

**READY.  
SET.  
GO!**

**2023 POCKET GUIDE TO ETHANOL**



**T**his quick reference guide is loaded with key updated statistics for the U.S. ethanol industry, including data on supply and demand, and the industry's value for the supply chain, U.S. economy, the environment, and consumer health. For a more comprehensive review, check out our popular

companion publication:

***2023 Ethanol Industry  
Outlook: Ready.  
Set. Go!***



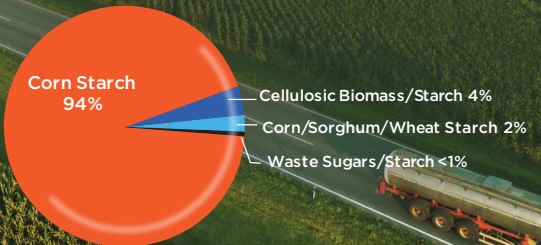
**Geoff Cooper**  
*President & CEO*

RFA has been the premier trade association for the U.S. ethanol industry for more than 40 years. Head to **[www.EthanolRFA.org](http://www.EthanolRFA.org)** to explore our membership, initiatives, and open access resources.

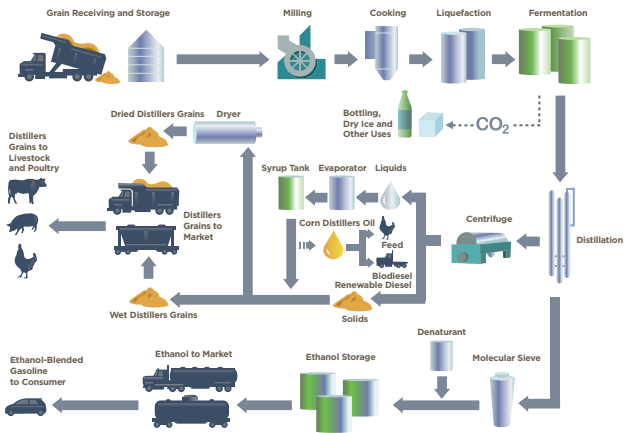
# FROM FARM TO FUEL

Ethanol (ethyl alcohol) is produced from plant materials that contain starches, sugars, and cellulosic matter.

## U.S. ETHANOL PRODUCTION BY FEEDSTOCK TYPE



## DRY MILL ETHANOL PROCESS



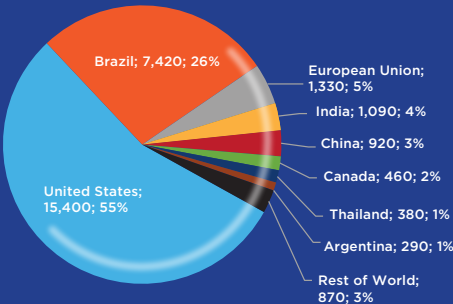
Source: RFA

# FUEL ETHANOL SUPPLY

The U.S. is the leading producer of ethanol, supplying over **half**—more than **15.4 billion gallons (bg)**—of the world’s output.

## 2022 GLOBAL FUEL ETHANOL PRODUCTION BY COUNTRY

*Country; million gallons; share of global production*



*Source: RFA analysis of public and private data sources*

Over the last 20 years, U.S. ethanol biorefineries’ installation and nameplate production capacity has *grown exponentially*.

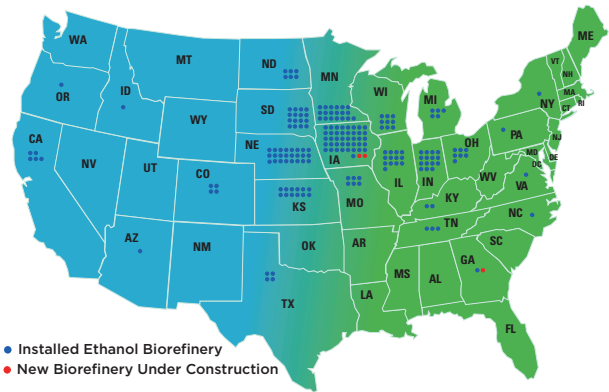
## HISTORICAL ETHANOL BIOREFINERY COUNT & PRODUCTION CAPACITY

Year	Installed Ethanol Biorefineries	Total Installed Production Capacity (mgy)	Average Capacity per Biorefinery (mgy)
2002	66	3,190	48
2007	136	7,888	58
2012	211	14,838	70
2017	211	16,241	77
2022	199	17,946	90



