



POWERED BY PARTNERSHIPS

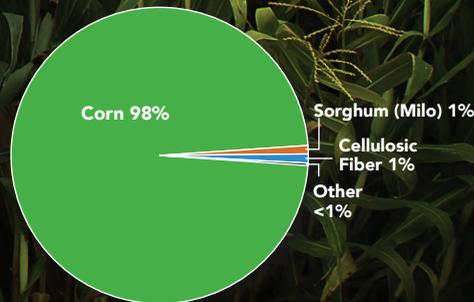
2024 POCKET GUIDE TO  
**ETHANOL**

This handy guide offers the latest statistics and info on the U.S. ethanol industry. For more detail, download RFA's **2024 Ethanol Industry Outlook** at [EthanolRFA.org/resources/annual-industry-outlook](https://EthanolRFA.org/resources/annual-industry-outlook).

## A RENEWABLE FUEL

Ethanol, or ethyl alcohol ( $C_2H_5OH$ ), is produced from **biomass**—renewable organic materials containing starches, sugars, or cellulosic matter.

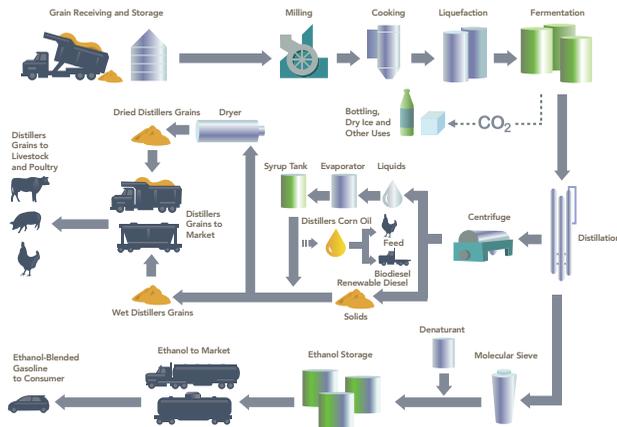
### U.S. ETHANOL PRODUCTION BY FEEDSTOCK TYPE



**Geoff Cooper**  
President & CEO

The Renewable Fuels Association is the leading trade association for America's ethanol industry. Explore our member profiles, initiatives, information resources and more at [EthanolRFA.org](https://EthanolRFA.org).

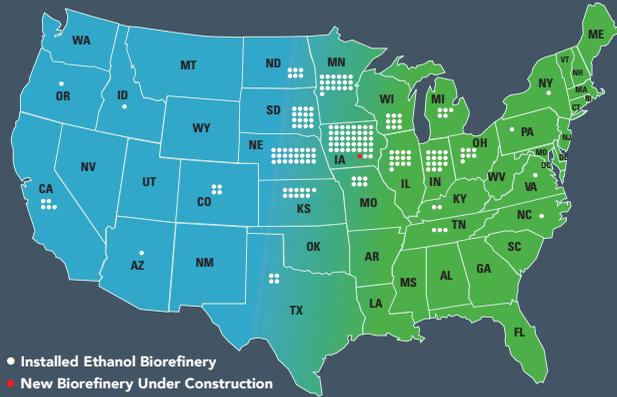
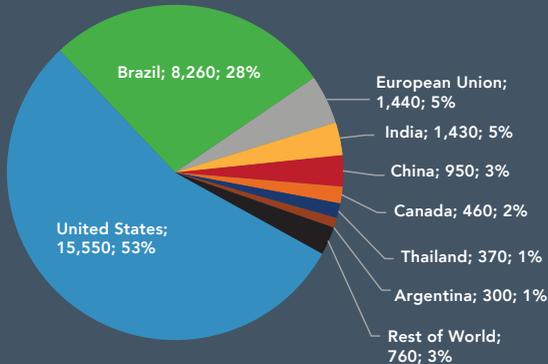
### DRY MILL ETHANOL PROCESS



# A U.S. POWERHOUSE

The U.S. is the **largest global producer of ethanol**, with **15.6 billion gallons** representing more than half of the worldwide output.

