E85 and Blender Pumps:

A Resource Guide to Ethanol Refueling Infrastructure

SPECIAL THANKS TO THESE ORGANIZATIONS FOR SUPPORTING THE DEVELOPMENT OF THIS GUIDE:

DuPont Danisco Cellulosic Ethanol
Maryland Grain Producers Utilization Board
Minnesota Corn Growers Association
Nebraska Corn Board
Nebraska Ethanol Industry Coalition

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Developed by the **Clean Fuels Foundation** and the **Nebraska Ethanol Board**

In cooperation with the **U.S. Department of Agriculture** and the **Flex Fuel Vehicle Awareness Campaign**

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USDA

Dear Readers:

It is with great pleasure we are able to team with the Clean Fuels Foundation and the National FFV Awareness Campaign in order to provide the important information contained in The E85 and Blender Pump Refueling Guide. We hope you will find this to be a valuable reference tool as you consider becoming part of the distribution network of higher blends of ethanol.

These high-level blends of ethanol, such as E85, can substantially reduce greenhouse gas emissions and displace significant volumes of imported petroleum. With millions of flexfuel vehicles on the road today, the chicken-or-egg question has been answered: they are both here. As our nation works together to meet the Renewable Fuel Standard and achieve the many benefits that come from the increased use of renewable fuels, blender pumps like those discussed in this guide will be critical. The U.S. Department of Agriculture is working along side industry and other government agencies to support the market development and infrastructure required.

The Obama Administration believes ethanol plays a vital role in revitalizing the rural economy. When fully implemented, the Renewable Fuel Standard is estimated to raise farm income by more than $13 billion and increase overall farm income by nearly 40 percent. We are proud to be part of the solution to our nation's dependence on imported oil and our national effort to reduce greenhouse gases.

We hope the logistical, financial, and other information contained in this guide helps you to seriously consider including blender pumps that dispense a range of flex fuels. The Department of Agriculture stands ready to work with you and encourage you to contact us if we can be of any assistance at **www.Rurdev.usda.gov.**

Sincerely,

Dallas Tonsager Signature

Dallas Tonsager
Under Secretary for Rural Development

Clean Fuels Foundation

Nebraska Ethanol Board

To Our Readers:

The phenomenal success of ethanol as an additive to gasoline has now opened the doors to a new era of higher ethanol blends. With 9 million flexfuel vehicles on the road today and millions more entering the market in the coming years, blends as high as 85 percent ethanol can be used in these vehicles. The distribution of these fuels requires new modern dispensing devices that are springing up across America. These blender pumps, capable of dispensing several grades of ethanol and gasoline combinations, provide an opportunity for petroleum retailers to expand their product line and take advantage of this new demand sector.

This guide has been prepared to assist all interested parties in gaining a better understanding of the opportunities, challenges, and solutions to increasing the flow of ethanol through expanded refueling infrastructure. It contains a wealth of information and resources to help answer questions ranging from permitting and construction to available financial assistance. For many it will be the first step in expanding into this dynamic new market and we urge you to contact us if we can be of any further assistance in this regard. Ethanol is currently improving air quality, reducing our use of imported oil, creating American jobs, and providing a significant boost to the entire economy

We are pleased to be able to provide this information and hope to hear from you.

Sincerely,

Douglas A. Durante
Executive Director
Clean Fuels Foundation

Sincerely,

Todd C. Sneller
Administrator, Nebraska Ethanol Board
Chairman, Clean Fuels Foundation

1 Introduction

This publication was created to help fuel marketers and other interested parties learn more about ethanol fuels. The Resource Guide includes information about ethanol fuel marketing opportunities and the various blends available for conventional and Flexible Fuel Vehicles. The Guide provides technical details about E10 fuel dispensers for any vehicle on the road, to special blends for many conventional vehicles and the 9 million flex fuel vehicles in use today. These ethanol fuel options give consumers more choices at the pump while providing fuel marketers more diverse and profitable products. The Guide explains why installing ethanol fuel dispensers makes sense for fuel marketers who want to tap a growing customer base. We believe readers will find information in the Guide helpful when considering ways to turn this ethanol marketing opportunity into reality. The Guide also identifies sources of additional assistance with market development and technical support.

Demand for ethanol fuels has increased steadily during the past decade due to performance, environmental benefits and other factors. The Energy Independence and Security Act of 2007 further increased the total amount of required renewable fuel use up to 36 billion gallons by 2022. This federal fuel requirement plus discretionary demand for ethanol creates an opportunity for marketers to increase fuel sales.

The Blend Wall

Most fuel marketers have experience marketing the conventional ten percent ethanol blends, often referred to at retail as E10. The vast majority of conventional motor vehicles, off-road vehicles, marine engines, and other outdoor engines have been designed, manufactured, and warranted to operate on up to 10% ethanol. If 10% ethanol were blended in each gallon of gasoline sold in the U.S., the maximum ethanol use would be limited to ~13.6 billion gallons. It is anticipated that 13.3 billon gallons of ethanol will be produced from conventional feedstocks such as corn in 2012. Thus, the current limit of 10% ethanol in gasoline used in most conventional vehicles will be limited by total gasoline demand. Without an increase in demand, the nation's transportation fleet will be unable to consume the 2012 RFS target of 15 billion gallons. One means of accommodating increased ethanol production is the use of higher ethanol blends such as E30 and E85 in Flexible Fuel Vehicles.

As noted by various ethanol advocacy groups, it is unlikely that every gallon of gasoline sold in the nation will be blended with 10% ethanol. Logistical issues, use of fuel by off road equipment, and other factors generally limit the amount of ethanol in the form of E10 to ~ 12.5 billion gallons. As a result, the integration of increased ethanol volume in gasoline blended for use by Flexible Fuel Vehicles is a rapidly emerging marketing opportunity.

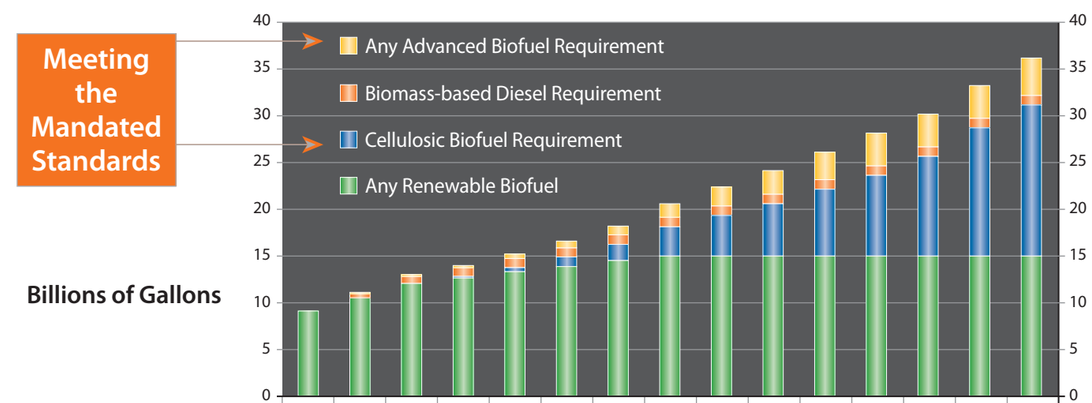
E15 and Beyond

Following a request filed by U.S. ethanol producers seeking to increase the allowable volume of ethanol in gasoline, the U.S. Environmental Protection Agency recently announced they have approved the use of ethanol blends up to 15% by volume in conventional motor vehicles for model years 2001 and newer. This decision expanded an earlier finding of the agency that such blends were only permitted to be used in 2007 and newer model year vehicles.

