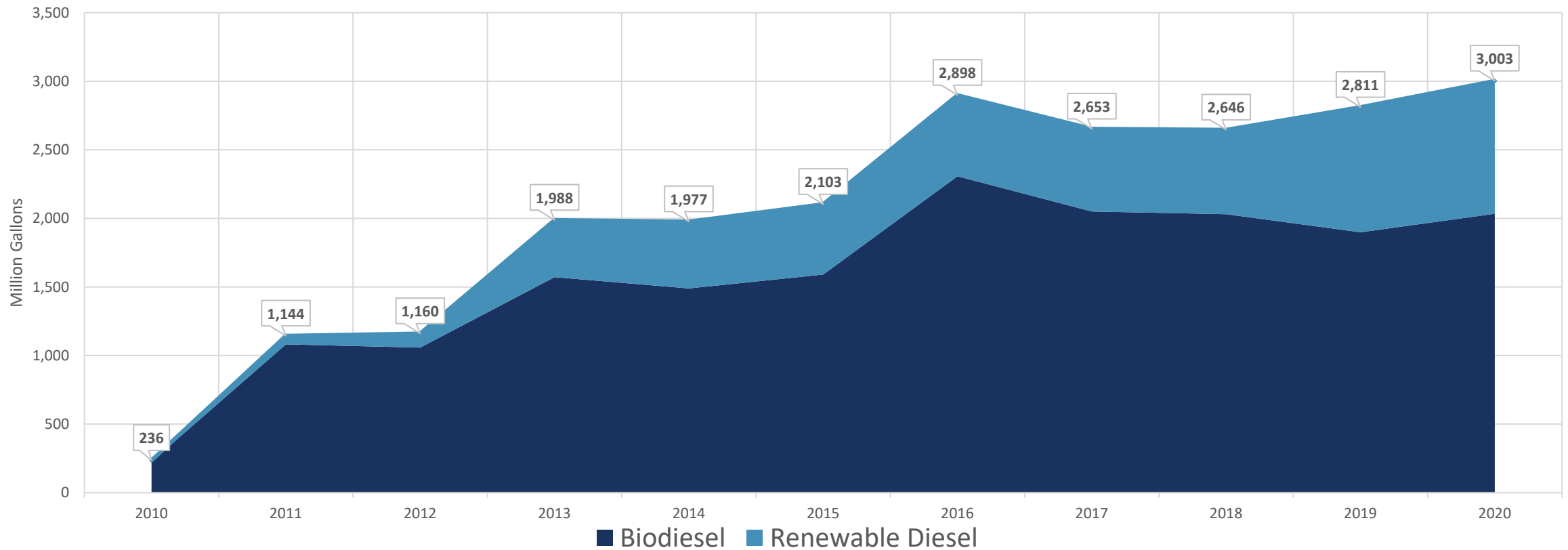
- H • Hydrogen
- O • Oxygen
- C • Biogenic Carbon
- C • Fossil Carbon

- **Biodiesel** – A fuel comprised of mono-alkyl esters of long chain fatty acids derived from vegetable oils or animal fats, designated B100, and meeting the requirements of ASTM D6751
- A biofuel intended as a substitute for diesel
- A renewable fuel for diesel engines made from fats and oils