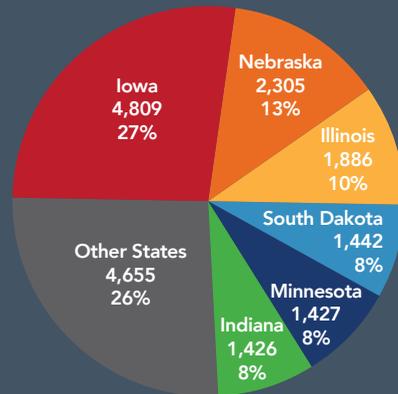
Country; million gallons; share of global production



**Half of the nation's ethanol capacity (mgy) is installed in the largest corn states of Iowa, Nebraska, and Illinois.**

| Year | Installed Ethanol Biorefineries | Total Installed Production Capacity (mgy) | Average Capacity per Biorefinery (mgy) |
|------|---------------------------------|---|--|
| 2003 | 72                              | 3,699                                     | 51                                     |
| 2008 | 170                             | 12,477                                    | 73                                     |
| 2013 | 210                             | 14,881                                    | 71                                     |
| 2018 | 210                             | 16,501                                    | 79                                     |
| 2023 | 198                             | 17,950                                    | 91                                     |

Nearly **200 biorefineries** across **24 states** have a cumulative total capacity of **18 bgy** of ethanol.



# FUELING THE ECONOMY

In 2023, biorefineries processed 5.3 billion bushels of corn worth **\$32 billion** into **\$46 billion** of ethanol and co-products. This **45% boost** makes ethanol the *most important value-added market* for U.S. farmers.



## Ethanol and the 2023 Economy

Direct Jobs ..... 72,463  
 Indirect/Induced Jobs ..... 322,002  
 Household Income ..... \$32.5 billion  
 GDP Contribution..... \$54.2 billion  
 Tax Revenues..... \$10.4 billion

## Ethanol's Value-Added Proposition

Based on average prices and product yields in 2023, a typical dry mill ethanol plant was adding approximately \$2.71 of additional value—a remarkable 45%—to every bushel of corn processed.

Corn Cost per Bushel

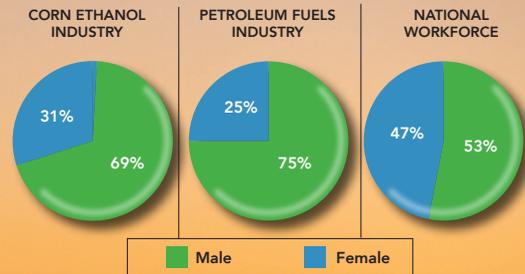
**\$ 5.99**



| Value of Outputs per Bushel |                |
|-----------------------------|----------------|
| Ethanol                     | \$ 6.53        |
| Distillers Grains           | \$ 1.64        |
| Distillers Corn Oil         | \$ 0.53        |
| <b>TOTAL</b>                | <b>\$ 8.70</b> |

The ethanol sector offers **good jobs** with **competitive wages** in rural communities where steady employment can be hard to find.

## WORKFORCE DEMOGRAPHICS



## SHARE OF WORKFORCE COMPOSED OF VETERANS

15%      9%      5%



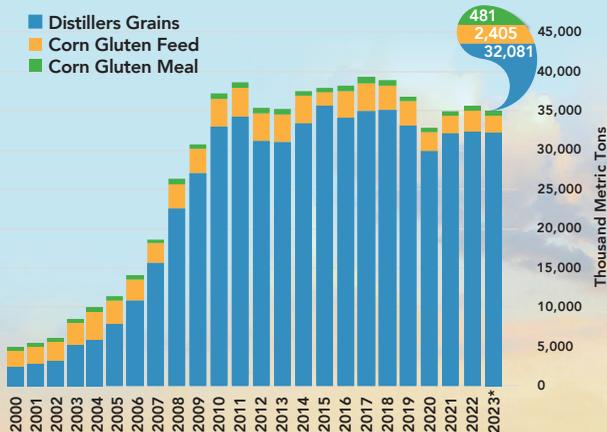
# FUEL AND FOOD

On average, **1 bushel of corn** yields:

|             |                                   |
|-------------|-----------------------------------|
| 2.9 gallons | Denatured fuel ethanol            |
| 14.8 pounds | Distillers grains (10% moisture)  |
| 0.9 pounds  | Distillers corn oil               |
| 16 pounds   | Captured biogenic CO <sub>2</sub> |

High-protein, low-cost ethanol co-products like distillers grains displace corn and soybean meal in **animal rations**.

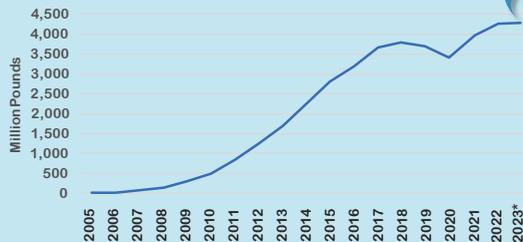
## U.S. ETHANOL INDUSTRY CO-PRODUCT ANIMAL FEED OUTPUT



Note: All co-products converted to 10% moisture basis.

\*Forecast based on Jan.-Oct. 2023 data

## DISTILLERS CORN OIL PRODUCTION

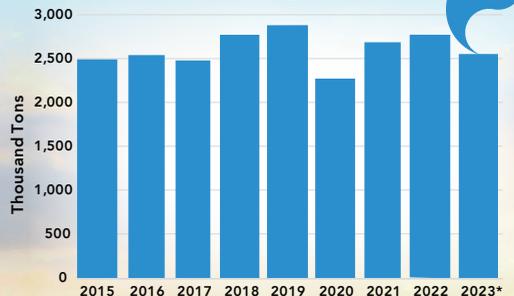


\*Forecast based on Jan.-Oct. 2023 data

**Distillers Corn Oil** is a feed ingredient and major feedstock for **renewable diesel/biodiesel**.

Traditional markets for **high-purity CO<sub>2</sub>** include food processing, beverage carbonation, dry ice production, and varied industrial applications.

## ANNUAL BIOGENIC CO<sub>2</sub> CAPTURED



\*Forecast based on Jan.-Oct. data

Dozens of biorefineries are planning to permanently sequester the CO<sub>2</sub> generated during fermentation, helping to lower the carbon intensity of their ethanol.

# HIGHER ETHANOL BLENDS

EPA approves E15 for **2001 and newer** cars and light trucks, while manufacturers have endorsed its use in **95%** of new cars and light trucks.

And roughly **25 million** flex fuel vehicles (FFVs) capable of running on E85 are on the road today.

Regrettably, **automakers have backtracked** on FFV production, scaling from 80 models a few years ago to just one FFV model in 2024.

## 2023 NATIONAL AVERAGE RETAIL PRICES FOR E10 & E85



Yet, E85's national average discount in 2023 was **\$0.88/gal.—a 26% savings!**

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



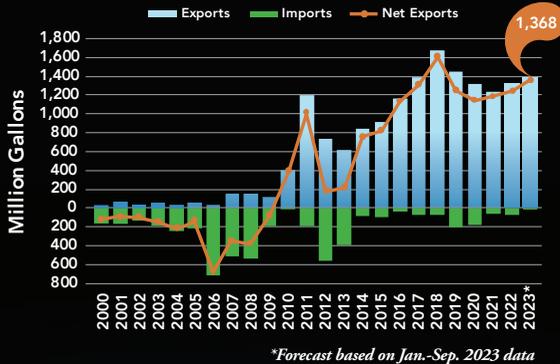
Expanded availability of E15 and flex fuels like E85 pushed the national average blend rate in 2023 to a **record high of 10.42%**—well beyond the so-called “10% blend wall.”