In the future, all motor vehicles and light duty engines may be approved to use up to 15% by volume ethanol. At that time additional ethanol will be consumed in conventional vehicles but total ethanol use must still be expanded via higher blends. In order to meet the 2011 requirement as well as the future 36 billion gallons ethanol requirements through 2022 the Flexible Fuel Vehicle fleet must use higher volumes of ethanol.

Table 1: The Energy Independence and Security Act of 2007 establishes an aggressive schedule of mandated renewable fuel use. With limitations on the amount that can be used in conventional vehicles, FFVs using high level blends will be critical to meeting these annual increases.

RFS2: Four Annual Standards



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Any Advanced Biofuel Requirement	0	0.1	0.2	0.3	0.5	0.75	1	1.5	2	2.5	3	3.5	3.5	3.5	4
Biomass-based Diesel Requirement	0	0.5	0.65	0.8	1	1	1	1	1	1	1	1	1	1	1
Cellulosic Biofuel Requirement	0	0	0.1	0.25	0.5	1	1.75	3	4.25	5.5	7	8.5	10.5	13.5	16
Any Renewable Biofuel	9.0	10.5	12	12.6	13.2	13.8	14.4	15	15	15	15	15	15	15	15
Total Renewable Fuel Requirement	9.0	11.10	12.95	13.95	15.20	16.55	18.15	20.50	22.25	24.00	26.00	28.00	30.00	33.00	36.00

Biomass Diesel in 2013 will be at least 1 BG

2

Flexible Fuel Vehicles

Flexible Fuel Vehicles are a class of motor vehicles not limited to the use of 10%, 15% or even 50% ethanol. These vehicles are identified as a Flexible Fuel Vehicle, or FFV, and are designed to operate on fuel blends of up to 85% ethanol (E85). Of the approximately 248 million registered cars and trucks operating in the U.S. today about 9 million are Flexible Fuel Vehicles.

FFVs are specially designed vehicles that contain fuel systems and other components that allow a vehicle to operate on a mixture of gasoline and ethanol that can vary from 0 percent to 85 percent ethanol. These cars and trucks have the same power, acceleration, payload, and cruise speed as conventionally fueled vehicles. Like gasoline vehicles, FFVs have a single fuel tank, fuel system, and engine.

FFVs are available in a range of models, including cars, light duty pick-up trucks, SUVs, and minivans. General Motors, Ford, and Chrysler LLC have pledged to produce 50% of their entire vehicle production as FFVs by model year 2012.

While the numbers of Flexible Fuel Vehicles in use continue to climb, they remain a small portion of the total cars and trucks in the U.S. In regard to numbers of alternative fuel vehicles, FFVs far outnumber other types of alternative fuel vehicles including CNG, LPG, electric, or hydrogen.

FFVs in Use in the U.S.

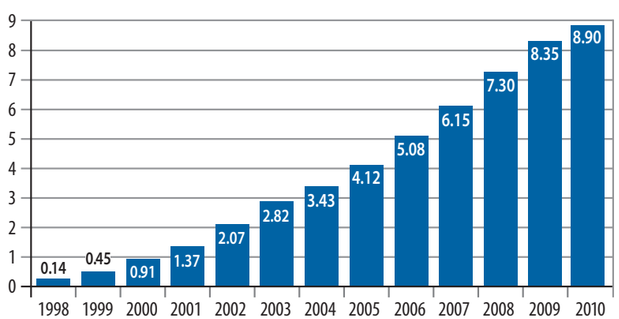


Table 2: FFV growth in U.S.

The additional components required to produce an FFV are generally less than $150 per vehicle and are not reflected in the retail price of a Flexible Fuel Vehicle. A comprehensive list of the various models of Flexible Fuel Vehicles can be found at the following website: **http://e85vehicles.com**

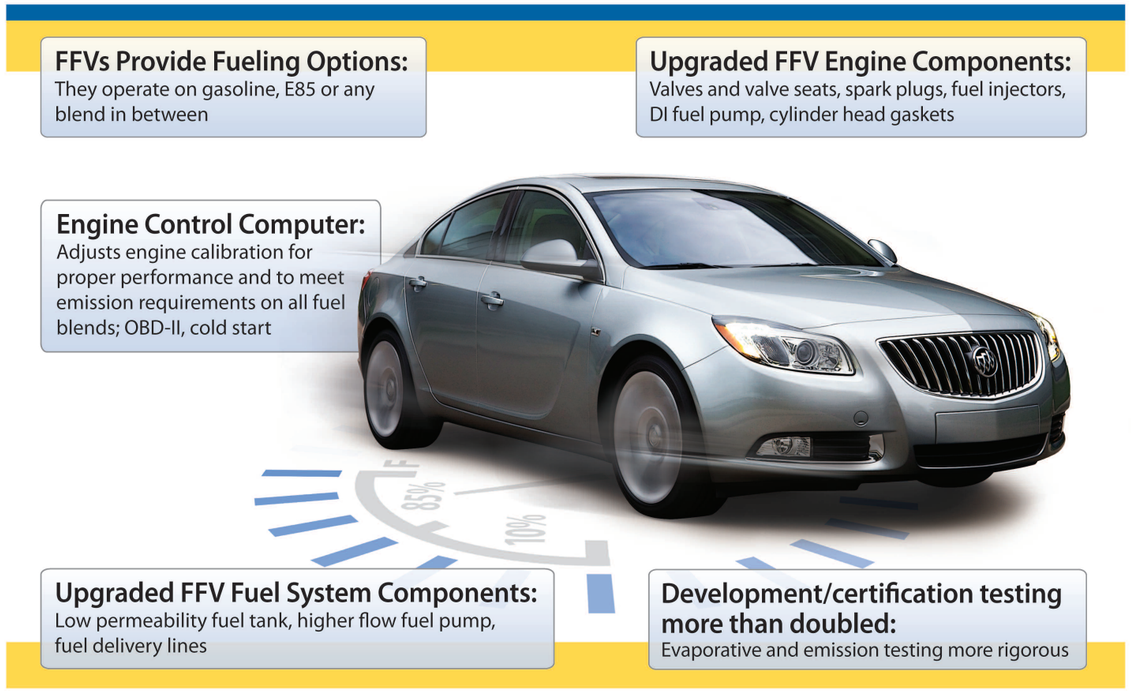


Figure 1: Outline of basic differences between a Flex Fuel Vehicle and conventional or "gasoline only" vehicle.