RENEWABLE DIESEL PROCESS



U.S. BIODIESEL & RENEWABLE DIESEL MARKET

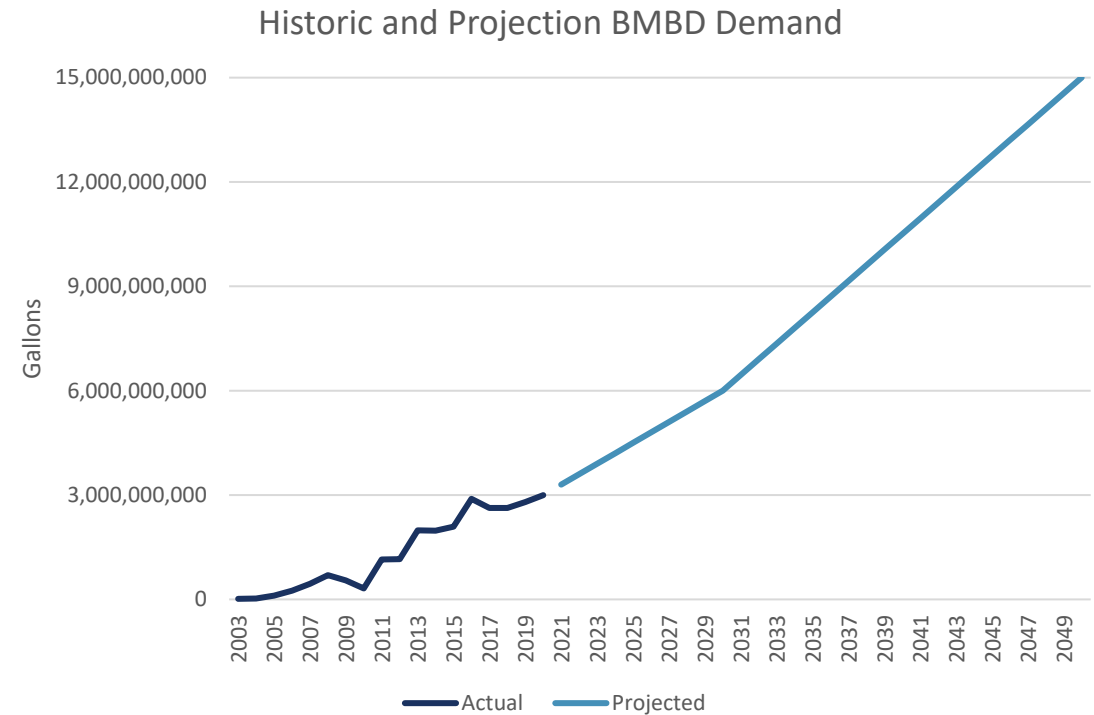


EPA EMTS: Biomass-based diesel volumes reported under the RFS in the D4, D5, and D6 categories.



UNITED STATES BIOMASS-BASED DIESEL DEMAND

- U.S. biomass-based diesel demand is over 3 billion gallons
 - 2020-2021 announcements of 4.5 billion gallons of additional RD capacity
- Biomass-based diesel is today's low carbon solution for home or industrial heating, heavy-duty trucking, emergency vehicles, marine applications, etc.
 - Recognition of long-term demand for diesel, kerosene, heavy fuel oil



BETTER TOGETHER

BIODIESEL

A “drop-in” fuel for home and industrial heating equipment **up to 20% and many up to 100%.**

Non-toxic, biodegradable, ultra-low sulfur and 0% aromatics.

High cetane and improved lubricity.

ASTM D6751



RENEWABLE DIESEL

A “drop-in” fuel in all home and industrial heating equipment **up to 100%.**

Ultra-low sulfur and 0% aromatics.

Higher cetane.

ASTM D975



PRODUCING THE FUEL

BIODIESEL

- Lower capital costs
- Lower temperature, pressure, and energy process
- Uses any oil or fat
- Process favors low Free Fatty Acids (FFA)
- Co-produces
 - Glycerin (feed)
 - Fatty acids and distillation bottoms (energy)

RENEWABLE DIESEL

- Higher capital cost, larger capacity
- Higher temperature, pressure, and energy process
- Uses any oil or fat
- Process can use very-long-chain fatty acids (waxes)
- Co-produces
 - Naphtha (gasoline)
 - LPG



ECONOMICS AND CREDITS

BIODIESEL

- B100 is eligible for RFS (1.5 RINs/gallon), federal blender's tax incentive (\$1.00 per gallon)
- B100 eligible for California LCFS credit, with value dependent upon CARB Carbon Intensity (CI) score
- Biodiesel blends are used across the U.S. under a variety of programs and markets

