



**2022  
POCKET  
GUIDE TO  
ETHANOL**

## **RFA POCKET GUIDE TO ETHANOL—**

**A quick reference for U.S. ethanol industry statistics and companion to the Renewable Fuels Association's comprehensive Ethanol Industry Outlook (available online at [EthanolRFA.org](http://EthanolRFA.org)).**

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**Geoff Cooper**  
*President & CEO*

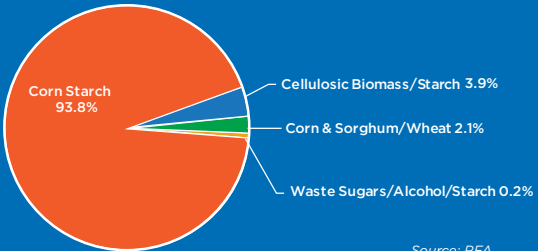
**RFA is the nation's leading trade association that expertly zeroes in on driving expanded demand for American-made renewable fuels and bioproducts worldwide. RFA members include renewable fuels producers & their value chains, academia, and other stakeholders and advocates.**

***RFA Members led the way in committing to achieve a NET-ZERO carbon footprint for ethanol by 2050 or sooner.***

# ZEROING IN ON ETHANOL

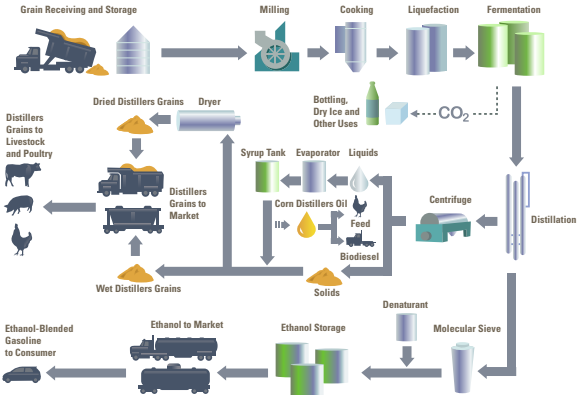
Ethanol is a **high-octane, low-carbon, biodegradable renewable fuel** primarily derived from the sugars, starches, and cellulosic matter found in plants.

## U.S. ETHANOL PRODUCTION CAPACITY BY FEEDSTOCK TYPE



Source: RFA

## DRY MILL ETHANOL PROCESS



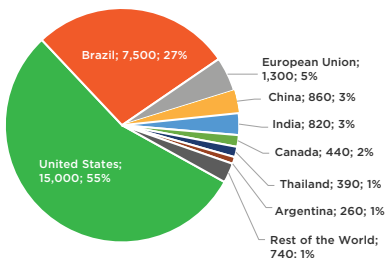
Source: RFA

# WHO MAKES ETHANOL?

The United States is the world's top producer of ethanol, supplying more than half the world's output.

## 2021 GLOBAL FUEL ETHANOL PRODUCTION

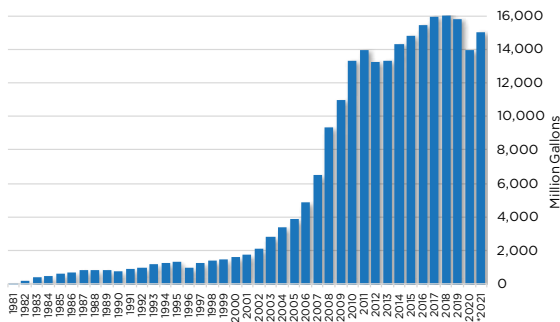
Region; million gallons; share of global production



Sources: RFA analysis of public and private data sources

U.S. ethanol biorefineries produced 15 billion gallons of ethanol in 2021, an 8 percent rebound after COVID curtailed production in 2020.

## HISTORICAL U.S. FUEL ETHANOL PRODUCTION

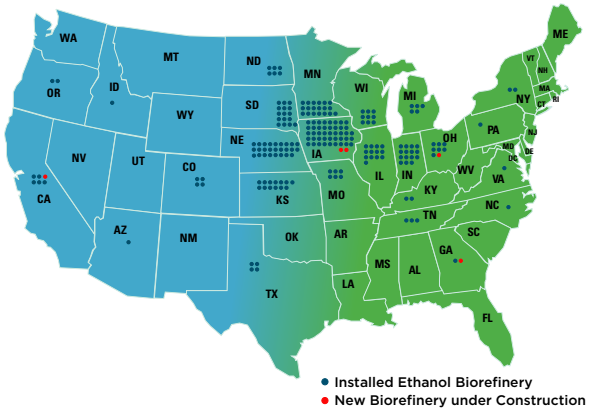


Sources: RFA and U.S. Energy Information Administration

\* Estimated

25 states are home to 208 biorefineries with a combined ethanol production capacity of 17.7 billion gallons per year.