In many cases, consumers are not able to acquire a certain model and engine line of vehicle in anything but a flexible fuel configuration. Again, an FFV may be operated on gasoline, any level blend of ethanol up to 85% by volume, or any combination thereof. ***The operation of a Flex Fuel Vehicle is absolutely "transparent to the consumer" as the fueling systems, acceleration and power are equal to, if not better than, conventional vehicles.***

Identifying Flex Fuel Cars and Trucks

The exterior of an FFV needs no modifications and thus an FFV looks identical to vehicles that operate on gasoline only. Since an FFV looks like any other vehicle, a car owner could be driving an FFV and not even realize it. Some of the methods that help identify a vehicle that can operate using E85 are:

- FFV or E85 may be printed on fuel cap or fuel door.

Flex Fuel Identifiers

Most Flex Fuel Vehicles will have FFV or E85 printed on the fuel cap or fuel door.

- The vehicle identification number (VIN) will include characters that identify the vehicle as a Flex Fuel Vehicle. Go to www.e85fuel.com/flexible-fuel-vehicles
- The Owner's Manual will identify the vehicle as a Flex Fuel Vehicle.

It is important to note that ONLY FFVs may use any blend of ethanol ranging from 0 to 85% by volume ethanol.

Most vehicles will have a FFV emblem on the exterior car body.

Benefits of an FFV

A number of benefits are attributable to FFVs, including:

- A reduction in greenhouse gas emissions ranging from 20% to 70% depending on the feed stock used to produce ethanol. Ethanol produced from cellulosic materials generates the greatest reductions in GHG emissions.
- Reductions in the use of imported petroleum. The more than 13 billion gallons of ethanol required by the RFS during 2011 will generally be recognized as reducing oil imports by an equivalent amount.
- Generation of a significant number of jobs related to the production of ethanol. Most of these new jobs are located in rural communities where ethanol is produced and transported to markets via truck and rail.
- Automakers do not add a charge to the base cost of a Flexible Fuel Vehicle. Consumers are able to purchase an alternative fuel vehicle (FFV) absent the large additional costs associated with hybrid, natural gas, or propane vehicles.

In general, E85 may reduce fuel economy and range by about 20 percent, meaning FFVs will travel fewer miles on a tank of E85 than on a tank of gasoline simply due to the fact that ethanol contains less energy than gasoline.

Driving conditions, vehicle maintenance, tire inflation, and a number of other factors all impact fuel mileage. Motorists should be cognizant that the higher the ethanol content, the lower the energy content. "At the pump pricing" for high level blends should be lower than unleaded gasoline to reflect the reduced driving range.

A summary of E85 prices at a number of retail fuel locations across the nation can be found at: **www.e85prices.com**

BTU Content

	Heating Value
Gasoline	115,400 BTU/gal
Diesel	128,700 BTU/gal
Compressed Natural Gas	960 BTU/cubic foot
Ethanol	75,670 BTU/gal
Propane	83,500 BTU/gal
Biodiesel	117,093 BTU/gal

Table 3: Summary of the BTU content of various forms of transportation fuels. 1 BTU is the equivalent of the heat generated by a common wooden kitchen match.

Note: *Recent studies conclude that actual fuel economy reductions when using ethanol fuels are less than theoretical linear projections. Using E85, for example, would suggest a projected fuel economy penalty of 26.5%. Actual fuel mileage decreased between 14% to 19% in the vehicles tested.*

3

Liquid Fuel Dispensers

Fueling a motor vehicle is a regular experience for most American drivers. Gasoline is a highly combustible, volatile, hazardous, and carcinogenic material produced from crude oil hydrocarbons. The material safety data sheet for unleaded gasoline shows at least fifteen hazardous chemicals present in various amounts, including benzene (up to 5% by volume), toluene (up to 35% by volume), naphthalene (up to 1% by volume), and trimethylbenzene (up to 7% by volume).

Because fuel dispensers are the focal point of distributing fuel to the general public, and gasoline and gasoline blends are hazardous substances, they are subject to stringent requirements regarding safety, accuracy and security. Ethanol blended fuels, while less toxic, are still subject to these safety requirements.

In order to ensure the health and safety of the public air, land and water, liquid fuel dispensers are regulated by:

- U.S. Dept. of Labor, Occupational Safety and Health Administration
- U.S. Dept. of Transportation, Office of Pipeline Safety
- Environmental Protection Agency, Office of Underground Storage Tanks
- State Fire Marshal
- Local Code Enforcement Official
- Other "Authorities Having Jurisdiction" or AHJ

As noted by the list of federal, state and local agencies engaged with approval of liquid fuel dispensing systems, it is CRITICAL that all requirements be followed when installing equipment that will be used to dispense blends of gasoline and ethanol.

Ethanol Equipment Requirements

Ethanol is a fairly common chemical and is generally considered to be much less hazardous than unleaded gasoline. While ingestion of ethanol can pose a long term risk as can skin exposure, fuel grade ethanol is identical to beverage grade ethanol with one important difference: Fuel grade ethanol is denatured, or poisoned with unleaded gasoline to prevent human ingestion.

While ethanol is much less dangerous than unleaded gasoline, its chemical characteristics must be considered when establishing a fuel dispensing system.

First, ethanol is a polar solvent which means that ethanol can conduct electricity. This is a factor for two primary reasons:

- Ethanol as a conductor of electricity provides an environment where galvanic corrosion can take place inside the piping, pumps, tanks and dispensers of the fueling system. This action of galvanic corrosion can be acute when ethanol comes in contact with aluminum.

- As a polar solvent, ethanol also readily absorbs water, thereby impacting fuel quality and greatly affecting the materials and methods for suppressing ethanol fires.

Additionally, ethanol blends can cause corrosion of some soft metals and reduce the tensile strength of some nonmetallic materials. Zinc, brass, lead, and aluminum have shown sensitivity to degradation. Ethanol blends may also cause swelling and loss of function on certain nonmetallic materials such as natural rubber, polyurethane, cork gaskets, leather, polyvinyl chloride, nylon, and certain thermoplastic and thermoset polymers. Only ethanol compatible materials should be used in the storage and dispensing systems.

Codes and Standards

For purposes of consistent enforcement of the safety regulations related to dispensers and handling of liquid fuels, most state and local code enforcement officials have adopted fire prevention standards promulgated by the National Fire Protection Association, NFPA. **http://www.nfpa.org/.** Ethanol blends are defined as a Class 1 flammable liquid by the National Fire Protection Association. Guidelines related to the dispensing, handling and storage of liquid fuels are found in:

- NFPA Code 30: FLAMMABLE AND COMBUSTIBLE LIQUIDS CODE and
- NFPA Code 30A: CODE FOR MOTOR FUEL DISPENSING FACILITIES, AND REPAIR GARAGES

In order to meet the standards of NFAP 30 and 30A, all equipment for storing, piping, and dispensing liquid fuels must be either Listed or have a "Statement of Equivalency":

The codes define 'Listed" as:
Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction (AHJ) and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

The Code defines "Equivalency" as:
The use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this code. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

Equipment that is "Listed" must also be "Labeled".