RENEWABLE DIESEL

- RD100 is eligible for RFS 1.7 (RINs/gallon) LPG 1.1, Naphtha ~1.4, federal blender's tax incentive (\$1.00 per gallon RD)
- RD100 eligible for California LCFS credit, with value dependent upon CARB Carbon Intensity (CI) score
- Almost all RD is used in California and other highly incentivized markets





LIFE CYCLE EMISSIONS

BREAKING DOWN THE LIFE CYCLE OF ADVANCED BIOFUEL

Well-to-Tank (WTT)

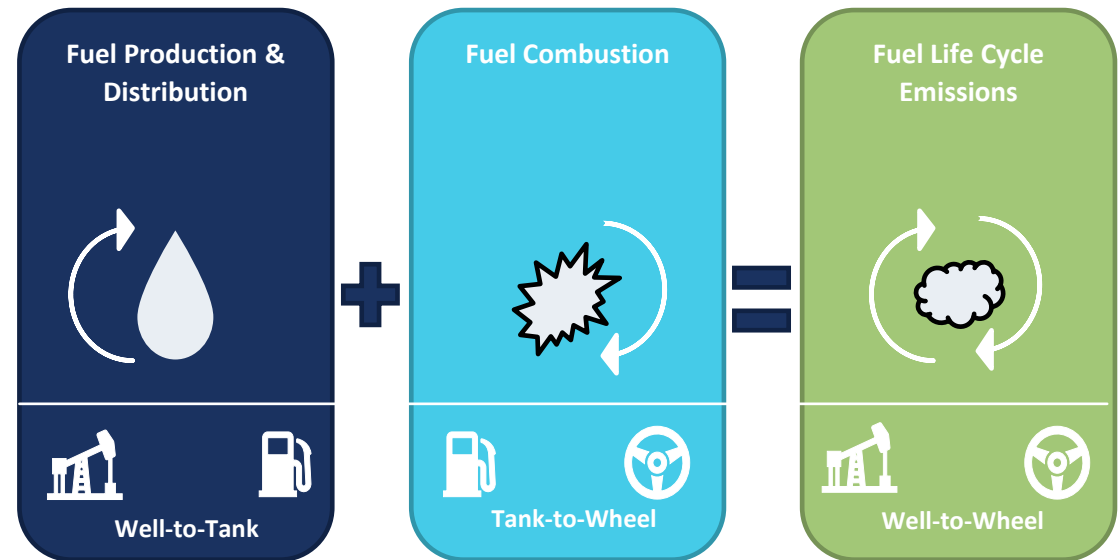
WTT emissions are associated with the production and distribution of liquid transportation fuels. These are categorized as Scope 3 emissions for most fuel consumers.

Tank-to-Wheel (TTW)

TTW emissions derive from fuel combustion that powers Scope 1 activities. Zero fossil CO₂ emissions are reported for electricity, hydrogen fuel cells, and biofuels. Non-CO₂ greenhouse gases are reported with their respective totals.

