United States

Drivers and Policies

The Energy Policy Act of 1992 (EPAct) requires that certain centrally fuelled fleets (federal, state, and alternative fuel provider fleets, such as utility companies) acquire light-duty alternative fuel vehicles (AFVs) as most of their new vehicle acquisitions. Further, AFVs are being promoted for their benefits on emission reductions, energy diversification, and low costs of operations.

The U.S. Department of Energy (DOE) Technology Integration Program (formerly the Clean Cities Program) is a government-industry partnership program that supports local decisions to reduce petroleum use in the transportation sector through the use of alternative fuels, hybrid and electric-drive vehicles, idle reduction technologies, smarter driving practices, and improved fuel economy measures. The functioning of the program has been described in previous AMF annual reports. More information on the program can be found at www.cleancities.energy.gov. The most recent data from the Technology Integration Program are for 2017 and show that the program saved 972,600,000 gasoline gallons equivalent (gge), which included 730,400,000 gge from alternative fuels/vehicles and 83,400,000 gge from electric and hybrid vehicles.

The U.S. Transportation Sector continues to use a large amount of renewable fuels. The primary driver of renewable fuel use in the U.S. is the Renewable Fuel Standard (RFS), which was adopted in 2005 and expanded in 2007 (RFS2). It requires increasing the volume of renewable fuel to be used in motor fuels. On November 30, 2018, the U.S. Environmental Protection Agency (EPA) finalized the volume requirements and associated percentage standards under the RFS program for calendar year 2019 for cellulosic biofuel, biomass-based diesel, advanced biofuel, and total renewable fuel. The EPA also finalized the volume requirement for biomass-based diesel for 2020.[1] These volumes were slightly higher than those for 2018 compliance. However, the values were significantly lower than those originally targeted in the RFS legislation, which envisioned much more robust growth in cellulosic fuel production than has materialized.

The cellulosic biofuel category was created largely with cellulosic ethanol in mind. However, renewable natural gas from landfills and anaerobic

[1] U.S. EPA, Final Renewable Fuel Standards for 2019, and the Biomass-Based Diesel Volume for 2020, https://www.epa.gov/renewable-fuel-standard-program/final-renewable-fuel-standards-2019-and-biomass-based-diesel-volume

digesters, treated as cellulosic biofuel by the EPA through rulemakings in 2013 and 2014, has dwarfed liquid fuels in that category. Biomass-based diesel is mainly traditional biodiesel, derived from soy, corn oil, canola, and other vegetable and animal fats and oils. These categories are nested into the category of advanced biofuels, which also includes renewable diesel, biogas, renewable heating oil, and renewable fuels co-processed in petroleum refining. Finally, the broad category "Renewable Fuel" includes all of these categories combined with starch- and sugar-based ethanol. Various federal and state programs provide incentives for other alternative and advanced motor fuels. Lists of these are available at afdc.energy.gov/laws/.

The State of California developed the Low-Carbon Fuel Standard (LCFS) to reduce the average carbon intensity of its transportation fuels by 10% from 2010 to 2020. In 2019, the LCFS was revised to extend to 2030 with reduced carbon intensities for California's transportation fuels.[2] Using life-cycle analysis, different carbon intensities were developed for different fuels, including alternative fuels and biofuels. With both the RFS and LCFS, a significant amount of biofuels are used in California, more than 1.8 billion gge in 2017.

Advanced Motor Fuels Statistics

The U.S. Energy Information Administration (EIA) estimated that total U.S. transportation energy consumption for the first 10 months of 2018 was 23,561 trillion British thermal units (Btu), up about 1% from the same period in 2017.[3] More than 90% of this consumption is petroleum-based fuels (gasoline and diesel), with most of the remainder being ethanol blended into gasoline at 10%. Biomass accounted for 1,177 trillion Btu during these 10 months, natural gas for 708 trillion Btu, electricity for 22 trillion Btu, and propane for 9 trillion Btu.[4]

Biofuels

The best biofuel use data come from the EPA's recording of Renewable Identification Numbers (RINs) filed by refiner/marketers of liquid transportation fuels, as shown in Figure 1.[5] Each RIN is equivalent to

[2] California Air Resources Board, Unofficial electronic version of the Low Carbon Fuel Standard Regulation, https://www.arb.ca.gov/fuels/lcfs/fro_oal_approved_clean_unofficial_010919.pdf

[3] *EIA Monthly Energy Review*, January 2019.

