

# Renewable Fuels



Renewable Fuels Foundation



Renewable Fuels Association



## Vehicle Technology

## Unit 3 Lesson 1

### Precepts

- C. Vision
  - C1. Contemplate the future.
- F. Continuous Improvement
  - F4. Adapt to emerging technologies.

### National Standards

NL-ENG.K-12.6. Applying Knowledge.

### Student Learning Objectives

- As a result of this lesson, the student will ...
1. Identify the need and desire to develop vehicles that run on ethanol.
  2. Identify which manufacturers are developing vehicles that run off of ethanol.
  3. Recognize that ethanol vehicles success will continue to grow in the future.

### Time

Instruction time for this lesson: 50 minutes.

### Resources

[www.ethanolrfa.org](http://www.ethanolrfa.org)  
[www.cleanfuelsohio.org](http://www.cleanfuelsohio.org)  
<http://auto.howstuffworks.com/how-e85-ethanol-flex-fuel-works1.htm>  
<http://geography.about.com/library/blank/blxusa.htm>  
<http://geography.about.com/library/blank/blxbrazil.htm>

### Tools, Equipment, Supplies

Writing surface  
Projector  
Screen  
Assess. A  
TM.A  
TM.B  
AS.A – one per student  
AS.B – number of copies needed varies upon the number of groups created  
AS.C – one per student

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AS.D – one per student  
AS.E – one per student  
AS.F – one per student (optional)  
Stopwatch  
Markers, colored pencils, or crayons  
Tape  
Computer and Internet Access

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### Key Terms

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The following terms are presented in this lesson and appear in ***bold italics***:  
***Economical***  
***Environmental***

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## INTEREST APPROACH

*Gain student interest by asking what their favorite vehicle is. The teacher might project a picture of her/his favorite vehicle on the screen to gain attention. Have students share with the class their favorite vehicle. Then ask a few students to share with the class reasons why that vehicle is their favorite. After a few students have shared, ask them to think about whether their favorite vehicle can burn ethanol. Explain that ethanol is sold in many places in the United States including major cities. Finally, have students consider why we would want to use ethanol. This thought will lead to the first objective.*



Think for a moment about your favorite vehicle. What is the make and model? Tell us your favorite vehicle.

Now, think about reasons why that vehicle is your favorite. Who can tell us the reasons why your favorite is your favorite?

Awesome, you are really passionate about your favorites! Do any of these favorite vehicles burn ethanol?

Nearly all gasoline automobiles can burn a gasoline/ethanol blend. In major cities across the United States and in rural areas we find these blends of 10% ethanol and 90% gasoline called gasohol or E10. One out of every eight gallons of gasoline sold in the United States contains ethanol.

Think for a moment about why we would want to use ethanol. *Pause.*  
This is one of the topics we will consider today. Let's get started!

### *Optional Interest Approach:*

*If computer and Internet access is available: Use AS.F to locate the nearest E85 stations to students' homes or the school by following the directions for #1. Then have students follow the directions for #2. Students will access the website link, enter both the make and model of their vehicle or their parents' vehicle, record the cost and emissions information, and record the information provided by the website for matches to the vehicle they entered. The instructor can have students share (in small groups or to the entire class) the information they gathered from the vehicle comparisons. A wall chart could be created that displays the information students collected from this activity as a reference for the current and other units on Ethanol.*

**OBJECTIVE 1.** Identify the need and desire to develop vehicles that run on ethanol.

I. There is a growing need to find more **economical** and **environmental** friendly ways to power the world's fleet of automobiles.

- A. E85 ethanol contains far fewer potential contaminants than found in gasoline.
  - 1. The U.S. Department of Energy says vehicles fueled with E85 ethanol have lower carbon monoxide and carbon dioxide emissions than conventional gasoline or diesel vehicles.
  - 2. Ethanol reduces exhaust VOC emissions by 12%.
  - 3. Ethanol reduces toxic emissions by 30%.
- B. Reduces the consumer cost of gasoline by extending the supply
- C. Provides an alternative to costly imported oil. Today, ethanol reduces the need to import 128,000 barrels a day of oil and the fuel additive. Just 23.8 gallons of ethanol can replace one barrel of imported oil.
- D. Gives leverage to independent gasoline marketers competing against larger, more powerful integrated oil companies

*Present the information for objective 1 through guided notes. Provide each student with a copy of AS.A. The instructor can use TM.A or record the content on the writing surface. While working through each item of the outline, guide students to the desired responses through questions.*



Our first objective is to identify the need and desire to develop vehicles that run on ethanol. To do this, let's record some information. On the handout there is some missing information and our task is to find these missing terms. Take out a writing utensil to record the missing terms as we discover them.