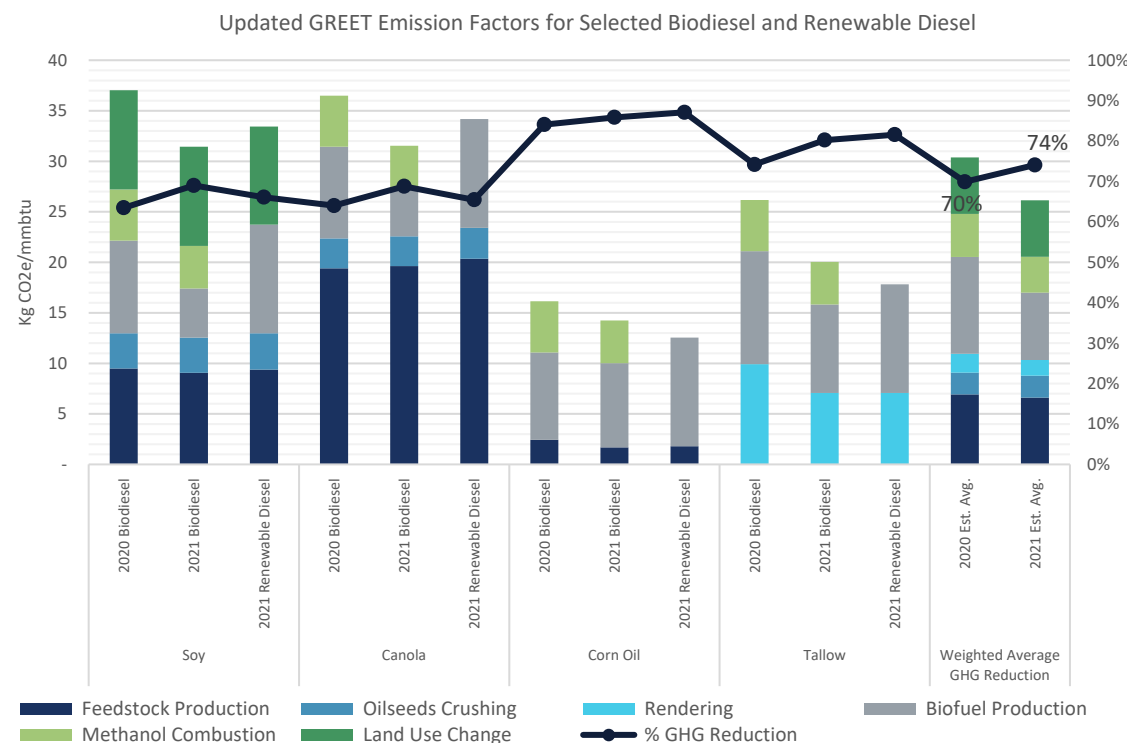
Well-to-Wheel (WTW)

WTW emissions represent the total from the full fuel life cycle and are equivalent to the sum of WTT and TTW. These emissions are commonly normalized and reported as carbon intensities, grams of carbon dioxide equivalent per MJ of fuel (g CO₂e/MJ). This normalization allows for the quicker comparison of the carbon intensity of different fuel types and energy carriers.



LIFE CYCLE EMISSIONS OF BIODIESEL

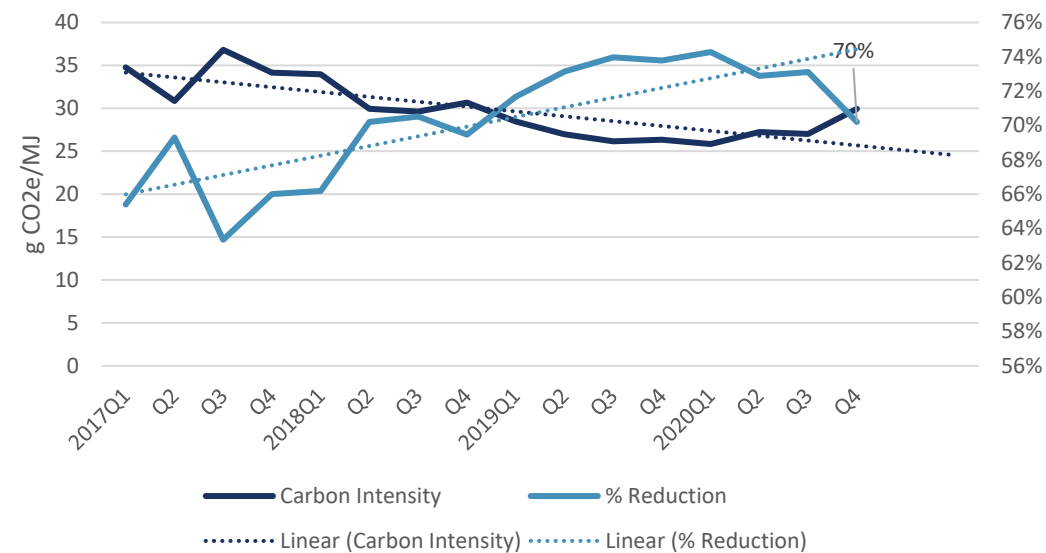
- Increases in energy efficiency, farming practices, and a cleaner overall energy mix continue to lead to emission reductions
- Argonne National Lab is the leading expert in the life cycle emissions of energy, including heating and transportation fuels
- Their model, GREET, documents a continued improvement in the carbon footprint of biodiesel for a growing list of feedstocks
- Inputs (fats and oils) into biodiesel production surveyed through EIA form 22-M used to calculate weighted average production