## ANNUAL ETHANOL BLEND RATE



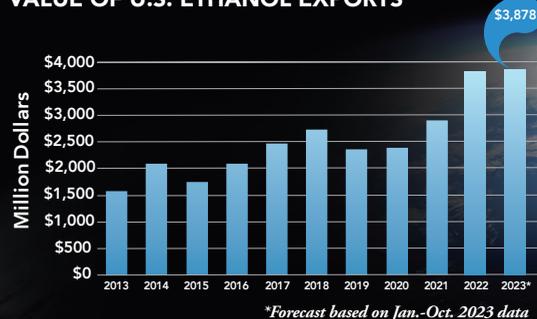
# A GLOBAL MARKET

## ETHANOL EXPORTS AND IMPORTS



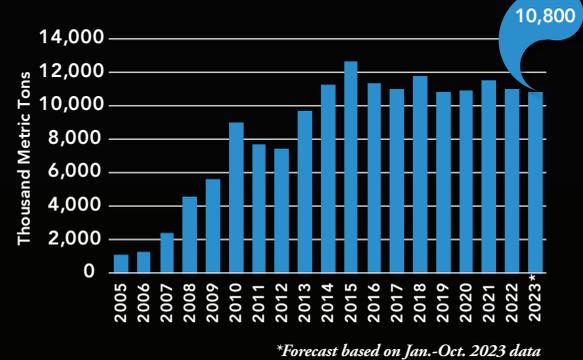
Booming ethanol exports—**representing 9%** of U.S. output and **\$4 billion** in sales—were bolstered by national commitments to *reducing GHG emissions and improving air quality.*

## VALUE OF U.S. ETHANOL EXPORTS



Steady global demand for DDGS pulled **1 of every 3 tons** produced in the U.S. into foreign markets.

## U.S. DISTILLERS GRAINS EXPORTS



Together, U.S. ethanol and co-products landed in **over 90 countries.**

### 2023 TOP U.S. EXPORT MARKETS

#### ETHANOL

1. Canada (47%)
2. United Kingdom (11%)
3. European Union (9%)
4. South Korea (7%)
5. India (5%)

#### DISTILLERS GRAINS

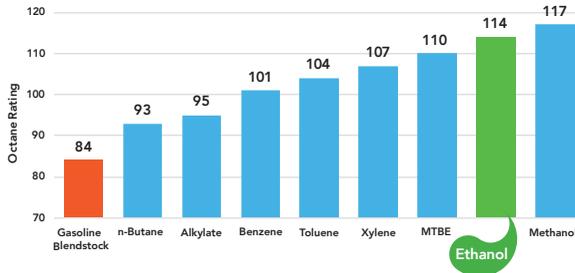
1. Mexico (21%)
2. South Korea (11%)
3. Vietnam (10%)
4. Indonesia (8%)
5. Canada (7%)

Conversely, the U.S. imported a **negligible volume** of foreign ethanol or DDGS in 2023.

# THE POWER OF OCTANE

Ethanol is the **lowest cost, highest octane** fuel additive available to gasoline refiners and blenders today.

## BLENDING OCTANE RATINGS OF VARIOUS OCTANE BOOSTERS



Ethanol also helps to **moderate consumer fuel prices**.