### U.S. ETHANOL BIOREFINERIES BY STATE



Over half the installed U.S. ethanol name-plate capacity is concentrated in Iowa, Nebraska, and Illinois.

Rank	State	MGY
1	Iowa	4,678
2	Nebraska	2,351
3	Illinois	1,912
4	Minnesota	1,371
5	Indiana	1,388
6	S. Dakota	1,253
7	Ohio	716
8	Kansas	602
9	Wisconsin	596
10	N. Dakota	547

Source: RFA

# ENERGIZING THE ECONOMY

Ethanol is a major driver fueling the U.S. farm economy and serves as the most important value-added market for farmers. In 2021, ethanol biorefineries profitably processed more than 5.1 billion bushels of corn, despite a 74% feedstock price increase.

## Ethanol's Value-Added Proposition

Based on average prices and product yields in 2021, a typical dry mill ethanol plant was adding approximately \$2.42 of additional value—or 40%—to every bushel of corn processed.

**\$ 5.93** Corn Cost per Bushel

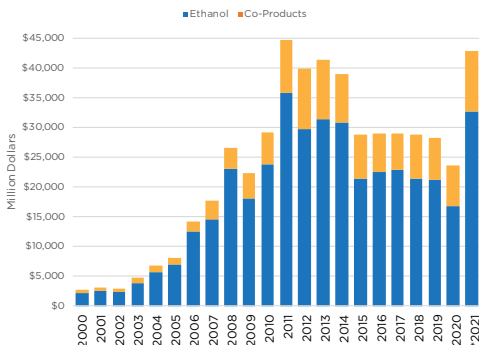


### Value of Outputs per Bushel

Ethanol	\$ 6.54
Distillers Grain	\$ 1.52
Corn Distillers Oil	\$ 0.45
<b>TOTAL</b>	<b>\$ 8.51</b>

In 2021, with rebounding production and higher market prices, the value of the U.S. ethanol industry's output jumped to \$43 billion.

### GROSS VALUE OF U.S. ETHANOL INDUSTRY OUTPUT



Source: RFA based on U.S. Dept. of Agriculture data \* Estimated

The ethanol industry's impact on the economy is considerable as the economic recovery from the effects of COVID gains ground.

Ethanol biorefineries offer skilled jobs and good wages in rural communities where attractive employment opportunities are often hard to find. **18%** of ethanol employees are **military veterans—triple** the national workforce average.

## Ethanol and the 2021 Economy

Direct Jobs.....	73,193
Indirect/Induced Jobs .....	334,220
Household Income .....	\$28.7 billion
GDP Contribution .....	\$52.1 billion

Ethanol producers and shippers have an impeccable safety record, thanks in large part to RFA's multi-year investment in award-winning safety training programs.

RFA and its partners offered 35 free online and in-person training seminars and courses to nearly **1,600** participants in 2021 alone. These first-rate safety programs earned **national recognition for the 9th consecutive year.**

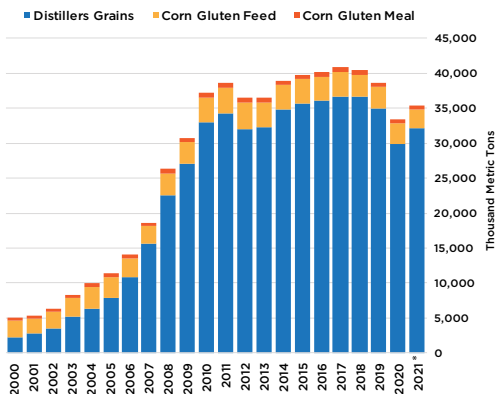
# FOCUSING ON FEED

**1 BUSHEL OF CORN** yields, on average:

- 2.9 gallons of denatured fuel ethanol
- 15.1 pounds of distillers grains (10% moisture)
- 0.8 pounds of corn distillers oil
- 17 pounds of biogenic carbon dioxide

The U.S. ethanol industry generated **35.4** mmt of distillers grains and gluten feed/meal.

## U.S. ETHANOL INDUSTRY CO-PRODUCT ANIMAL FEED OUTPUT



Source: RFA and U.S. Dept. of Agriculture.

