



# E85 Fueling Infrastructure Trends: A Decade in Review

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## List of Acronyms

AFDC	Alternative Fuels Data Center
AFV	alternative fuel vehicle
E15	gasoline blended alternative fuel containing 10.5%–15% ethanol
E85	gasoline blended alternative fuel containing 51%–83% ethanol (depending on geography and season)
EPAct	Energy Policy Act
FFV	flex-fuel vehicle
RFS	Renewable Fuel Standard

# Table of Contents

<b>Background</b> .....	<b>1</b>
<b>Ethanol Basics</b> .....	<b>1</b>
<b>History of E85 Use and Regulatory Support</b> .....	<b>1</b>
<b>E85 Fueling Stations</b> .....	<b>2</b>
<b>Geographic Availability of E85 Fueling Stations</b> .....	<b>3</b>
<b>Fuel Use and Consumption</b> .....	<b>4</b>
<b>FFVs</b> .....	<b>5</b>
<b>The Future of E85 and Low-Level Ethanol Blends</b> .....	<b>7</b>
Consumer Education .....	8
Policy Tools.....	8
<b>References</b> .....	<b>9</b>

# List of Figures

Figure 1. Ethanol fuel consumption in the United States, 2000–2020.....	2
Figure 2. E85 station count, 2011–2021. ....	3
Figure 3. Public E85 fueling station concentration by state, 2021.....	3
Figure 4. Private E85 fueling station concentration by state, 2021.....	4
Figure 5. E85 station count and FFV model availability. ....	5
Figure 6. AFV registrations by fuel type. ....	6
Figure 7. Number of FFVs registered in the federal fleet, 2010–2017.....	6

## Background

This report provides information on ethanol fueling infrastructure and industry trends over the last 10 years. It is informed primarily by ethanol fueling station location data collected through the U.S. Department of Energy’s Alternative Fuels Data Center (AFDC) Station Locator from 2011 through 2021 (AFDC 2021a). Industry stakeholders, including the Renewable Fuels Association and Growth Energy, also provided data and additional context around trends seen in the data.

## Ethanol Basics

Ethanol is a widely used, domestically produced renewable fuel made from corn and other plant materials. Ethanol can be blended with gasoline in different amounts to meet corresponding individual consumer needs. Nearly all fuel-grade ethanol is sold as E10, a low-level blend of 10% ethanol, which is approved for use in all conventional light-duty vehicles. E15 (10.5%–15% ethanol) is approved for use in model year 2001 and newer conventional light-duty vehicles and flex-fuel vehicles (FFVs). Only FFVs can use E85, an alternative fuel containing 51%–83% ethanol (depending on geography and season).<sup>1</sup> Intermediate blends between E15 and E85 are also approved for use in FFVs.<sup>2</sup> E85 qualifies as an alternative fuel under the Energy Policy Act (EPAAct) of 1992 (AFDC 2022c).

## History of E85 Use and Regulatory Support

The EPAAct of 1992 requires a certain percentage of federal, state, and alternative fuel provider (e.g., utility) fleet light-duty vehicle acquisitions in defined metropolitan statistical areas to be alternative fuel vehicles (AFVs). Historically, many fleets have acquired FFVs to meet this requirement. In the early 2000s, the United States required the use of ethanol in transportation fuels through the Renewable Fuel Standard (RFS), as established by the EPAAct of 2005 and extended by the Energy Independence and Security Act of 2007. The RFS set minimum requirements for the use of renewable fuels, including ethanol, and created steadily rising use targets to reach 36 billion gallons of renewable fuel by 2022 (EPA 2021). EPAAct 2005 also requires federal fleets to use alternative fuel in fleet dual-fuel vehicles (e.g., FFVs) if the fuel is available within 3 miles of the vehicle’s refueling or garaged locations and does not cost more than gasoline on a per-gallon basis (AFDC 2022a; FEMP 2008, 2021).