**199** plants in **25** states have a total nameplate capacity of **17.95** bg per year.

**U.S. FUEL ETHANOL BIOREFINERIES BY STATE**



**Half** of the nation’s ethanol capacity is installed in the three largest corn states—Iowa, Nebraska & Illinois.

**TOP STATES BY ETHANOL NAMEPLATE CAPACITY**

Rank	State	MGY	Share of U.S. Capacity
1	Iowa	4,759	27%
2	Nebraska	2,280	13%
3	Illinois	1,856	10%
4	S. Dakota	1,442	8%
5	Indiana	1,423	8%
6	Minnesota	1,414	8%
7	Ohio	732	4%
8	Kansas	602	3%
9	Wisconsin	596	3%
10	N. Dakota	555	3%

# FUELING THE ECONOMY

In 2022, biorefineries processed **5.3 billion** bushels of corn into a record **\$51 billion** of ethanol and co-products. This **34%** boost makes ethanol the most important value-added market for U.S. farmers.

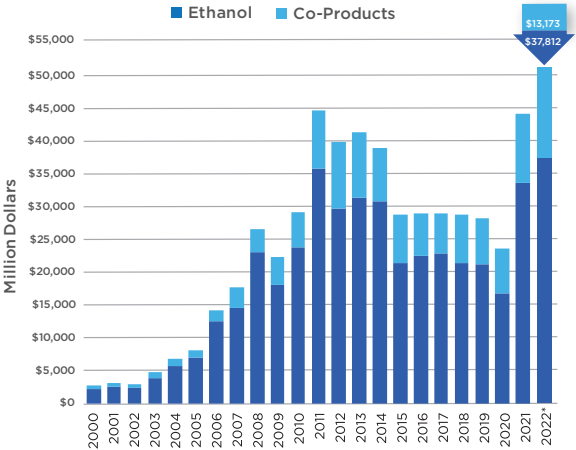
## Ethanol's Value-Added Proposition

Based on average prices and product yields in 2022, a typical dry mill ethanol plant was adding approximately \$2.44 of additional value—or 34%—to every bushel of corn processed.

**\$ 7.15**    Corn Cost  
per Bushel

Value of Outputs per Bushel	
Ethanol	\$ 7.10
Distillers Grain	\$ 1.85
Corn Distillers Oil	\$ 0.64
<b>TOTAL</b>	<b>\$ 9.59</b>

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



Source: RFA based on U.S. Energy Information Admin. and U.S. Dept. of Agriculture data. \*Forecast

Despite a turbulent economy, the ethanol industry's financial performance generated substantial economic impacts in 2022.

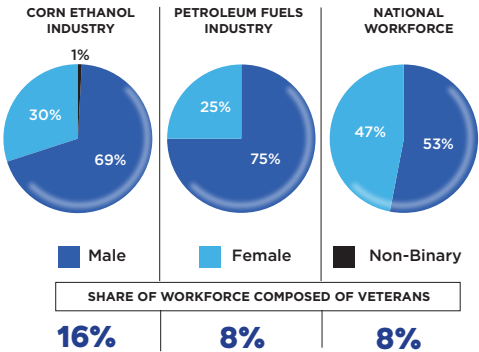
### Ethanol and the 2022 Economy

Direct Jobs.....	78,802
Indirect/Induced Jobs.....	342,876
Household Income.....	\$34.8 billion
GDP Contribution .....	\$57 billion

Source: ABF Economics LLP

Ethanol biorefineries offer **skilled jobs** and **good wages** in rural communities where attractive employment opportunities can be hard to find.

### WORKFORCE DEMOGRAPHICS



Source: U.S. Dept. of Energy data

**Protecting Our Communities:** Over **70%** of ethanol is transported across the nation via rail—roughly **395,000** carloads per year. RFA's award-winning training program has fostered an impeccable safety record.

# BEYOND MOTOR FUEL

Ethanol biorefineries provide fuel and food.

## 1 bushel of corn yields, on average:

- 2.9 gal. Denatured Fuel Ethanol
- 15.1 lbs. Distillers Grains (10% moisture)
- 0.9 lbs. Corn Distillers Oil
- 16 lbs. Biogenic Carbon Dioxide\*

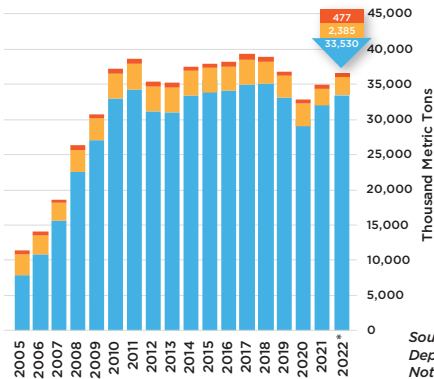
Source: RFA based on U.S. Dept. of Agriculture data. \*Approximately 30 percent of U.S. dry mills capture CO<sub>2</sub> from fermentation.