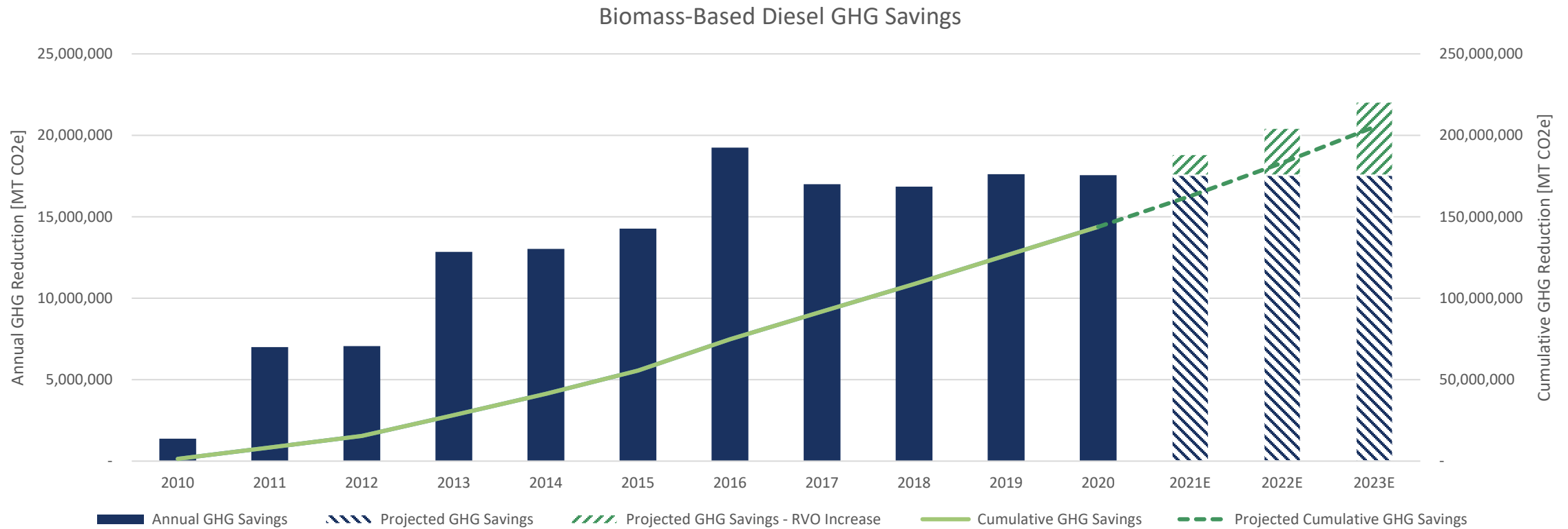
REDUCING LIFE CYCLE EMISSIONS

- California Low Carbon Fuel Standard documents similar trends in GHG to federal data
 - Other similar global programs show similar results: British Columbia, Oregon, Germany
- Policy and innovation have driven the production of more, cleaner biomass-based diesel from a more diverse range of raw materials
- Leading producers are reducing GHG emissions by ~90% compared to diesel according to California Air Resources Board

