

Ethanol Blends: Providing a Renewable Fuel Choice

More than 21 million vehicles on U.S. roads are flexible-fuel vehicles (FFVs) as of August 2022. These vehicles can operate on either gasoline or blends of gasoline and ethanol up to E85 (a gasoline–ethanol blend containing 51% to 83% ethanol).

As a renewable fuel, ethanol offers significant advantages. It is produced predominantly in the United States, made from home-grown feedstocks, and burns cleaner than gasoline.

What is an FFV?

An FFV, as its name implies, has the flexibility of running on more than one type of fuel. FFVs can be fueled with unleaded gasoline, E85, or any blend of the two up to 83% ethanol. Like conventional gasoline vehicles, FFVs have a single fuel tank, fuel system, and engine.

FFVs are equipped with modified components designed specifically to be compatible with ethanol's chemical properties. The illustration on this fact sheet describes the main modifications for FFVs versus conventional gasoline-powered vehicles. These modifications ensure seamless operation and a long, useful life across a wide range of ethanol blends.

Since FFVs can operate on gasoline or blends up to E85, many vehicle owners don't realize their car is an FFV and that they have a choice of fuels to use. Visit [FuelEconomy.gov](https://fuel-economy.gov) to learn how to identify an FFV (fuel-economy.gov/feg/ethanol.shtml). You can also find a list of available FFVs on the [Alternative Fuels Data Center](#).

Are FFVs available?

In the past, FFVs were widely available from multiple manufacturers. Vehicle manufacturers were motivated to receive Corporate Average Fuel Economy (CAFE) credits for producing FFVs. When the regulations for CAFE credits



These model year 2020 trucks can use E85. You can find out if your vehicle can use gasoline/ethanol blends up to E85 by looking for a yellow gas cap or badge on the vehicle body, checking the fuel door, or reading your owner's manual. *Photo by Joanna Allerhand, NREL 67273*

changed, FFVs became less available. For model year 2022, Chevrolet, Ford, and General Motors have limited FFV offerings for fleets and consumers.

Do ethanol blends affect vehicle performance?

FFVs operating on E85 generally handle and perform just as well as when fueled with gasoline. Light-duty vehicles made after 2001 can use blends up to E15 and perform normally. However any blend over E15 can only be used in FFVs. Sensors in the FFV system automatically prompt adjustments for fuel composition, so emissions and standard performance areas such as power and acceleration are not significantly affected by E85. E85 that contains 83% ethanol content has about 27% less energy per gallon than gasoline. The impact on fuel economy is proportional to the amount of ethanol in E85. Standard test results for fuel economy of FFVs and their gasoline counterparts are posted on [FuelEconomy.gov](https://fuel-economy.gov).

What are the costs and benefits of using E85 and other mid-level blends?

Generally, FFVs are available at the same cost or a minimum premium compared with conventional models. Manufacturers provide standard warranties for FFVs equal to those for gasoline vehicles at no additional charge. Total fuel costs may increase because of E85's impact on fuel economy as described above. Both gasoline and ethanol prices fluctuate based on market factors. E85 is generally priced below gasoline but may not be priced low enough to overcome the reduction in fuel economy. Regional E85 prices and comparisons with gasoline are available in the [Alternative Fuel Price Report](#).

A benefit of using ethanol is reduced emissions. Using the Greenhouse gases, Regulated

Emissions, and Energy Use in Technologies (GREET) model, Argonne National Laboratory calculates that greenhouse gas emissions are reduced up to 40% when using ethanol produced from corn.¹ Using ethanol also reduces CO₂ emissions and significantly reduces emissions of many harmful toxics, including benzene, a known human carcinogen. However, ethanol increases emissions of acetaldehyde, a toxic pollutant that studies have shown to be less harmful than benzene.²

How are FFVs identified?

Since September 2006, the Energy Policy Act of 2005 requires auto manufacturers to place a label inside the FFV fuel compartment that states the vehicle can run on either E85 or gasoline. Flexible-fuel capability is also outlined in the owner's manual.

Where are ethanol stations located?