The U.S. ethanol industry generated **36.4 mmt** of distillers grains and gluten feed/meal in 2022.



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

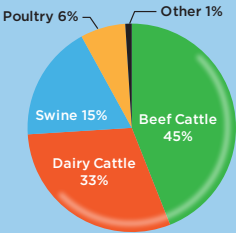
■ Distillers Grains   ■ Corn Gluten Feed   ■ Corn Gluten Meal



Source: RFA and U.S. Dept. of Agriculture.  
Note: All co-products converted to 10% moisture basis.  
\*Forecast

Distillers co-products are valuable **high-protein, low-cost** substitutes for corn and soybean meal in animal rations.

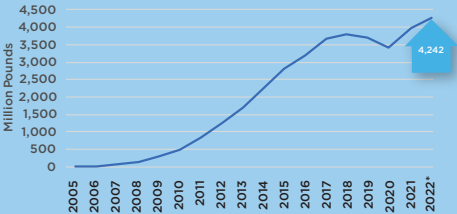
2022 DISTILLERS GRAINS CONSUMPTION BY SPECIES



Source: Distillers grains marketing companies

Ethanol plants extracted over **4.2 billion pounds** of corn oil used for poultry feed and as a biodiesel and renewable diesel feedstock.

CORN DISTILLERS OIL PRODUCTION



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

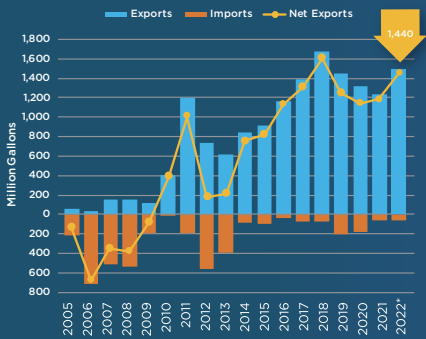
\*Forecast



# A GLOBAL MARKET

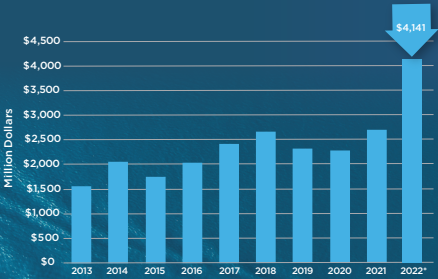
The U.S. extended its net exporter status for a **13th** consecutive year. U.S. ethanol exports rebounded to **1.4 bg**—the second-highest level ever—representing **9%** of production and **\$4.1 billion** in sales. U.S. imports accounted for less than **0.5%** of domestic ethanol consumption.

## U.S. ETHANOL EXPORTS AND IMPORTS



Sources: U.S. Dept. of Commerce, U.S. Census Bureau, Foreign Trade Statistics.  
\*Forecast based on Jan.-Sep. 2022 data

## VALUE OF U.S. ETHANOL EXPORTS

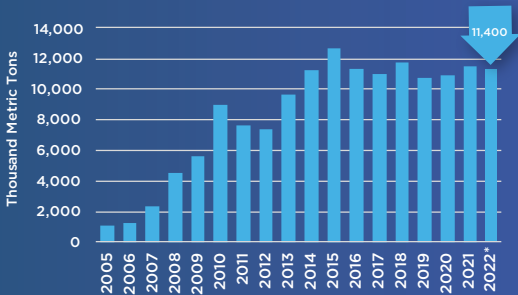


Sources: U.S. Dept. of Commerce, U.S. Census Bureau, Foreign Trade Statistics.  
\*Forecast based on Jan.-Sep. 2022 data



The U.S. exported **1 out of every 3 tons** of distillers grains produced, or **11.4 mmt**. The breadth of demand for U.S. ethanol co-products extends to more than **50 countries**.

### U.S. DISTILLERS GRAINS EXPORTS



Sources: U.S. Dept. of Commerce, U.S. Census Bureau, Foreign Trade Statistics. \*Forecast based on Jan.-Sep. 2022 data

**Half** of U.S. distillers grains exports shipped to Southeast and East Asia while another **20%** landed in Mexico—our top importer for the last 6 years.