The Code defines "Labeled" as:
Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Underwriters Laboratory

Underwriters Laboratory, UL, is a National Recognized Testing Laboratory as established by the U.S. Dept. of Labor, Occupational Safety and Health Administration (OSHA). National Recognized Testing Laboratories are private sector organizations that meet the necessary qualifications specified by OSHA. These testing labs have been established to determine that specific equipment and materials ("products") meet consensus-based standards of safety to provide the assurance, required by OSHA, that these products are safe for use in the U.S. workplace.

In the U.S., the recognized national testing laboratory for fuel dispensing equipment is Underwriters Laboratory. UL has developed three certification paths for dispensers of pre-blended ethanol fuels:

1. UL 87 for gasoline and ethanol fuel blends up to E10.
2. UL Subject 87A-E25, which addresses gasoline and mid-level ethanol fuel blends up to E25.
3. UL Subject 87A-E85, which addresses gasoline and ethanol fuel blends up to E85, specified:
   - Equipment that has been certified to UL 87, IS NOT listed to dispense any fuel exceeding 10% ethanol by volume.
   - Equipment that has been certified to UL 87A-E25, IS ONLY listed to dispense fuel containing between 0 and 25% ethanol by volume.
   - Equipment that has been certified to UL 87A-E85 is listed to dispense fuel containing between 0 and 85% ethanol by volume.
     - Equipment certified pursuant to UL 87A-E85 IS NOT listed to accept the input of E98-E100 to act as a blending agent.

E85 UL Certified Equipment as of January 1, 2011

- **Dispensers**
  - Gilbarco*: Encore Series 300, 500, 550
  - Dresser Wayne*: G520, G610, G620, Ovation Model E
- **Hose:** Veyance Flexsteel Futura Ethan-all
- **Nozzle:** OPW 21GE and 21GE-A
- **Swivel:** OPW 241TPS-0492
- **Breakaway:** OPW 66V-0492
- **Shear Valves:** OPW 10P-0152E85 and 10P-4152E85
- **Submersible Turbine Pump:** FE Petro all AG models

For updates regarding UL Certified equipment for ethanol blends, check the Petroleum Equipment Institute at **http://resource.pei.org/altfuels/ByFuel.asp?fuel=E85#list** or the Alternative Fuel Data Center at: **http://www.afdc.energy.gov/afdc/technology_bulletins.html**

UL Certified Flexible Fuel Dispensers

These photographs represent the most recent UL Certified Flexible Fuel Dispensers produced by Gilbarco Veeder-Root: Encore Series 300 and 500

Photo: UL Certified Flexible Fuel Pump produced by Dresser-Wayne.

Use of Non-Certified Equipment

In some jurisdictions, the Authority Having Jurisdiction, (AHJ/Fire Marshal/Code Enforcement officials or others), may allow the use of a non-certified dispenser. With the use of proper hoses, nozzles, swivels and filters, it is possible to field modify dispensers to offer mid and high level blends. Field investigations and laboratory review have revealed little in the way of equipment degradation or danger when using a modified system to dispense mid and high level blends of ethanol.

Removal of all aluminum equipment, installation of approved hanging hardware, complete cleaning of tank systems, and evaluation of pipe and tank handling characteristics should be undertaken prior to selling mid and high-level blends from modified equipment. Such modified equipment must be visually inspected regularly to ensure no fuel leakage or spills.

The use of modified equipment to dispense mid and high-level grades of ethanol may not meet all federal regulations applicable to dispensing liquid fuels. Caution should be exercised to ensure safe operation and compliance.

Note: *Liquid fuel dispensers manufactured to meet UL Standard 87A are not certified by Underwriters Laboratory to dispense any level of ethanol exceeding 10% by volume. Using such equipment to dispense E15 may violate state and federal law. Check with your local equipment service organization to determine if your equipment is certified to dispense fuel exceeding 10% ethanol by volume.*

Prior to introducing modified equipment into commerce with the intent of dispensing mid and high-level blends of ethanol, check with your local code enforcement officials/Fire Marshal and your insurance company.

A listing of equipment companies that supply and install dispensers and related equipment can be found on the Petroleum Equipment Institute Web site at:

http://www.pei.org/portal/members/directory.asp?action=ByName

4

Dispensing Mid and High Level Ethanol Blends – Flex Fuel Pump

Beginning in the early 1990s, several automakers began to produce cars and light duty trucks that could operate on up to 85% ethanol by volume. In order to provide high level blends of ethanol to the motorists operating these Flexible Fuel Vehicles, several organizations began to advocate the establishment of E85 fueling sites. As of March 2011, there are approximately 2,400 locations across the nation where E85 can be purchased. The U.S. Dept. of Energy's Alternative Fuel Data Center maintains a listing of the existing E85 fueling stations at: **www.afdc.energy.gov/afdc/ethanol/ethanol_locations.html**

More recently, efforts have been focused on the establishment of "blender pumps" which offer multiple blends of ethanol products. Blender pumps have been in use for a number of years and generally refer to liquid fuel dispensers that draw fuel from two different tanks which are storing different grades of fuel. This system blends the two fuels within the hydraulic components of the dispenser, and then offers three or more grades of fuel based on the composition of the initial blending grades. The term "flexible fuel pump" is a more accurate description of systems that mix ethanol and a grade of gasoline which then offer single or multiple grades of ethanol blends.

The dispensing unit in **Figure 2** is a single product, single hose dispenser intended to only sell E85.

Single-Product Dispenser

Figure 2

With the number of labels, notices, and the design of the pump, a motorist should have no doubt that this dispenser only sells E85 which should only be used to in a Flexible Fuel Vehicle.

The unit shown in **Figure 2** is drawing E85 from a dedicated storage tank, either above or underground. In addition to the dispenser, the storage tank, piping, submersible pump, leak detection equipment, sump, fill pumps, and other equipment in contact with the ethanol should all be listed by UL or the retailer should be in possession of a statement of equivalency.

Correct Configuration of a Blender Pump

Figure 3

In order to dispense E85 from a dedicated pump, a separate E85 storage system **MUST** be used.

The pumps shown in **Figures 4 and 5** are referred to as MPDs, or Multi-Product Dispensers. These are also commonly known as 3+1 systems in that they dispense a total of 4 products, 3 of a similar nature and one additional fuel.

In the dispensers shown in **Figures 4 and 5**, each of the systems is dispensing three grades of gasoline from one hose and E85 from a separate hose. Any level of ethanol exceeding 10% by volume, **MUST** be dispensed from a separate and distinct hose. **DO NOT** dispense E10, E15, E30, and E85 from the same hose.