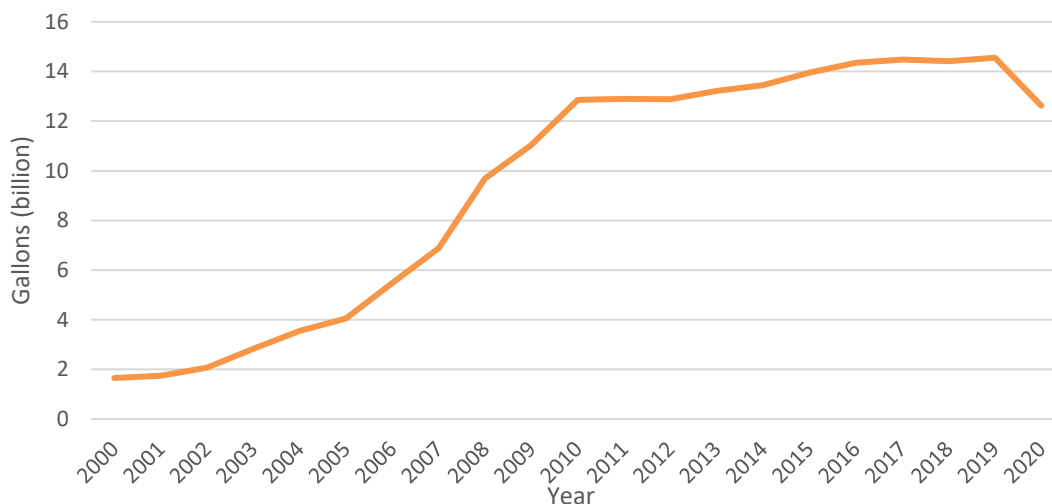
Due to RFS and EPAAct, ethanol as a transportation fuel grew rapidly in the 2000s. Growth in ethanol use leveled off but continued to increase at a slower rate after 2010 due to the expiration of a federal tax credit for ethanol blenders (EIA 2021). Despite the slowing rate of growth, most gasoline in the United States is still blended with 10% ethanol fuel by volume (EIA 2021). The only decrease in ethanol use in recent history was in 2020 due to the COVID-19 pandemic causing supply chain issues and dramatically reducing vehicle travel and fuel consumption.

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<sup>1</sup> ASTM International has a specification for gasoline-ethanol blends containing 51% to 83% ethanol to ensure proper vehicle starting, operation, and safety in varying temperature conditions. For additional information on ASTM D5798, see: <https://www.astm.org/d5798-21.html>

<sup>2</sup> For additional background on E85 and FFVs, see the U.S. Department of Energy’s “Ethanol Basics” fact sheet: [https://afdc.energy.gov/files/u/publication/ethanol\\_basics.pdf](https://afdc.energy.gov/files/u/publication/ethanol_basics.pdf).

However, this impact was felt across a diversity of fuel markets and was not limited to ethanol (Figure 1).