### TOP 5 U.S. EXPORT MARKETS IN 2022

#### ETHANOL

- 1. Canada (32%)
- 2. South Korea (13%)
- 3. European Union (11%)
- 4. India (7%)
- 5. United Kingdom (5%)

#### DISTILLERS GRAINS

- 1. Mexico (20%)
- 2. Vietnam (12%)
- 3. South Korea (11%)
- 4. Canada (9%)
- 5. Indonesia (8%)

# ALL IN ON OCTANE

What is an **OCTANE RATING**? It's the measure of a fuel's ability to resist "knocking" in the engine when the air/fuel mixture detonates prematurely during combustion.

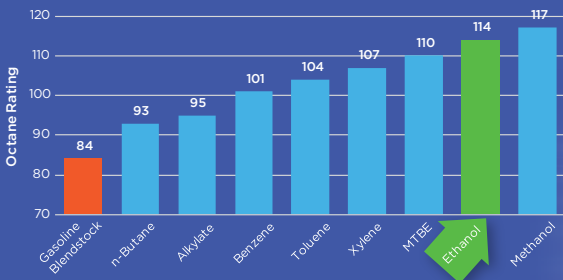
## Where's the Demand for Octane?

**Automakers** favor turbocharged, higher-compression engines that require the use of high-octane gas.

**Consumer** sales of premium (high-octane) fuel have seen steady growth for the last 15 years.

**Refiners** boost sub-octane gasoline blendstock with lower-cost octane to make 87 AKI finished fuel.

### BLENDING OCTANE RATINGS OF VARIOUS GASOLINE BOOSTERS



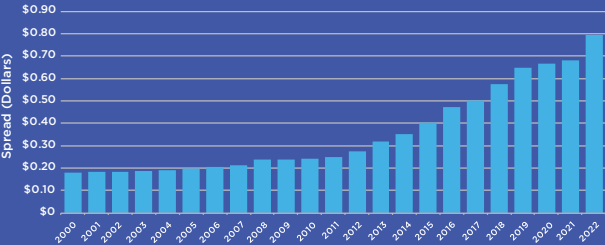
Source: U.S. Dept. of Energy



**Low-cost ethanol** has the **highest AKI** of any competing octane source. Moreover, aromatic hydrocarbon octane sources like benzene and toluene worsen air pollution and are highly toxic.

Ethanol has helped **moderate fuel prices** and can do even more—as the price spread between regular and premium fuel has increased.

### REGULAR-TO-PREMIUM FUEL PRICE SPREAD



Source: U.S. Dept. of Energy

Demand for octane sources should grow due to the use of *advanced engines*, *tighter gasoline specifications*, and the *expansion of lower-cost E15 and mid-level ethanol blends*.

# CLEARING THE AIR WITH ETHANOL

Ethanol is the best tool available to reduce tailpipe emissions of harmful pollutants.

## **Adding ethanol to gasoline reduces:**

- **Carbon Monoxide.** This can cause harmful health effects by reducing oxygen delivery to the body's organs.
- **Exhaust Hydrocarbons.** These form ground-level ozone (smog). Exposure irritates the nose and eyes, damages the lungs, and aggravates respiratory problems.
- **Air Toxics.** These pollutants can cause cancer and reproductive effects such as birth defects.
- **Fine Particulate Matter.** This is the main cause of reduced visibility (haze) and is linked to problems like heart attacks and aggravated asthma.

A 2021 study led by The Hormel Institute shows that ethanol-blended fuels like E10, E15 or E85 result in **fewer toxic emissions** from vehicles and present a **lower risk to human health** than regular gasoline. The researchers concluded that biofuels contain **fewer carcinogens** and therefore **reduce cancer risk**.

# THE NET-ZERO SOLUTION

Ethanol is already a low-carbon fuel that helps to clean up our nation's transportation fuels. An Argonne National Laboratory analysis shows today's typical corn ethanol reduces GHG emissions by 44%-52% when compared to gasoline.

## **RFA Member Producer Pledge:**

**By 2030**, ensure ethanol reduces GHG emissions by at least **70%** (on average).

**By 2050**, ensure that ethanol achieves **net-zero** lifecycle GHG emissions (on average).

Pathways to net-zero emissions could include workable improvements on the farm and biorefinery, especially with **renewable energy use** and **carbon capture and sequestration**.