Multi-Product Dispensers

Figure 4: MPD or 3 plus 1

Figure 5: MPD or 3 plus 1

The dispensers shown in **Figures 4 and 5** have been retrofitted by the owners and do not represent UL Certified systems. These systems have been approved by the local Authority Having Jurisdiction/Fire Marshal and are considered to be safe, accurate, and environmentally sound.

In order to dispense three grades of gasoline plus E85 as shown in the **Figures 4 and 5**, a separate E85 storage tank **MUST** be utilized.

The dispenser shown in **Figure 6** is a Flexible Fuel Pump or sometimes referred to as a "blender pump."

This system draws product from two or more storage tanks and blends the various fuels within the dispenser itself.

Note that the mid and high-level ethanol blends are being dispensed from the hose on the left, and the unleaded gasoline is being dispensed from the hose on the right.

Flexible Fuel Blender Pump

Figure 6

Two and Three Tank Systems

As a result of the Renewable Fuel Standard and the oxygen requirement in reformulated gasoline, the vast majority of gasoline being delivered to retail sites contains 10% ethanol. The ability of a retailer to acquire "clear gasoline" or gasoline which has not pre-blended with ethanol will impact the retailers' options at the blender pump.

As previously noted, Flexible Fuel Pumps, (blender pumps) are fuel dispensers that draw fuel from separate storage tanks and can dispense preprogrammed blends of ethanol and gasoline. The number and types of fuels that can be sold from a Flexible Fuel Pump are dependent on the number of storage tanks feeding the dispenser.

Two-Tank Dispensing System

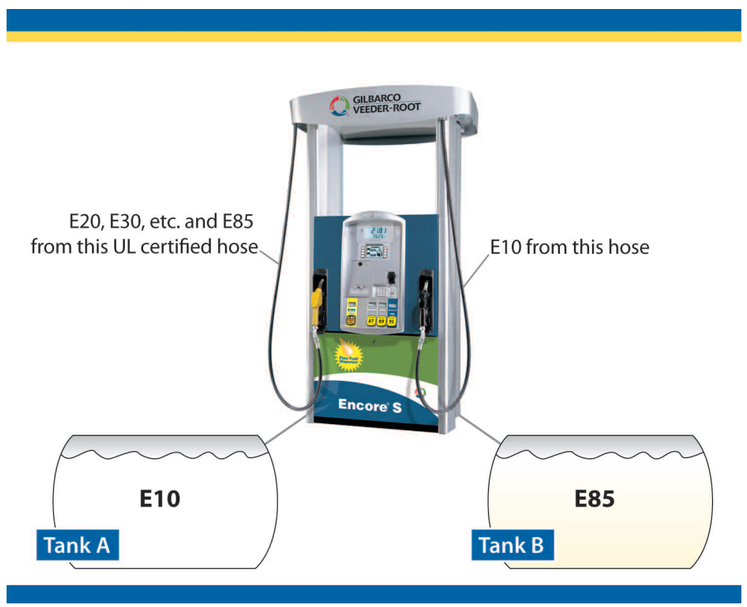


Figure 7

Two-Tank System

The graphic in **Figure 7** represents a Flexible Fuel Pump that utilized two (2) underground fuel storage tanks. In this example, the retailer is receiving pre-blended E10 and storing that product in Tank A. The retailer then chooses to receive E85 and stores that product in Tank B.

E10 is dispensed from the hose on the right and various blends of ethanol are dispensed from the hose on the left. The retailer using this two-tank example is unable to sell any grade of gasoline that is not blended with ethanol.

Three-Tank System

The graphic in **Figure 8** represents a Flexible Fuel Pump that utilizes three (3) underground fuel storage tanks. In this example, the retailer is receiving pre-blended E85 and storing that product in **Tank A.** The retailer is also receiving pre-blended E10 and storing it in **Tank B.** Finally, the retailer chooses to receive and store Premium gasoline and does so in **Tank C.**

E10 is dispensed from the hose on the right as are other grades of gasoline such as 89 and 91 Octane gasoline. The various blends of ethanol such as E30 and E85 are dispensed from the hose on the left.

Three-Tank Dispensing System

Figure 8

The use of three tanks in the retail fueling system allows a retailer to offer any blend of ethanol and other non-ethanol blended fuels such as 87, 89, 91, or 93 Octane gasoline.

Note: *Do not store ethanol fuels exceeding E85 in an underground storage tank. UL has not certified any dispenser to intake ethanol exceeding 85% by volume. Additionally, other safety considerations regarding head space volatility with the storage of E98/100 may also exist.*

5

Quality Control

ASTM International, originally known as the American Society for Testing and Materials (ASTM), is a voluntary international consensus standards organization that develops and promotes standards regarding the characteristics and performance of materials, products, systems, and services. Members include producers, end users, and governmental regulatory agencies.

ASTM standards generally serve to: (1) help products be accepted in the marketplace, (2) make it easier to ensure that suppliers are provided with a quality product, and (3) aid with regard to procurement or regulatory requirements. The following chart represents the most recent ASTM standards applicable to the sale of 85% ethanol by volume.

All E85 that is stored for use as liquid fuel should meet ASTM 5798-10. All E85 that is stored for use as a blending agent in a Flexible Fuel pump should also meet ASTM 5798-10.

ASTM 5798-10

Standard Specification for Fuel Ethanol (Ed75-Ed85) for Automotive Spark-Ignition Engines			
Property	**Value for Class**		
ASTM Volatility Class	1	2	3
Ethanol Plus Higher Alcohols (minimum volume %)	79	74	68
Hydrocarbons (including denaturant) (volume %)	17-21	17-26	17-30
Vapor Pressure at 37.8°C kPa psi	38-59 5.5-8.5	48-65 7.0-9.5	66-83 9.5-12.0
Lead (maximum, mg/L)	2.6	2.6	3.9
Phosphorus (maximum, mg/L)	0.2	0.3	0.4
Sulfur (maximum, mg/kg)	210	260	300
	All Classes		
Methanol (maximum, volume %)	0.5		
Higher Aliphatic Alcohols, C3-C8 (maximum volume %)	2		
Water (maximum, mass %)	1.0		
Acidity as Acetic Acid (maximum, mg/kg)	50		
Inorganic Chloride (maximum, mg/kg)	1		
Total Chlorine as Chlorides (maximum, mg/kg)	2		
Gum, Unwashed (maximum, mg/100 mL)	20		
Gum, Solvent-Washed (maximum, mg/100 mL)	5.0		
Copper (maximum, mg/100 mL)	0.07		
Appearance	Product shall be visibly free of suspended or precipitated contaminants (shall be clear and bright).		

Table 4: Source: U.S. Dept. of Energy, "Handbook for Handling, Storing, and Dispensing E85. July 2010

Fuel Adjustment Considerations When Using Flexible Fuel Pumps

Seasonal Volatility Changes: In order to ensure winter cold start and prevent summer vapor lock, seasonal volatility standards have been established for E85. E85 content varies between 68% and 85% ethanol, depending on location and time of year. This seasonal adjustment is common in the fuel industry and also occurs with gasoline. Seasonal adjustments in ethanol volumes are intended to assist with winter cold starting and prevent summer vapor lock. Station owners offering various ethanol blends should ensure that certified technicians program the blender pump dispenser throughout the year to reflect the seasonal ethanol content requirements.