### 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 has seen exponential growth for the last 15 years.

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

# LET'S CLEAR THE AIR

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

Adding ethanol to gasoline reduced GHG emissions from the transportation sector in 2023 by **56.5 million mt**. This is equivalent to:

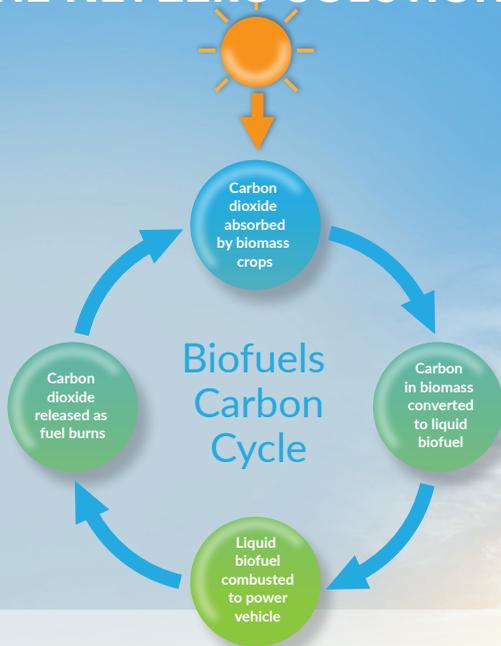
- Removing 12 million cars from the road for a year
- Eliminating annual emissions from 15 coal-fired power plants
- Eliminating emissions from 325,000 roundtrip flights from Los Angeles to New York City

A 2022 University of California, Riverside study shows that replacing E10 with E15 reduces:

|                                  |            |
|----------------------------------|------------|
| <b>Particulate matter</b>        | <b>18%</b> |
| <b>Carbon monoxide</b>           | <b>17%</b> |
| <b>Hydrocarbon gas emissions</b> | <b>8%</b>  |
| <b>Nitrogen oxide</b>            | <b>3%</b>  |

A 2021 study led by the Hormel Institute concludes that ethanol-blended fuel produces **significantly lower emissions** of toxic chemicals known to cause **cancer**.

# THE NET-ZERO SOLUTION



## 2021 RFA Member Producer Pledge

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

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

A 2022 landmark study identified multiple technology pathways to achieving these goals—**10 years ahead of schedule**.

Indeed, today **8 out of 10** member facilities are already on track to reach these goals.

# ETHANOL TAKES FLIGHT

The U.S. aviation sector consumed over **24 bgy** of petroleum-based jet fuel and emitted **10%** of all transportation-related emissions in 2023.

## U.S. JET FUEL CONSUMPTION



Global aviation can decarbonize with **ethanol**. SAF made from distillers corn oil is *already capable* of offering a **70%** GHG reduction.

**“Mark my words: By the next 20 years, farmers are going to be providing 95 percent of all the sustainable airline fuel.”**

— President Joe Biden, at a July 2023 event in Maine

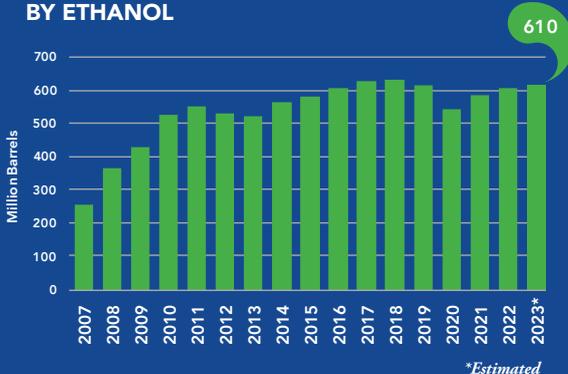
And, **ethanol-to-jet fuel** can approach—or exceed—net-zero carbon emissions through a combination of cleaner production technologies.



# ENERGY SECURITY

The U.S. imported **one-third** of its U.S. crude oil in 2023. Americans paid OPEC member countries **\$29 billion** for oil—that's **\$221 per household**.

## HISTORICAL OIL IMPORT DISPLACEMENT BY ETHANOL



Fortunately, the addition of ethanol to the U.S. fuel supply reduced the need for over **600 million barrels of foreign oil**.

A 2023 University of California, Berkeley-led study confirmed:

The presence of ethanol in our fuel supply **reduced U.S. gas prices by \$0.77/gal.** between 2019-2022.

Access to renewable fuels **limits the bargaining power** of foreign fuel producers, leading to a higher degree of fuel security.

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