**Flying High with Low-Carbon Ethanol:** The federal **SAF Grand Challenge**—which would expand U.S. sustainable aviation fuel production to 3 bg by 2030 and 35 bg by 2050—and provisions within the landmark **Inflation Reduction Act** target the large-scale reduction of aviation GHGs.

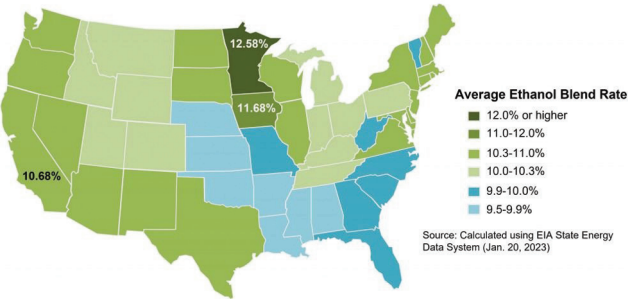
SAF is an **enormous opportunity** for low-carbon ethanol. The first commercial-scale production is expected to take flight within the next **2 years**.



# HIGHER ETHANOL BLENDS

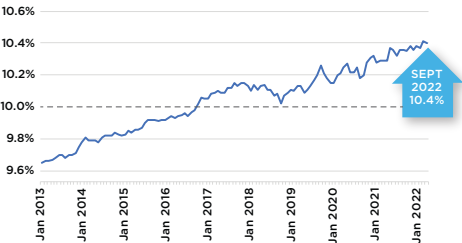
Higher ethanol blends like E15 and E85 continue to expand in the marketplace. In 2021, **35 states and D.C.** blasted through the so-called 10% ethanol “blend wall,” reaching a record blend rate of **10.3%**.

## 2021 ETHANOL SHARE OF GASOLINE CONSUMPTION BY STATE ("BLEND RATE")



Federal analysis indicates the U.S. ethanol blend rate also hit a record summertime average of **10.5%** in 2022.

## 12-MONTH MOVING AVG. BLEND RATE OF ETHANOL IN GASOLINE

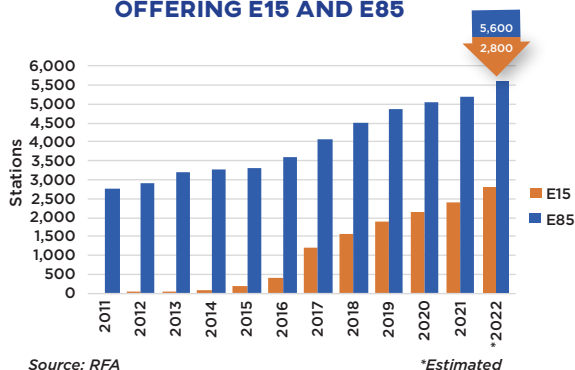


Source: RFA based on U.S. Energy Information Administration data

## E15:

- Approved for use in model-year **2001 and newer** light-duty vehicles and all FFVs.
- **9 out of 10 LDVs** on the road today are approved by their manufacturer for E15.
- Available at more than **2,800** retail stations

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



## E85:

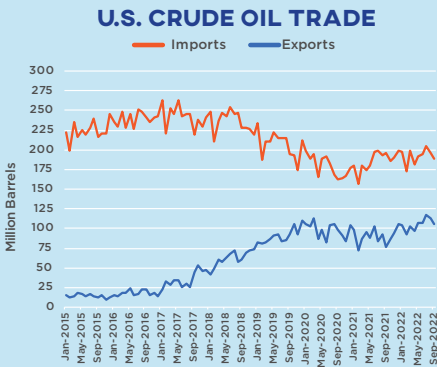
Available at more than **5,600** stations. Yet, automakers have backtracked on FFV production—availability is down roughly 90% in 8 years.

## HBIIP:

USDA's Higher Blends Infrastructure Incentive Program has allocated **\$200 million** in two initial rounds, with a third tranche expected this year. Another **\$500 million** is earmarked for biofuels blending infrastructure under the IRA.

# ENERGY SECURITY

In 2022, the U.S. imported **35%** of its U.S. crude oil—nearly **200 million barrels** per month.



While U.S. crude oil production and exports have increased, our nation still imports nearly 200 million barrels per month.

*Source: RFA based on U.S. Dept. of Energy data*

The U.S. transferred **\$31 billion**—or **\$240 per household**—to OPEC nations to pay for crude oil imports.

Fortunately, the addition of ethanol to the U.S. fuel supply **displaced more than 600 million barrels of foreign oil** and helped to hold down gasoline prices.



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