A retailer using a Flexible Fuel Pump may choose one of two methods to ensure the seasonal standards are met:

1. Adjust the high level blend of ethanol which is in storage from 85% by volume during the summer to 68% by volume during the winter.
   a. This process will require a certified pump technician to come on-site to adjust the mixtures of any mid-level blends that will be impacted by varying the ethanol content.
2. Maintain the high ethanol volume in the storage tank and have a certified pump technician come on site to adjust the amount of gasoline that is being blended into the E85 to lower its ethanol content to E68/70 during the winter.

Whatever process is followed to ensure that seasonal volatility standards are achieved, the use of a flexible fuel pump will **REQUIRE** blending modifications twice annually. In most jurisdictions, a state certified dispenser technician will be required to undertake this task.

Note: *A checklist for retailers who may install or operate equipment to dispense ethanol blended fuels is available at www.ethanolretailer.com under "Pump Checklist."*

6

Financial Assistance Programs

A variety of resources are available to support financing of ethanol fueling infrastructure. Financial support ranges from grants to loan guarantees and low interest loans. These resources are available from public and private sources at the federal, state and local level in some cases. Financial resources can often be combined. Parties interested in these financial incentives should review the following information and contact local biofuel officials for additional details

Example of Federal Income Tax Credit Use

- A retailer wishes to install a new 3 plus 2 Flexible Fuel Dispenser to be able to sell E10, E30, and E85. Gasoline will also be sold from the unit in the form of 89 and 91 octane products. The new dispenser will cost $26,000.

  A similar dispenser that is not designed to sell E85 costs $19,000.

- The incremental cost of the dispenser is $7,000 and the tax credit is 30% of that amount or a total of $2,100.

*The U.S. Department of Energy operates the **Alternative Fuels Data Center** which provides a comprehensive summary of federal, state, and local incentives that may be available to assist in developing alternative fuel infrastructure. The Alternative Fuel Data Center can be found at: **http://www.afdc.energy.gov/afdc/laws/state***

Government Programs: Federal

The U.S. Department of Energy has been the lead agency in providing grants for alternative fuel infrastructure. There are several different opportunities throughout the year to apply for such funds. The DoE Office of Energy Efficiency and Renewable Energy (EERE), through its biomass programs, has issued Requests for Proposals (RFPs) and Notices of Funding Available (NOFA). Please consult the DoE website and ask to be included in future notices.

The Clean Cities Program of the Department of Energy also regularly issues RFPs for refueling infrastructure grants. The agency has been active in funding E85 fueling facilities across the country.

The U.S. Department of Agriculture (USDA) offers a variety of programs that support biofuel development. The Rural Energy for America Program (REAP), authorized under section 9007 of the 2008 Farm Bill, may soon announce that E85 and ethanol blender pump projects are eligible for financial support. It is expected that the existing REAP grant guidelines will apply. Under these guidelines, a cash grant of 25% may be available for eligible projects, up to a $500,000 project cap. The project cost balance of 75% may be eligible for a REAP Loan Guarantee. Applications for this program are submitted through the state office of the USDA. Contact **www.rurdev.usda.gov** to locate your state USDA office for further details on this and other programs.

The other means by which the federal government supports the production and sale of ethanol blends as well as refueling infrastructure is through tax incentives. The Volumetric Ethanol Excise Tax Credit provides a $0.45 tax credit for each gallon of ethanol to the first blender of ethanol. Additionally, cellulosic ethanol producers receive a $1.01 a gallon credit and there is also a 10-cent per gallon small-producer tax credit for ethanol.

In regard to financial assistance to offset the costs of alternative fuel infrastructure development, there remains a federal income tax credit of 30% of the cost of the improvements up to $30,000. This tax credit is only available on the "incremental cost" of the alternative fuel improvements.

Both the $0.45 per gallon VEETC and the federal alternative fuel infrastructure development tax credit expire Dec. 31, 2011. The tax credit may be claimed using IRS Form 8911 found at: **http://www.irs.gov/pub/irs-pdf/f8911.pdf**

The Tax Relief, Unemployment Insurance Reauthorization and Job Creation Act of 2010 (PL 111-312) also includes an incentive allowing companies to expense 100% of the cost of new capital acquisitions in 2011. The bonus depreciation provision also extends to capital equipment placed in service after December 8, 2010. For 2012, bonus depreciation is worth 50% of the cost of property placed in service. **The value of this incentive will vary by retailer, marginal tax rate, cost of equipment being installed, and the form of the taxable entity.**

State	Incentive Program	Tax Credit
Missouri	NO	Yes 20% up to $20k
Minnesota	Yes 75%	up to $50k
Illinois	Yes 30%	up to $30k
New York	Yes 50% up to $50k	Yes, 50% up to $50k
Kansas	NO	Yes, 40% up to $100k
Iowa	Yes 50% up to $50k	
Florida	Yes 50% up to $50k	
South Dakota	Yes $10k per pump	
Ohio	Yes $20k per site	

Table 5: State Incentive Programs

NOTE: *Consult your tax professional prior to planning on the use of any tax credit as a number of restrictions apply.*

Government Programs: State

A number of states also offer incentives and tax credits to assist with offsetting the cost of alternative fuel infrastructure. An example of state programs include:

In addition to funds authorized and appropriated by the states, there are limited federal funds that were administered to states through the American Recovery and Reinvestment Act (ARRA) via block grants. These funds can be used for refueling infrastructure including E85 and blender pumps. Consult your individual state energy office for further details and funding availability.

NOTE: *State incentives can change rapidly and are generally limited by appropriations or legislatively imposed maximum costs. Check with your state energy office for current regulations and status of programs.*

Industry Programs

Several ethanol industry organizations provide cash grants for the installation of E85 and blender pumps. Growth Energy has provided grants of $2,500 for E85 dispensers and up to $5,000 for blender pumps. The Renewable Fuels Association and the American Coalition for Ethanol has a similar grant program. In addition, several state corn grower organizations have financial assistance programs available or can assist in other ways.

For additional information contact:
www.growthenergy.org
www.rfa.ethanol.org
www.ethanol.org
www.ncga.org

A summary of Federal incentives, laws and regulations, funding opportunities, and other federal initiatives related to alternative fuels and vehicles, advanced technologies, or air quality may be found at **http://www.afdc.energy.gov/afdc/laws/fed_summary.** Additional incentives may also be available through the U.S. DOE Clean Cities Program link at: **Financial Opportunities.**

7

Considerations in Choosing Markets, Locations and Fuel Grades

Flexible Fuel Vehicles represent a growing and viable option for the sale of mid and high level blends of ethanol. The sale of ethanol as a form of transportation fuel is the only segment of the liquid transportation fuel market which continues to grow. The adoption of the Renewable Fuel Standard as part of the Energy Independence and Security Act of 2007, guarantees the continued expansion of the use of biofuels such as ethanol.