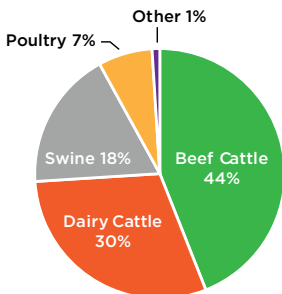
Note: All co-products converted to 10 percent moisture basis

\*Estimated

Ethanol co-products are a high-protein, high-energy substitute for corn, soybean meal, and other ingredients in animal feed rations worldwide.



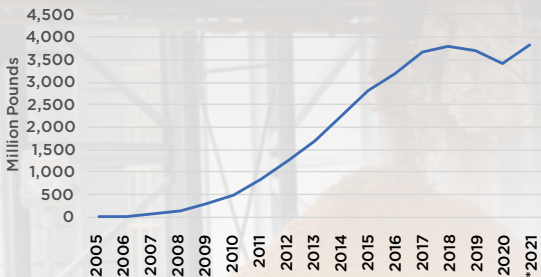
## DISTILLERS GRAINS CONSUMPTION BY SPECIES



Source: U.S. Dept. of Agriculture

Ethanol plants extracted over **3.8 billion lbs.** of corn distillers oil. This **\$2.1 billion** market underpins biodiesel and renewable diesel production as well as poultry feed.

## CORN DISTILLERS OIL PRODUCTION



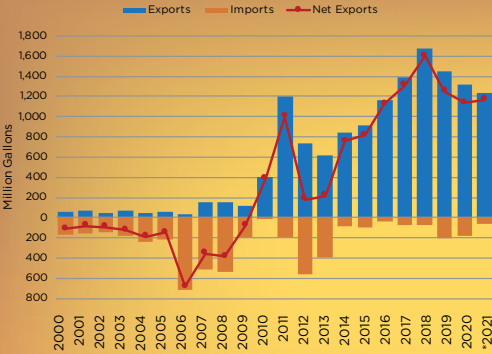
Sources: U.S. Dept. of Agriculture and RFA

\*Estimated

# GLOBAL DEMAND

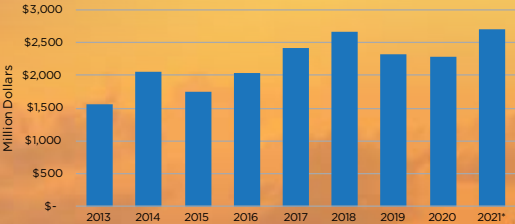
U.S. ethanol exports were robust in 2021 at **1.2 billion** gallons, despite declining to a five-year low. This **\$2.7 billion** export market helped the U.S. remain a net exporter for its **12th** consecutive year.

## U.S. ETHANOL EXPORTS AND IMPORTS



Sources: U.S. Dept. of Commerce, U.S. Census Bureau, Foreign Trade Statistics  
\*Estimated based on Jan.-Nov. 2021 data

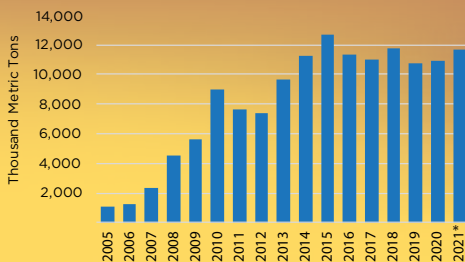
## VALUE OF U.S. ETHANOL EXPORTS



Sources: U.S. Dept. of Commerce, U.S. Census Bureau, Foreign Trade Statistics  
\*Estimated based on Jan.-Nov. 2021 data

The U.S. exported **1** out of every **3** tons of distillers grains produced, or **11.6** mmt. The global marketplace is vast with over **50** countries importing U.S. DDGS—**1/2** of U.S. exports land in Southeast and East Asia.

## U.S. DISTILLERS GRAINS EXPORTS



Sources: U.S. Dept. of Commerce, U.S. Census Bureau, Foreign Trade Statistics \*2021 estimated based on Jan.-Nov. 2021

### TOP DESTINATIONS FOR U.S. ETHANOL

1. Canada
2. India
3. South Korea
4. China
5. Brazil

### TOP DESTINATIONS FOR U.S. DISTILLERS GRAINS

1. Mexico
2. Vietnam
3. South Korea
4. Indonesia
5. Turkey

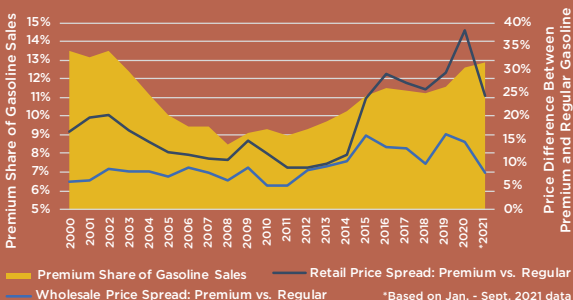
# POWERFUL OCTANE

A fuel's **OCTANE RATING** is the measure of its ability to resist “knocking” in the engine, which is caused when the air/fuel mixture detonates prematurely during combustion. According to the U.S. Department of Energy, “Using a lower octane fuel than required can cause the engine to run poorly and can damage the engine and emissions control system over time. It may also void your warranty.”