**Figure 1. Ethanol fuel consumption in the United States, 2000–2020.**

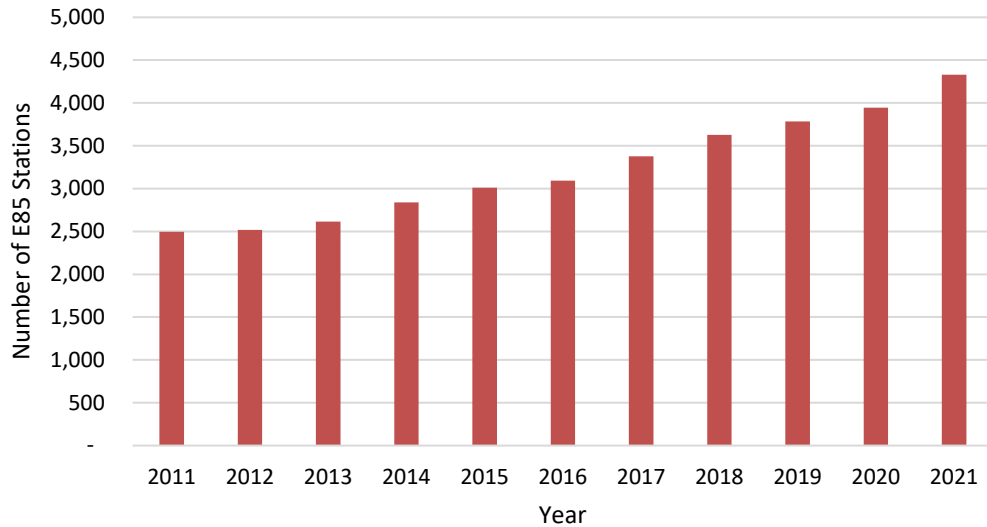
Source: EIA 2021

Similar to the impact of RFS on total ethanol use, the U.S. Department of Agriculture (USDA) Biofuels Infrastructure Partnership and Higher Blends Infrastructure Incentive Program have supported the expansion of E85 infrastructure since 2010. Specifically, the Biofuels Infrastructure Partnership offered competitive matching grants to states, and the Higher Blends Infrastructure Incentive Program offered grants to fueling facilities and retailers to fund the costs of infrastructure for higher-ethanol-blend fuel, including E85. A total of \$99.9 million has been awarded to states for ethanol infrastructure development, helping make E85 more accessible to both fleets and individual consumers (USDA 2022a, 2022b). The National Highway Traffic Safety Administration’s Corporate Average Fuel Economy standards also provided support for FFV manufacturing until this ended in model year 2019.

## E85 Fueling Stations

As E85 became widely available, the number of fueling stations offering E85 grew dramatically. Between 2000 and 2010, E85 stations grew by 1,932%, with most growth occurring after 2005 (AFDC 2021a). This growth was the result of the legislative and regulatory programs previously outlined, including RFS and EPA’s Act. From 2010 to today, this growth rate slowed but remained positive, with the number of E85 stations growing by 72% (Figure 2). As of December 2021, the majority of E85 stations are public, with only 5.4% of total E85 stations for private fleet use (AFDC 2021a).<sup>3</sup>

<sup>3</sup> Informed by Station Locator data. Due to private station data collection challenges, there is likely a data gap between the number of private stations on record and the number that actually exist.

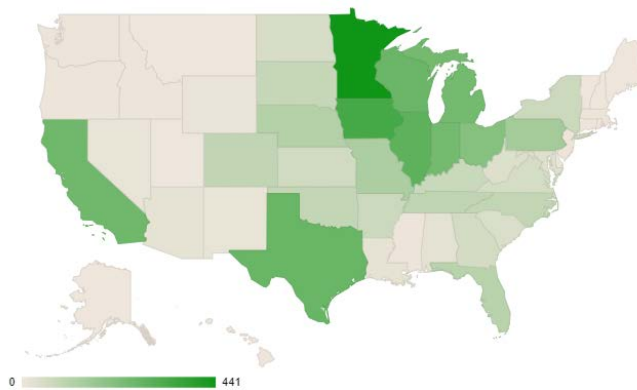


**Figure 2. E85 station count, 2011–2021.**

Source: AFDC 2021e

## Geographic Availability of E85 Fueling Stations

E85 has historically been more widely available in the Midwest and Great Plains than in other regions of the United States due, in part, to these states being the main ethanol producers in the country. Illinois, Indiana, Iowa, Minnesota, Nebraska, and South Dakota produce 72% of the country’s ethanol (AFDC 2021e). These states produce a large amount of ethanol due to their proximity to corn production, access to water resources, and livestock that can feed on byproducts of ethanol production (EIA 2018).