The number of stations offering ethanol continues to increase across the nation. As of August 2022, more than 4,100 stations in 42 states sold E85, and more than 1,300 offer mid-level blends. To find ethanol stations throughout the country, check out the [Alternative Fueling Station Locator](#), a database maintained by the Alternative Fuels Data Center. To find mid-level blends, use the Advanced Filters, Fuel tab and select "Include only stations offering mid-level blends" under Ethanol (E85). This easy-to-use database also allows users to plot routes across town or across the nation, showing E85 stations along the way. ■

¹ Michael Wang, Uisung Lee, Hoyoung Kwon, and Hui Xu. "Life-Cycle Greenhouse Gas Emission Reductions of Ethanol with the GREET Model." Presented at the 2021 National Ethanol Conference, February 17, 2021. <https://afdc.energy.gov/files/u/publication/ethanol-ghg-reduction-with-greet.pdf>

² Kevin Whitney and Tony Fernandez. "Characterization of Cold Temperature VOC and PM Emissions from Flex Fuel Vehicles Operating on Ethanol Blends." Presented at the 17th CRC On-Road Vehicle Emissions Workshop, March 26–28, 2007.

Engine calibration updates:

Fueling and spark advance calibrations are directed by the vehicle computer to control combustion, enable cold start, and meet emissions requirements.

Internal engine parts:

Piston rings, valve seats, valves, and other components must be made of ethanol-compatible materials designed to minimize the cleansing effects of alcohol fuels, which can wash lubrication from parts.

Fuel identifier system:

System automatically senses the composition of the fuel and adjusts engine for varying ethanol-gasoline blends.

Fuel system electrical connections and wiring:

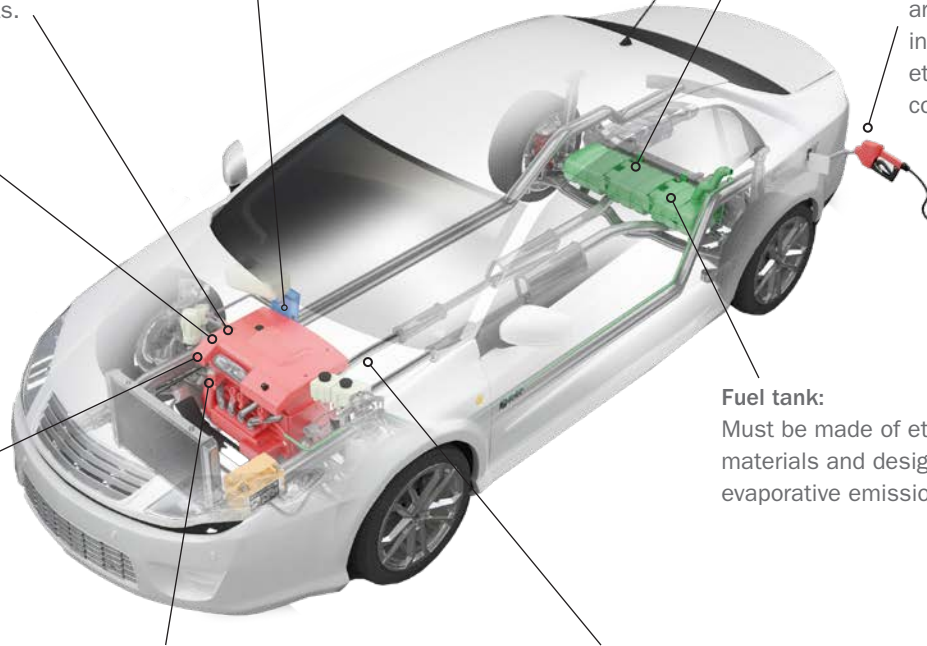
System must be electrically isolated and made of materials designed to handle ethanol's increased conductivity and corrosiveness (if exposed to fuel).

Fuel pump assembly:

In-tank components must be made from ethanol-compatible materials and sized to handle the increased fuel flow needed to compensate for ethanol's lower energy density.

Fuel filler assembly:

Anti-siphon and spark arrestor features are included to handle ethanol's increased conductivity.



Fuel injection system:

Components must be made of ethanol-compatible materials and designed for higher flow to compensate for ethanol's lower energy density.

Fuel rail and fuel lines:

Components must be made of ethanol-compatible materials with seals, gaskets, and rubber fuel hoses rated for ethanol use.

Resources

Alternative Fuels Data Center:

afdc.energy.gov

American Coalition for Ethanol:

www.ethanol.org

Clean Cities:

cleancities.energy.gov

Fuel Economy:

www.fueleconomy.gov

Growth Energy:

<https://growthenergy.org/>

Handbook for Handling, Storing, and Dispensing E85:

https://afdc.energy.gov/files/u/publication/ethanol_handbook.pdf

Renewable Fuels Association:

www.ethanolrfa.org

U.S. Environmental Protection Agency:

www.epa.gov/transportation-air-pollution-and-climate-change

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For more information, visit:

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