The share of gasoline sales represented by **premium grade** hit a nearly **20-year high** in 2021. Automakers favor turbocharged, higher-compression engines that use or require high-octane gasoline. Their need for a **clean, affordable source of octane like ethanol** will intensify with increasingly stringent fuel economy.

The **wholesale price spread** between premium and regular gasoline grades fell to a more historically consistent level in 2021 but the **retail price spread** remained elevated after spiking higher during the pandemic.

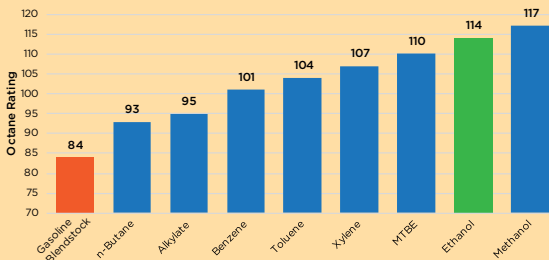
## PREMIUM GASOLINE: SHARE OF SALES AND PRICE DIFFERENCE VS. REGULAR



Sources: U.S. Dept. of Commerce, U.S. Census Bureau, Foreign Trade Statistics \*Estimated based on Jan. - Nov. 2020 data

Ethanol has a blending octane rating of **114 AKI—the highest value** of any competing octane source. Plus, competing aromatic hydrocarbons like benzene are toxic and worsen air pollution.

**BLENDING OCTANE RATINGS OF VARIOUS GASOLINE OCTANE BOOSTERS**



Source: U.S. Dept. of Energy

## REFINERS PREFER ETHANOL

Refiners have largely optimized their processes to reduce hydrocarbon-based octane production to take advantage of ethanol's properties:

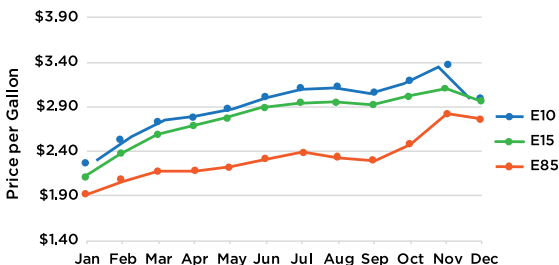
- Most regular gasoline is produced using lower cost blendstock with an 84-octane rating.
- **Refiners add 10% ethanol** to gasoline to boost it up to 87 octane.
- Higher blends like **E15 and E30** offer an even greater octane boost to today's regular gasoline.

# HIGHER ETHANOL BLENDS

Increasing the use of ethanol higher blends is a key strategy for reaching long-term **low-carbon goals**.

- **E15 fuel** is composed of 15% ethanol and 85% gasoline.
- E15 is **approved for use in model year 2001 and newer** cars, light-duty trucks, medium-duty passenger vehicles (SUVs), and all flex-fuel vehicles (FFVs).
- **9 out of 10** of light-duty vehicles on the road today are approved by their manufacturer to run on E15.
- E15 has a **higher octane rating** and typically **costs less** than regular unleaded.

2021 NATIONAL AVERAGE RETAIL PRICES FOR E10, E15 & E85



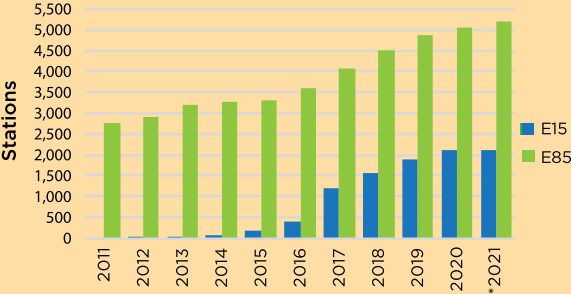
Source: RFA based on data from [E85prices.com](http://E85prices.com)

In 2021, the **federal government** prioritized efforts to expand infrastructure to facilitate, including **\$100 million** in matching infrastructure funding and proposing **\$960 million** in the Build Back Better Act.