**Figure 3. Public E85 fueling station concentration by state, 2021.**

Source: AFDC 2021b

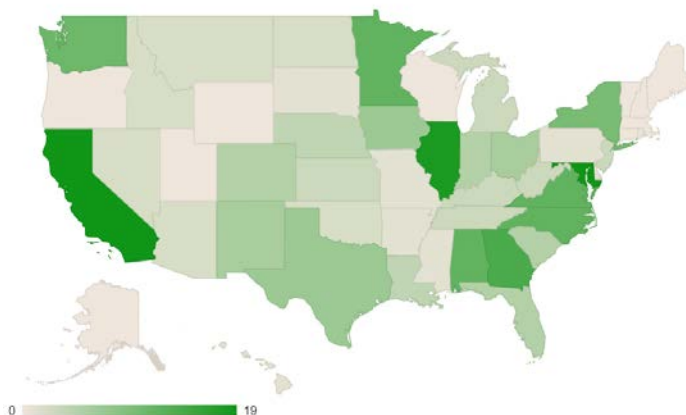
Not all states with a high concentration of E85 stations are large ethanol producers, as seen in Figure 3. California’s high concentration of E85 stations is due largely to the state’s Low Carbon Fuel Standard, which requires a reduction in the carbon intensity of transportation fuels and for fuel producers and importers to meet specified average carbon intensity requirements.



Alternatively, some states, such as Texas, produce ethanol at a smaller scale but have high FFV registration numbers. Industry stakeholders report that Texas' high concentration of E85 stations is due to the combination of it being an ethanol producer and having the highest number of registered FFVs in the country—over 2.3 million, almost double the number registered in California—due to a high demand for pickup trucks, which were produced as FFVs for a number of years. (Experian 2021).<sup>4</sup>

More recently, stations offering E85 and mid-level ethanol blends have been constructed in locations like Miami, Florida, and New York City, New York (White 2021). This is likely due to the high traffic that these stations experience and increasing consumer demand for ethanol blends, as well as USDA Biofuels Infrastructure Partnership and Higher Blends Infrastructure Incentive Program grant awards providing funding to states and fuel retailers, including Florida, to spur infrastructure development.

The distribution of private E85 stations—those used by government, commercial, or other fleets—is different than public E85 stations (Figure 4). These stations represent only 5% of total E85 stations in the country and are primarily concentrated in California, Maryland, Illinois, and Georgia (AFDC 2021b). This distribution is attributable to a combination of incentives for fleets to use FFVs, fleet vehicle acquisition and fuel use requirements, favorable E85 prices, and low-carbon fuel standard requirements.



**Figure 4. Private E85 fueling station concentration by state, 2021.**

Source: AFDC 2021b

## Fuel Use and Consumption

Private individuals have been the primary consumers of low-level ethanol blends because the fuel is blended into gasoline at 10%–15% fuel by volume, and with 27.9 million FFVs on the road, private individuals offer large market potential for E85 (Experian 2021). State and government fleets, on the other hand, were drivers of the increase in E85 use in the 2000s due to EPA requirements. In recent years, however, state and federal governments have steadily