Much has been written regarding the so-called "E10 blend wall." Many ethanol advocacy organizations are working to increase the volume of ethanol that can be used in conventional vehicles from 10% to 15%. A recent EPA ruling allows MY 2001 and newer vehicles to use E15 but the availability of this blend will be limited in the near term. Market growth via E15 use will be gradual and ethanol demand from this market segment will be minimal in the near term. FFVs, which can use any blend of ethanol from 0 to 85%, clearly represent a market segment for increasing ethanol demand today and in the future.

While Flexible Fuel Vehicles represent a growing and viable option for the sale of mid and high level blends of ethanol, it should be remembered that the numbers of FFVs are only a fraction of the total registered vehicles, in any state. Retailers recognize the small market currently offered by FFVs, and while the potential growth in numbers of FFVs is unlimited, current market issues must be considered.

It is important to note that very few, if any, mid/high level ethanol fueling stations have been established absent the provision of some type of financial support to the retailer which helps offset the cost of improvements. Today, this is more important than in the past. New UL certified dispensers have an added cost of ~$8,000 over conventional gasoline only pumps.

A retailer wishing to install a Flexible Fuel Pump will be limited by several factors that should be considered including:

1. **Number of existing tanks at a retail location.**
   A retail location with an existing two tank system is limited in the ability to sell mid-grade and premium fuels. Three tank sites can store E10, E85, and premium fuel in the various tanks and offer any type of ethanol blend and most octane grades of gasoline. The installation cost of a new Flexible Fuel Dispenser, including labor, will be approximately $30,000. Should it be necessary to install a new 10,000-gallon tank to store E85 for purposes of blending, the costs may increase by up to $100,000.

2. **Local Code Enforcement Officials requirement to use UL Certified equipment.**
   The local Authority Having Jurisdiction may require the use of UL certified equipment which will require the purchase of new equipment. Retrofitting an existing pump to handle E85 can be accomplished for as little as $4,000, depending on factors including available storage, access to dispenser components and location. New pumps and installation costs will exceed $30,000 per dispenser.

3. **Is the retail site "franchised" by a major oil company?**
   Approximately 52% of all retail fueling sites remain "franchise operated" and such franchise agreements generally do not allow the sale of ethanol blends other than 10% or 85% by volume. While the Petroleum Marketing Practices Act was modified in the 2007 Energy Independence and Security Act, the modifications only require the allowance to sell E85. Mid-level blends such as E15 and E30 were not addressed in the Act. It is unlikely that any retailer operating under a franchise agreement will be allowed to sell higher ethanol blends such as E30 under the branded retail canopy.

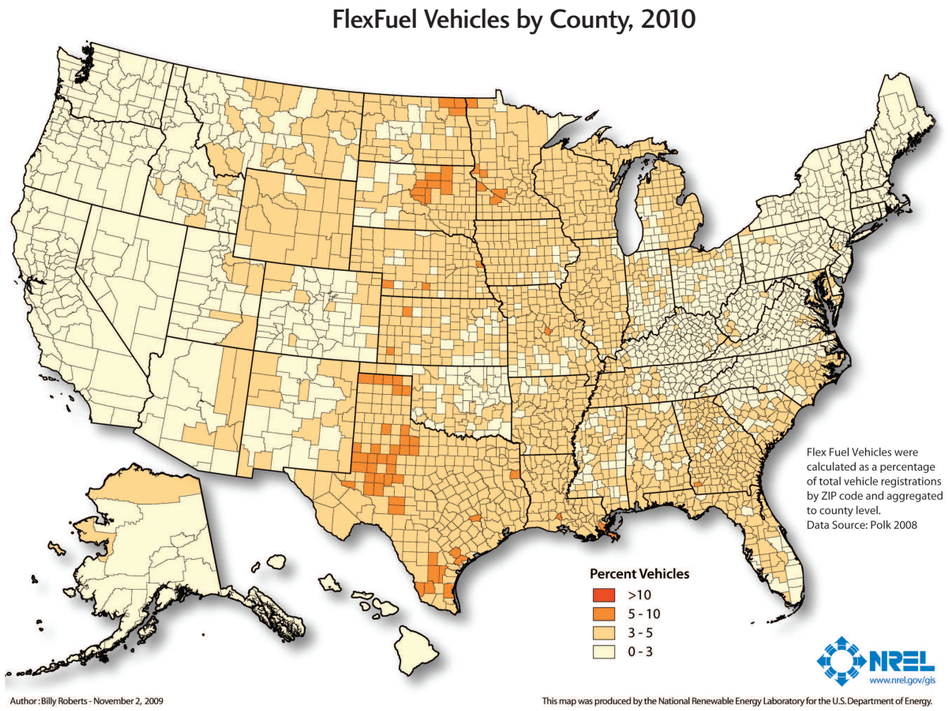


Figure 9: FFV locations by county. Updated FFV registration data by county available at: **http://maps.nrel.gov/transatlas**

4. **Number of FFVs in adjacent market.**
   Obviously the establishment of a mid/high-level blend fueling site should not occur in areas without large numbers of FFVs. As stated in Federal Law, **ONLY** FFVs are allowed to use blends of ethanol exceeding 15% by volume. Conventional vehicles MY2001 and newer may use blends of 15% ethanol. Large numbers of FFVs are critical to the long term success of any mid/high-level blend fueling site.

Figure 9 (pg 23) represents the location of FFVs by county throughout the nation. More detailed information based on ZIP code registrations of FFVs is also available. Check with state motor vehicle registration officials for information regarding FFV registrations by ZIP code.

5. **Number of stations in the areas that offer mid/high level blends of ethanol.**
   According to the U.S. Department of Transportation, Highway Statistics, there are approximately 243 million cars and light duty trucks on the nation's highways. **With 162,000 retail fueling stations, this represents ~ 1 retail gas station per 1,500 cars and trucks.**

As noted below in **Table 6,** some areas in the upper Midwest are well served by E85 fueling stations. In fact, a few areas may actually be "over served" by mid/high level fueling locations.

State	# of FFVs *	# of E85 sites **	FFVs per E85 site
South Dakota	40,413	104	388
North Dakota	33,957	56	606

Table 6

* RL Polk and Company, April 2010 FFV Registrations by State
** Alternative Fuel Data Center, Dec. 2010 E85 stations by State

Table 6 may reflect a saturation level or "over subscription" of mid/high level ethanol fueling stations based on the number of FFVs in a few states. Given this saturation of stations per FFV, it is possible that retailers offering the fuel may have difficulty in achieving profitability.

There are also a number of states that are significantly "underserved" with mid/high level blend ethanol fueling sites, including:

State	# of FFVs *	# of E85 sites **	FFVs per E85 site
Pennsylvania	275,991	36	7,666
Ohio	344,236	69	4,988
Alabama	171,009	17	10,060
Massachusetts	102,841	3	34,280

Table 7

* RL Polk and Company, April 2010 FFV Registrations by State
** Alternative Fuel Data Center, Dec. 2010 E85 stations by State

The states identified in **Table 7** offer opportunities for additional infrastructure development. These areas are not adequately served by existing mid/high-level ethanol blend fueling stations. These markets offer an opportunity for increased ethanol fuel sales.

