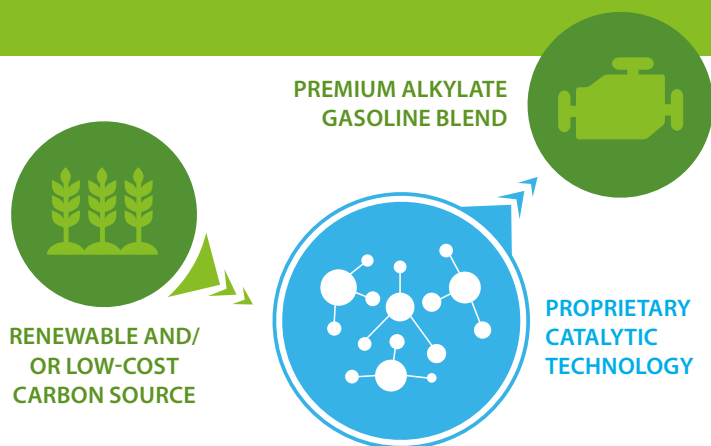




SYNTHETIC HIGH-OCTANE GASOLINE BLENDSTOCK

ADVANTAGES OF THE TECHNOLOGY

- 1 Hydrocarbon product** provides octane boost **without blend wall**
- 2 High octane** (>95 research octane number [RON]) with **low vapor pressure** and **no sulfur**
- 3 Minimal aromatics**, no toxicity, reduced particulate emissions
- 4** Compared to traditional methanol-to-gasoline: **higher yield, minimal aromatics; lower capital expenditures and operating expenses; longer up-time with less frequent regeneration; higher value product**
- 5** Provides a pathway to generate Renewable Identification Numbers (RINs) from biomethanol and biogas



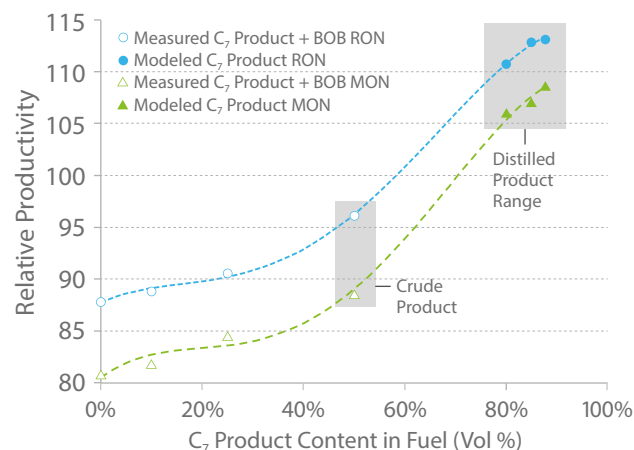
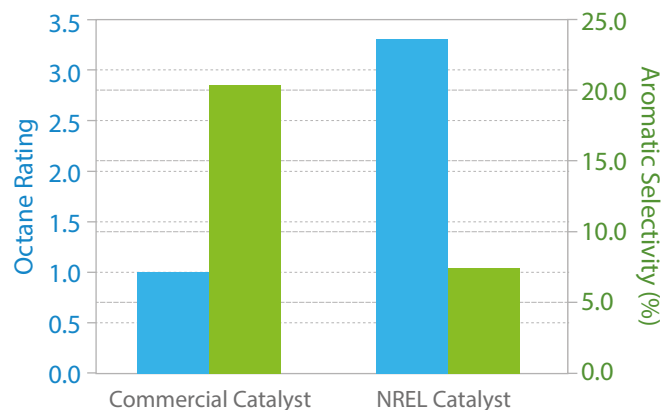
VALUE PROPOSITION AND DIFFERENTIATORS

Mid-sized automotive fuel refiners can **increase net revenues by more than \$60 million/year** using our product to:

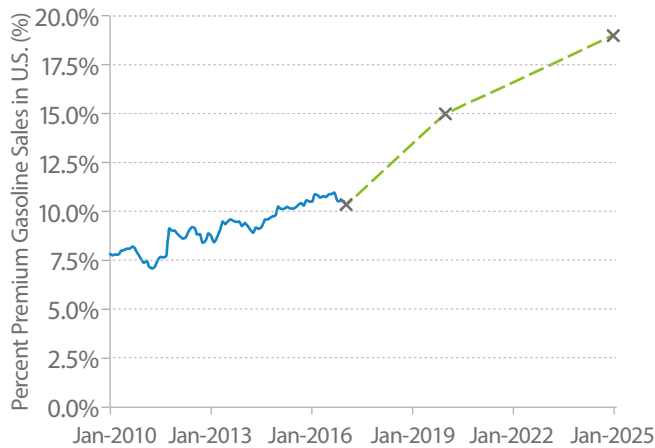
- Produce more **premium-grade fuel** to address growing demand
- Blend-up lower grades to **salable products**
- **Increase efficiency** of reformer operation
- **Reduce the volume** of crude oil purchased.

All of this is possible while still meeting regulatory mandates (Renewable Fuel Standard, Low Carbon Fuel Standard, and California Air Resources Board programs) with cellulosic biofuel RINs.

Increased productivity, reduced aromatics, tunable product octane



Market Drivers for High-Octane Gasoline



Premium Fuel Sales and Forecast
Source: U.S. Energy Information Administration and Oil Price Information Service



Premium-Regular Gasoline Price Difference
Source: U.S. Energy Information Administration

WE ARE SEEKING STRATEGIC PARTNERSHIPS AND COOPERATIVE RESEARCH AND DEVELOPMENT

- Methanol producers targeting the **U.S. fuel market**, and looking to **increase demand and value** of their product
- Syngas producers targeting a **high-value product from gas-to-liquids** technology
- Renewable feedstock providers (biomethanol, biosyngas, biogas) looking to **capitalize on RINs with a non-oxygenate** product
- Refiners seeking a **low- or no-capital source of high-value octane**, and those looking to meet regulatory volume mandates
- Automotive original equipment manufacturers looking to **leverage high octane gasoline to meet Corporate Average Fuel Economy** standards.



CONTACT US to discuss how our technology can address your needs

Daniel Ruddy, Jesse Hensley, Joshua Schaidle
303-384-6322, HighOctane@nrel.gov

NREL's catalytic carbon transformation research is supported by the U.S. Department of Energy (DOE), Energy Efficiency and Renewable Energy (EERE), Bioenergy Technologies Office (BETO).



National Renewable Energy Laboratory

15013 Denver West Parkway
Golden, CO 80401

303-275-3000 • www.nrel.gov

NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Operated by the Alliance for Sustainable Energy, LLC

NREL/FS-5100-72357 • August 2019

NREL prints on paper that contains recycled content.