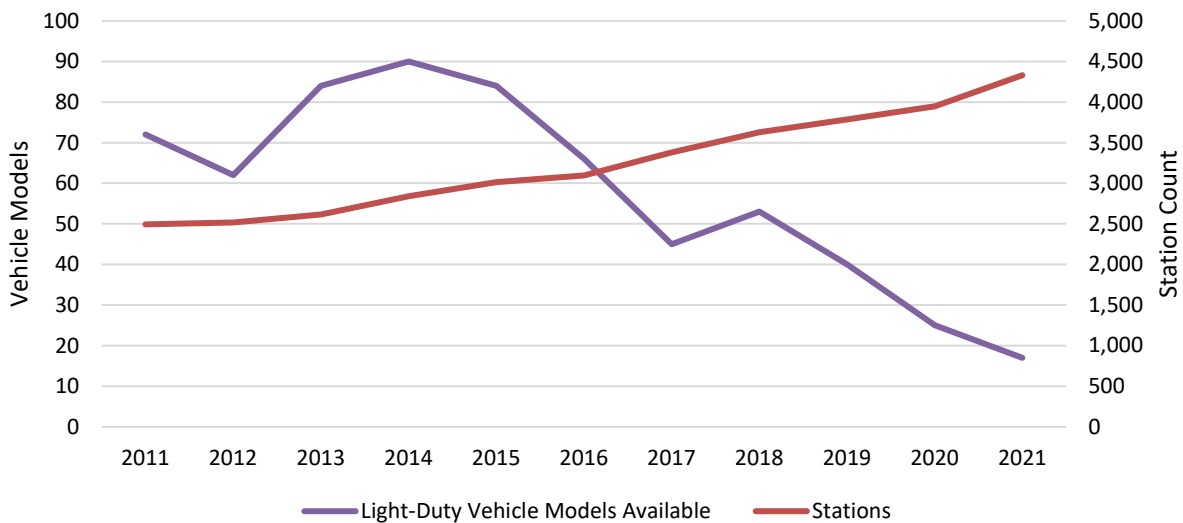
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<sup>4</sup> Registration numbers are from 2020.

reduced E85 use, which may be a result of fleets turning their attention to other alternative fuels or otherwise purchasing more fuel-efficient vehicles.

## FFVs

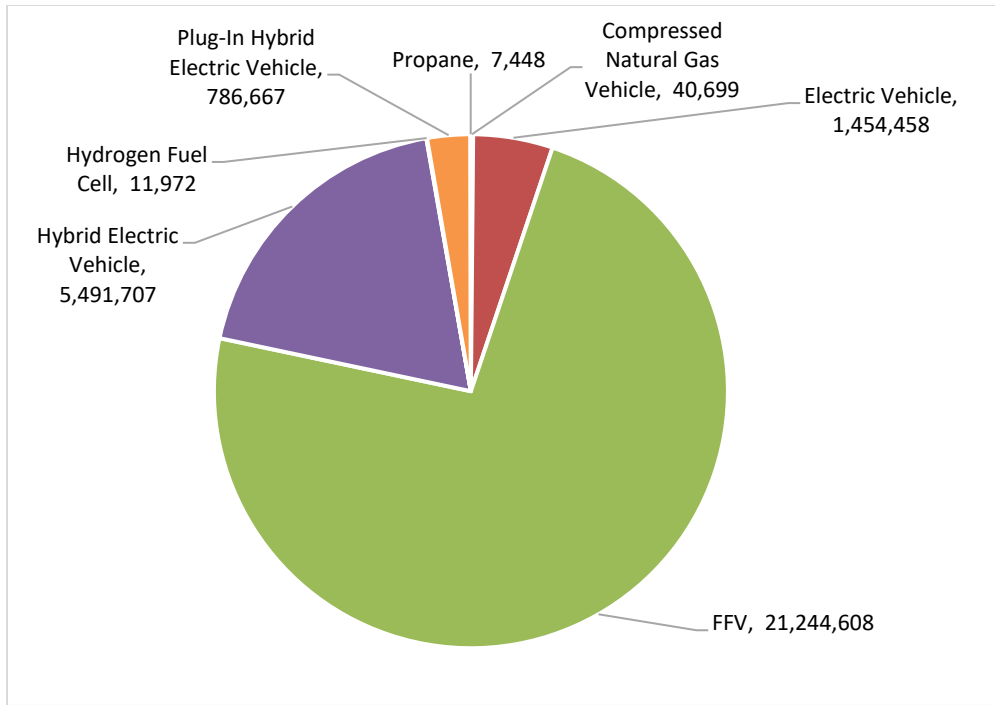
Whereas E85 stations and ethanol consumption have continued to increase in the United States, the number of FFV models available has steadily declined since 2014 (Figure 5). The decrease in FFV models can be attributed to the change in Corporate Average Fuel Economy credits, removing the incentive for original equipment manufacturers to produce FFVs. The loss of production credits and longer vehicle lifespans have resulted in a decrease in FFV model availability.