Average Biodiesel Carbon Intensity and GHG Savings in CA LCFS Program



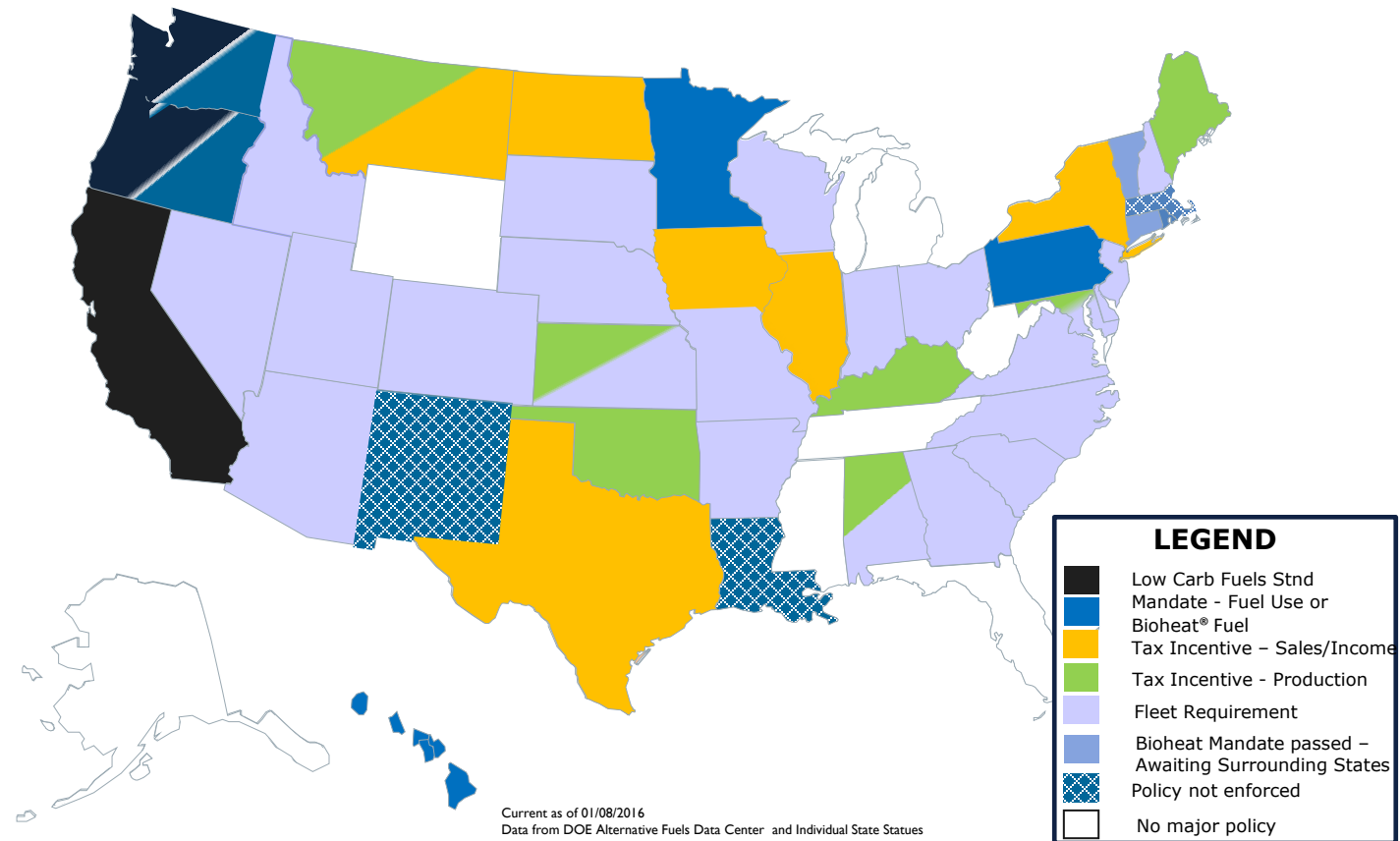
BIOMASS-BASED DIESEL GHG SAVINGS





POLICY AND RESOURCES

STATES WITH NOTABLE BIODIESEL POLICIES



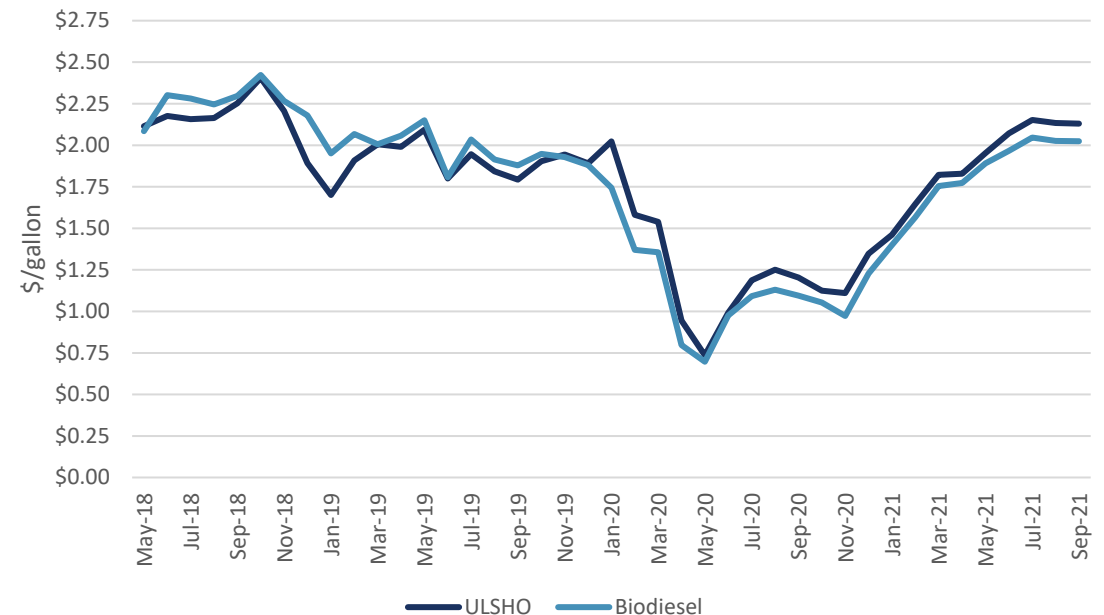
BIOHEAT® FUEL POLICY DRIVERS

- Bioheat® Fuel is a blend of biodiesel and heating oil.
- Sept 2019 Northeast Heating Industry Summit, “Providence Resolution”, unanimously agreed between fuel and equipment companies:
 - “Be it resolved that the heating oil industry will reduce its greenhouse gas emissions, based on 1990 levels: 15 percent by 2023; 40 percent by 2030; and Net-zero by 2050 (i.e., B20, B50, B100)”
 - R.W. Beckett Corp and Carlin Combustion Technologies certify burners to B20 in Q3 2020, representing the vast majority of burner, boiler, and furnace sales. B100 certified burners are anticipated to be introduced in 2022/2023
- CT, RI, and New York: passed bills for future B50 oilheat requirements, others likely
- Early adopter dealers already selling B50, B100 into existing homes, large boilers
 - NY School District purchasing B100 compatible boilers
- Gathering data, started negotiating on formal ASTM and UL standards up to B100

BIOHEAT[®] FUEL CONVERSION AND USE

- Low to no cost of conversion up to B20
- Bench testing, lab durability testing, and field trials w/B20 completed:
 - Data used to change ASTM D396 heating oil fuel standard (2015) and UL296 safety listing standard (2020) up to B20
- NBB, NORA, industry already started bench testing, lab durability testing, and field trials with B50 and B100 in home heating oil (using successful B20 model)
 - Material compatibility and pump durability testing OK (tested up to B100)
- Most companies now selling equipment supporting B20, B20 use is common

Wholesale Pricing for Biodiesel & Petroleum Heating Oil
New York Harbor





MATT HERMAN
DIRECTOR, ENVIRONMENTAL SCIENCE
NATIONAL BIODIESEL BOARD

MHERMAN@BIODIESEL.ORG

319-215-0833