[4] Ibid.

[5] EPA, 2018, "Fuels Registration, Reporting, and Compliance Help," https://www.epa.gov/fuels-registration-reporting-and-compliance-help/rins-generated-transactions

1 gallon of ethanol by Btu content; RINs are generated when a motor fuel refiner/blender blends or sells the renewable fuel or fuel blend.

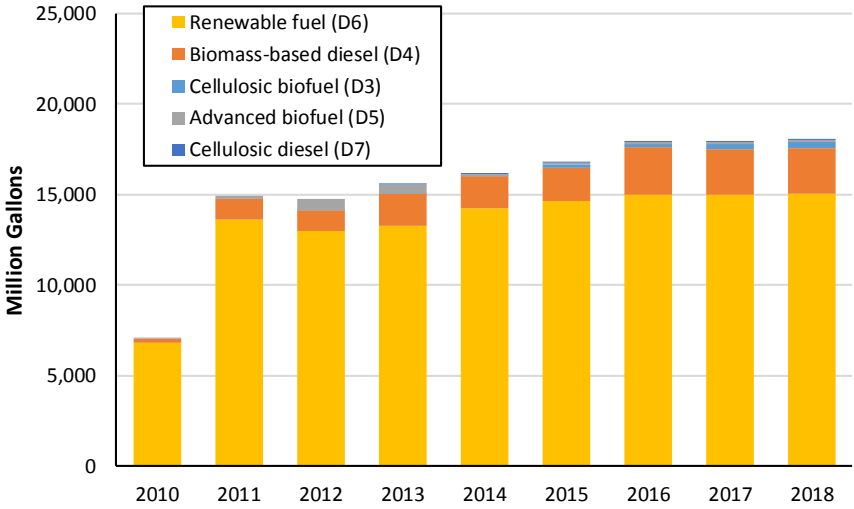

Fig. 1 Renewable Fuel Volumes Resulting from U.S. Renewable Fuel Standard

Electric Vehicles

Sales of plug-in electric hybrids (PHEVs) and battery electric vehicles (BEVs) in 2018, totaling 361,315, were up strongly compared to 195,571 in 2017.[6] In addition, 343,219 hybrid electric vehicles (non-plug-in) were sold in 2018, down from 362,868 in 2016.[7] Available plug-in models totaled 85 as of February 2018, down from 90 in January 2018.[8]

Alternative Fuel Infrastructure

The DOE's Alternative Fuels Data Center provides the number of alternative fuel refueling stations in the U.S.[9] As seen in Table 1, the total number of alternative fueling stations, exclusive of electric recharging stations, in the U.S. increased by 32% between 2012 and 2018. However, the number of biodiesel (B20), compressed natural gas (CNG), liquefied

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6 Argonne National Laboratory, 2019, "Light Duty Electric Drive Vehicles Monthly Sales Updates," anl.gov/energy-systems/project/light-duty-electric-drive-vehicles-monthly-sales-updates

7 Ibid.

8 DOE, 2016, Alternative Fuels Data Center, "Availability of Hybrid and Plug-In Electric Vehicles," afdc.energy.gov/vehicles/electric_availability.html

9 DOE, 2018, "Alternative Fueling Station Counts by State," afdc.energy.gov/fuels/stations_counts.html

natural gas (LNG), and liquefied petroleum gas (LPG) stations decreased slightly in 2018. The total number of public and private nonresidential electric vehicle recharging outlets jumped by over 500% over this same 6-year period, with a significant gain in 2018 as well.