**Figure 5. E85 station count and FFV model availability.**

Sources: AFDC 2021d; fueleconomy.gov 2022

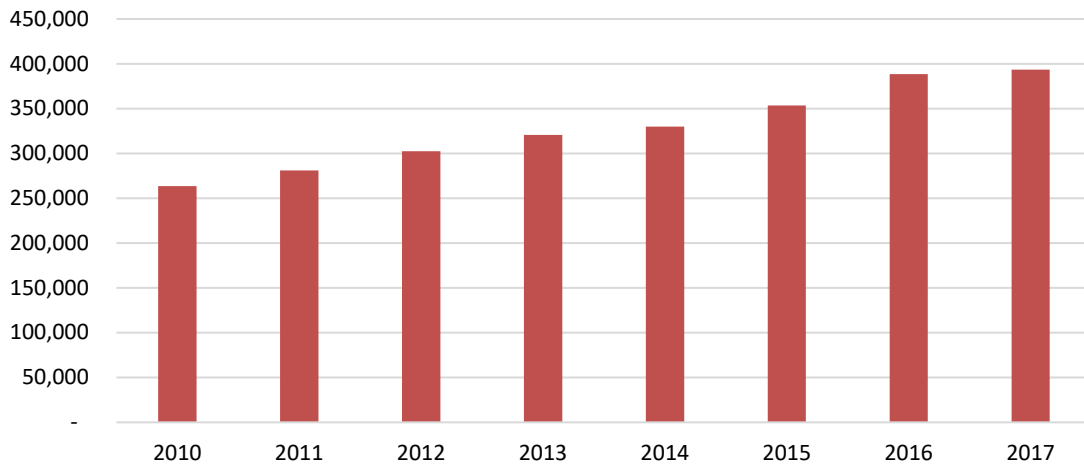
Despite the decrease in FFV model availability, FFVs make up the largest share of AFVs, totaling 73% of all registered AFVs (Figure 6). FFV registration growth hovers around 0.04% and is predominantly made up of light-duty vehicles. FFV drivers are attracted to the performance of E85, given its higher octane content than gasoline, as well as the cost savings of E85 compared to gasoline. As of July 2022, the national average price of E85 was \$3.93 per gallon compared with \$4.70 per gallon for gasoline, a difference of \$0.77 (DOE 2022). Further, the price of FFVs is similar to gasoline vehicles, making FFVs an attractive option for those looking to switch to an AFV.



**Figure 6. AFV registrations by fuel type, 2021.**

Source: Experian Information Solutions 2022<sup>5</sup>

As shown in Figure 7, Federal FFV registrations grew by almost 50% between 2010 and 2017, totaling just over 393,000 vehicles (EIA 2019). EAct requirements for state and federal fleets have acted as the primary driver in accelerating the adoption of FFVs in fleets.



**Figure 7. Number of FFVs registered in the federal fleet, 2010–2017.**

Source: EIA 2019

<sup>5</sup> Derived registration counts by the National Renewable Energy Laboratory, Experian Information Solutions. Data reflect 2021 numbers.

## The Future of E85 and Low-Level Ethanol Blends

As consumers and fleets pursue ways to reduce their transportation emissions and environmental impact, E85 offers a readily available solution for doing so. E85 station counts continued to increase throughout 2021, with industry stakeholders and the AFDC Station Locator reporting a net increase of over one new public station added per day.<sup>6</sup> Regulatory and incentive support for E85 infrastructure, coupled with demand for E85 from public and private entities and consumers, continues to expand the E85 market. Moving forward, industry experts predict that E85 will be primarily used by individual consumers, especially if E85 prices are lower than gas prices. Similarly, low-level ethanol blends offer an opportunity for gasoline-powered vehicles, including non-FFVs, to reduce emissions on a smaller scale.