## RFA & HBIIP

HBIIP is the U.S. Dept. of Agriculture’s Higher Blends Infrastructure Incentive Program. RFA has offered application assistance for two rounds of HBIIP funding, helping secure **\$24 million** in grants & **\$40 million** in matching commitments affecting **21** states and **244** retail stations, for a total of **1,200** new dispensers.

### EXPANSION OF U.S. RETAIL STATIONS OFFERING E15 AND E85



Source: RFA

**Retailers and consumers alike understand the value of lower-cost, higher-octane fuels like E15 and E85.**

# CARBON REDUCTIONS

## By the Numbers

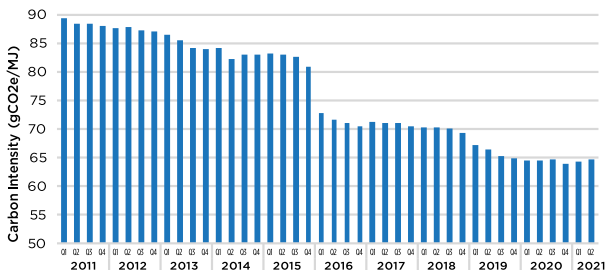
**Ethanol has a proven track record of cutting GHG emissions from transportation.**

- The use of ethanol and other biofuels under the Renewable Fuel Standard has reduced U.S. transportation sector GHG emissions by 980 million metric tons (MT) since 2008.
- In 2021 alone, the use of ethanol reduced GHG emissions by 54.5 million MT, like taking 12 million cars off the road for a year.

**Today's corn ethanol reduces GHG emissions by half compared to gasoline.**

Ethanol has been the cornerstone of emissions reductions in California—providing over 40% of the carbon reductions achieved under the state's Low Carbon Fuel Standard.

**CARBON INTENSITY OF STARCH-BASED ETHANOL  
IN CALIFORNIA GASOLINE**



Source: RFA using California Air Resources Board Data

Ethanol also reduces tailpipe emissions of harmful pollutants, such as carbon monoxide, air toxics and fine particulate matter.



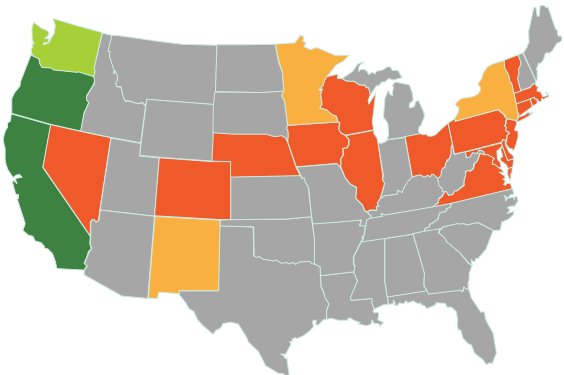
**An Industry first: In July 2021, RFA's Board of Directors unanimously agreed to a Net-Zero Commitment:**

- **By 2030, ensure that ethanol reduces GHG emissions by at least 70 percent, on average, when compared directly to gasoline.**
- **By 2050, ensure that ethanol achieves net zero lifecycle GHG emissions, on average.**

**States are leading the way in pursuing innovative policies and initiatives to expand the use of low-carbon renewable fuels.**

**STATE ACTIVITY ON LOW CARBON AND CLEAN FUEL STANDARDS**

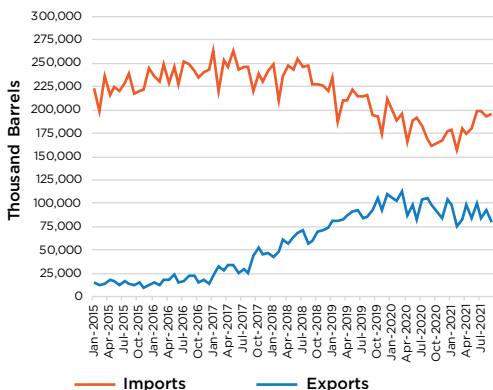
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|--|--|
|  Program implemented      |  CFP legislation introduced             |
|  CFP legislation passed |  Active discussion on CFP development |



# ENERGY SECURITY

Americans received a stark reminder in 2021 that the country is not energy independent. While U.S. crude oil production & exports have increased, the U.S. still imports nearly **200 million barrels** per month. And as of November 2021, gasoline prices have increased **58%** over the year-earlier level—the largest increase since 1980.

## U.S. CRUDE OIL TRADE



Source: U.S. Dept. of Energy

**One-third** of U.S. crude supplies came from foreign sources. Imports equated to **40%** of the oil processed by refineries. Fortunately, the addition of ethanol to the U.S. fuel supply displaced **531 million barrels** of foreign oil in 2021.

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