8

Marketing, Advertising, and Support Programs

Once a mid/high level ethanol blend fueling site has been established in an area that has an adequate number of FFVs and is not currently served by a competing ethanol fueling site, it is critical to ensure that the site is properly marketed and promoted. Targeted marketing of new ethanol fuel blends to FFV drivers is most effective when combined with advantageous fuel pricing and good signage at retail locations.

Marquee Signage

An essential first step in identifying a new ethanol fueling station is to ensure that the availability of the fuel is noted on the station marquee. Visible signage is a key to finding new ethanol products at new locations.

Proper Signage

These photos represent excellent signage on road-side marquees which allow motorists operating FFVs to know that high level blends of ethanol are available at each location. Proper ethanol product pricing can also present a retail advantage for fuel marketers.

Dispenser Identification

Motorist must be able to enter a refueling location and quickly identify the mid-high level blend ethanol dispenser. Use of consistent logos is also important.

Clean Cities Program

The U.S. Depart of Energy operates an alternative fuel advocacy effort as part of the Clean Cities Program. Clean Cities is a government-industry partnership sponsored by the DOE Vehicle Technologies Program. With nearly 90 local coalitions and more than 6,500 stakeholders, the Clean Cities mission is to reduce petroleum consumption in the transportation sector. Through a network of coordinators serving each Coalition, local stakeholders work together to determine which combination of technologies will best help their cities and regions reduce petroleum consumption.

The DOE Clean Cities Program can also be a source of grant funds to assist with offsetting the cost of alternative fuel infrastructure.

Clean Cities Coalitions

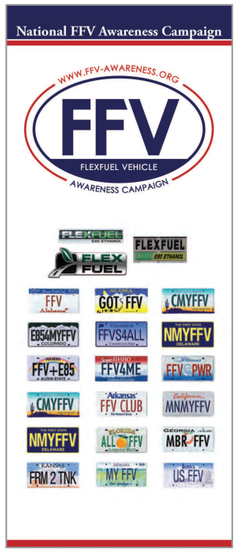
National Flex Fuel Vehicle Awareness Campaign

The FFV Awareness Campaign is a targeted public education effort to locate and educate owners of Flexible Fuel Vehicles and encourage them to use higher blends of ethanol.

The FFV Awareness Campaign assists with market development programs targeted at FFV drivers. Marketing efforts are designed to motivate FFV owners to use higher ethanol blends and E85 available at nearby locations. The Campaign encourages millions of new car buyers to consider early 40 new FFV models as they make their next vehicle purchase. This in turn will lead to new refueling stations with Flex Fuel pumps providing a range of ethanol fuel choices.

The Campaign is coordinated by the Clean Fuels Foundation and works with federal, state, and local officials to assist with outreach efforts. A primary goal of the Campaign is to reach drivers of FFVs and direct them to the nearest mid/high level ethanol blend fueling site. This market development effort is conducted with local fueling sites.

Information regarding the FFV Awareness Campaign can be found at:
http://www.ffv-awareness.org/



9

Summary and Conclusions

Through enactment of the Renewable Fuel Standard requiring the use of 36 billion gallons of renewable transportation fuels by 2022, the nation has established an aggressive public policy which seeks to increase the use of domestically produced renewable fuels while reducing the use of petroleum based transportation fuels. While the use of 36 billion gallons of renewable fuels has been identified as an important energy policy objective and codified into law, there is no assurance that RFS requirements will be achieved without increased biofuel use.

The use of mid and high-level blends of ethanol will require a number of actions:

- Massive production of Flexible Fuel Vehicles
- Massive investment in new fuel dispensing infrastructure
- Establishment of ethanol blend pricing that competes with gasoline on an equivalent mile per gallon basis
- Commitment by motorists to use renewable fuels

The RFS provides no guarantee regarding the use of ethanol other than that which can be used in conventional vehicles and at levels of 10% to 15% ethanol in the future. A coordinated effort is required to establish the business case so that retailers will make the investment necessary to expand ethanol fueling infrastructure. Furthermore, the nation's motorists will only embrace mid and high-level ethanol blends when the products are proven to be cost competitive, the fuel is readily available, and a general recognition of the benefits have been established.

Mid- and high-level ethanol blends used in Flexible Fuel Vehicles provide the only growth sector in an otherwise flat or declining demand for liquid transportation fuels. The relatively low cost of vehicles and infrastructure in comparison to hybrid and electric vehicles provides ethanol a significant advantage. These factors offer an excellent marketing opportunity for fuel retailers. A consistent energy policy and biofuels advocacy effort can help to advance ethanol blends and infrastructure development.

For additional information about ethanol fuels, Flexible Fuel Vehicles, and tips on ethanol fuel marketing please see the following web sites:

www.cleanfuelsdc.org
www.byoethanol.com
www.ethanolretailer.com
www.ethanol.org
www.ffv-awareness.org

Clean Fuels Foundation

The Clean Fuels Foundation was established in 1996 as the first charitable 501c3 organization dedicated specifically to educating the public about the need to develop alternative transportation fuels. The Clean Fuels Foundation has created and implemented several national education and awareness campaigns that include the Environmental Inaugural Ball, the Ethanol Across America program and radio show, and development and distribution of a number of publications. The effort is focused on educating key stakeholders about the benefits of reducing imported crude oil and replacing gasoline with clean burning renewable fuels. **www.cleanfuelsfoundation.org**

Nebraska Ethanol Board

Established in 1971, the Nebraska Ethanol Board assists ethanol producers with programs and strategies for marketing ethanol and related co-products. The Board supports organizations and policies that advocate the increased use of ethanol fuels—and administers public information, education and ethanol research projects. The Nebraska Ethanol Board also assists companies and organizations in the development of ethanol production facilities in Nebraska. For more information, visit **www.ne-ethanol.org.**

Flex Fuel Vehicle Awareness Campaign

The FFV Awareness Campaign is part of the broad array of outreach and education efforts of the Clean Fuels Foundation and the Ethanol Across America program. It is a joint effort by public and private interests to increase the demand for and use of high level ethanol blends. Endorsed by the U.S. Environmental Protection Agency, the campaign is working to locate and educate owners of Flex Fuel Vehicles (FFVs) and encourage them to use these higher blends of ethanol. As a comprehensive public education program, the campaign coordinates and leverages public and private partners who support the increased use of ethanol fuels. In addition, the FFV Awareness Campaign supports the Flex Fuel Vehicle Club where consumers can actively participate. The campaign goal is to make "Flex Fuel Vehicle" and "FFV" household words synonymous with economic, environmental and national security.
www.cleanfuelsfoundation.org • www.flexfuelvehicleclub.org