For fleets looking to pursue alternative fuels, E85 is particularly well-poised. While some alternative fuels are more expensive and require technological upgrades, several years of vehicle acquisition and transition, and new fueling infrastructure, E85 fueling infrastructure is widely available or otherwise cheaper to install than other alternative fueling infrastructure due to its similarity to and adaptability with gasoline infrastructure. Additionally, as previously discussed, the price of a gallon of E85 is often cheaper than a gallon of gasoline, and FFVs are comparable in price to their gasoline counterparts. The combination of these factors makes E85 an alternative fuel with a low barrier to entry.

Even for entities not interested in transitioning to alternative fuels, industry experts anticipate that E15 consumption will significantly increase in the next few years. Recent state and federal government actions also indicate a possible rise in E15 consumption in the near future. Nevada, Oregon, and Idaho have taken action to support the sale of low-level ethanol blends, increasing the required low-level ethanol blend ratio to above 10% and adopting rules to govern the sale of E15 (AFDC 2022d, 2022e; Strong 2022). Iowa has become the first state to adopt an E15 standard, requiring all refueling locations across the state to offer E15 by January 1, 2026 (Iowa Legislature 2022). Similarly, several states including Iowa, Kansas, Nebraska, and North Carolina offer incentives for the sale of E85 or purchase of FFVs (AFDC 2022b).

At the federal level, there has been increasing effort to reinstate the Consumer and Fuel Retailer Choice Act, allowing the sale of E15 year-round (Fischer 2021). President Biden announced a temporary allowance for E15 to be sold throughout summer 2022 to help alleviate high petroleum prices from June to September. Most recently, the U.S. Environmental Protection Agency released RFS final volume standards for 2020, 2021, and 2022, setting the renewable volume obligation for ethanol at 15 billion gallons, the highest in RFS history (McDaniel 2022; EPA 2022).

In the distant future, experts suggest ethanol will find many new uses including sustainable aviation fuel and other renewable and low-carbon products (Gevo 2022; Airport Technology 2022).

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<sup>6</sup> The AFDC Station Locator reported a net growth of 1.18 E85 stations per day from January to November 2021.

## Consumer Education

The biggest challenge in expanding consumer use of E85 is educating consumers on its use and compatible vehicles. E85 is not alone in that challenge, as other AFVs are experiencing the same problem. In particular, dealerships and salespeople are not trained on how to educate consumers on the vehicles they are purchasing. Successfully addressing the knowledge gap will help E85 reach its growth potential.

## Policy Tools

Low-carbon fuel standards could encourage E85 use over gasoline, reduce the price of E85, and increase the demand for a low-emission fuel. Although no federal standard has been established, California's LCFS has proven successful in supporting the growth of E85, increasing E85 consumption by 37.5 million gallons and generating 26.9 million metric tons of greenhouse gas emission savings from 2010 to 2020 in California alone (RFA 2021). Low-carbon fuel standards can be used to boost E85 and lower-level ethanol blend consumption and production while reducing transportation fuel carbon intensity.

Some states are already taking action to support the E85 market. Along with the state and federal legislative action noted above, the Nebraska Corn Board and corn checkoff programs from Kansas and Missouri have given \$1.25 million to California E85 retailers, supporting the increasing E85 demand among California residents and fleets (Nebraska Corn Board 2021). The Nebraska Corn Board reported that one station in California uses approximately 50,000 bushels of corn in a year, and the entire market consumed 40 million gallons in 2020, making the California ethanol market a good investment. Missouri has also announced a \$2-million infrastructure program for biofuels, including E85. Similarly, the federal government's Infrastructure Investment and Jobs Act (i.e., the Bipartisan Infrastructure Law) includes provisions to support low-carbon and alternative fuels, including E85, and infrastructure (AFDC 2021c).

The key to supporting E85, and all alternative fuels, is to educate consumers on the fuel and incentivize the use of alternative fuel over traditional petroleum products.

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