Table 1 Number of U.S. Alternative Fuel Refueling Stations by Type, 2012–2018 (including public and private stations)

Year	B20	CNG	E85	Electric Outlets[a]	H2	LNG	LPG	Total	Total Non-electric
2012	675	1,107	2,553	13,392	58	59	2,654	20,498	7,106
2013	757	1,263	2,639	19,410	53	81	2,956	27,159	7,749
2014	784	1,489	2,780	25,511	51	102	2,916	33,633	8,122
2015	721	1,563	2,990	30,945	39	111	3,594	39,963	9,018
2016	718	1,703	3,147	46,886	59	139	3,658	56,310	9,424
2017	704	1,671	3,399	53,141	63	136	3,478	62,592	9,451
2018	670	1,574	3,632	67,957	64	114	3,328	77,339	9,382

[a] Total number of recharging outlets, not sites.

Research and Demonstration Focus

The DOE's Vehicle Technologies Office (VTO) sponsors research in fuels and advanced combustion engines for the purpose of displacing petroleum-derived fuels, matching engines and fuel characteristics better, and increasing engine and vehicle efficiencies. This research covers a very broad range of fuel, engine, and vehicle technologies. The summary provided here focuses on fuels and fuel effects and is based on annual program reports.[10,11]

In 2015, DOE introduced a new initiative known as the Co-Optimization of Fuels and Engines, or Co-Optima. The initiative is led jointly by DOE's VTO and Bioenergy Technology Office (BETO). The goal of Co-Optima is to identify and evaluate technology options for the introduction of high-performance, sustainable, affordable, and scalable co-optimized fuels and engines. DOE envisions that the effort will run for approximately 10 years, including research on the relationship between fuels and engines, to achieve optimum efficiency and emissions with consideration of fuel production pathways that can enable commercial introduction. It includes both spark

[10] DOE, VTO, 2013, *Fuels and Lubricant Technologies 2012 Annual Progress Report*, DOE/EE-0911, June.

[11] DOE, VTO, 2012, *Advanced Combustion Engine Research and Development 2012 Annual Progress Report*, DOE/EE-0872, December.

ignition technologies, targeted for commercialization by 2025, and compression ignition technologies, targeted for commercialization by 2030. Identified metrics include:

- Enable additional 10% fuel efficiency in light-duty engines,
- Accelerate deployment of 15 billion advanced biofuel gallons/year, and
- Enable an additional 9% to 14% fleet greenhouse gas reduction by 2040.

The DOE's BETO promotes the development of new fuels from initial concepts, laboratory research and development, and pilot and demonstration plant phases. Research areas include feedstocks, algae, biochemical conversion, and thermochemical conversion for both fuels and high-value chemicals. For additional information, visit energy.gov/eere/bioenergy.

Outlook

The EIA's *Annual Energy Outlook 2019* projects decreasing transportation energy use from 2019 through 2038 due to mandated increases in fuel efficiency.[12] It projects that BEV sales will increase from 2% to 14% of total light-duty vehicles sold in the U.S. over 2018 to 2050, due to falling battery costs. In addition, PHEV projected sales will increase from less than 1% to 3% over the same period. Hydrogen fuel cell vehicle (FCV) projected sales are 0.3% of sales in 2050. In 2025, projected sales of light-duty BEVs, PHEVs, and FCVs will reach 1.3 million, about 9% of projected total sales of light-duty vehicles. The use of natural gas in medium- and heavy-duty vehicles is also projected to increase its share of total sales.

Additional Information Sources

- Oak Ridge National Laboratory, 2019, "Transportation Energy Data Book," January, cta.ornl.gov/data/tedbfiles/Edition37_Full_Doc.pdf
- EIA, 2019, *Annual Energy Outlook 2019*, eia.gov/outlooks/aeo/pdf/0383(2017).pdf
- EIA, 2019, *Monthly Energy Review*, Energy Information Administration, eia.gov/totalenergy/data/monthly/

[12] Energy Information Administration, *Annual Energy Outlook 2019*, https://www.eia.gov/outlooks/aeo/