Let's start at the beginning with Roman numeral I. Read through this incomplete sentence and think about two words that would make sense to fill in the blanks. When you have a response, raise your hand.

*Elicit student responses, record responses on the writing surface.*



These are all great responses! Many of these responses are similar to the terms we will use. To complete this statement, let's use the terms "**economical**" and "**environmental**". Fill in the blanks with "**economical**" and "**environmental**". These are two benefits to the use of ethanol.

Now let's look at line A. What word can be used to fill in the blank? *Elicit student responses, record on writing surface.*

Again, these are great answers! A word that might capture all of your ideas is "contaminants". Let's write "contaminants" in the blank.

As we think about the blanks in item 1, think about a specific poisonous compound that comes from engine exhaust. Also, think about a similar compound that can be harmful to the environment in large quantities. *Pause, allow students time to think.*  
Who has an idea as to what compounds we are looking for?

Awesome! The poisonous compound we are looking for is “carbon monoxide” and the other is “carbon dioxide”. Let’s record “carbon monoxide” and “carbon dioxide” in the blanks.

Read through item 2 and item 3, considering what might fit in the blank for item 3. Who can share your thoughts on the missing term? *Elicit responses.*

“Emissions” fits nicely into this sentence. Let’s record “emissions” in the blank for item 3.

As we look at item B, think about when you or your family buys gasoline. We want gas to be what? Inexpensive, isn’t that correct? Ethanol helps reduce consumer cost because it allows for more fuel to be in supply. So, let’s record “cost” and “supply” in the blanks.

For item C, we are looking for one word, but the tense will be different in different blanks. Take a moment to think about these blanks. *Pause.*  
Share your idea with someone next to you. *Pause.*

Who can share with us your thoughts on this missing word? “Import” is the word we’re looking for. We can record “imported” in the first blank, “import” in the second, and “imported” in the third blank.

Now that we have these blanks filled in, read item D.  
What questions are there about the content we’ve discovered?

*Explain further that the need drove auto manufacturers to develop the vehicles to run off of Ethanol, and the backing of U.S. Congress with bills to turn the U.S. auto fleet to be more **economical** and **environmentally** friendly.*



Something to remember from this content is that a need was created for ethanol because of **economic** and **environmental** reasons. Due to this need, or demand, auto makers began making fuels that can run off ethanol. In turn, the United States Congress is working to help make automobiles more **economic** and **environmentally** friendly. Let’s look more at what auto manufacturers are doing to promote ethanol use.

**OBJECTIVE 2.** Identify which manufacturers are developing vehicles that run off of ethanol.

II. E10 Unleaded is approved under the warranties of all domestic and foreign automobile manufacturers marketing vehicles in the United States.

A. Henry Ford built an *ethanol*-burning Model T before World War I, and over the years, thousands of fleet vehicles were modified to run on *ethanol*-based blends.

B. U.S. automakers began making E85 *ethanol*-compatible components standard on certain models in 1998.

1. America's top three automakers, Daimler-Chrysler, Ford and General Motors recommend the use of oxygenated fuels such as *ethanol* blends because of their clean air benefits and performance qualities. These manufacturers say they plan to put a combined total of 2 million additional E85 *ethanol* flex-fuel vehicles on the road each year starting in 2007.

2. For 2007, 29 different models for sale in the U.S. are E85 *ethanol* flex-fuel capable. That's up from 20 for the 2006 model year.

a. GM will offer 17 E85 *ethanol* flex-fuel models totaling about 400,000 vehicles. GM identifies its E85 *ethanol* flex-fuel vehicles with yellow gas caps and "Flex Fuel E85" badges.

b. Ford expects to sell 250,000 E85 *ethanol* flex-fuel models.

*Use the \$10,000 Pyramid Moment to aid students in learning the content for this objective. Prior to class, the instructor should prepare fact cards using AS.B. One set of fact cards is needed for every 3-5 students. Copy and cut cards and prepare for groups. Instructors should provide students with a copy of AS.C, which includes the content for this objective. Allow students time to review the material before engaging in the activity, check to see if there are questions. Provide students with directions for the activity, then direct students to engage in the activity.*

### *\$10,000 Pyramid Moment*

*Students will take on one of three roles: player, clue giver and teleprompter. The clue giver and player sit facing each other with the teleprompter standing behind the player, displaying fact cards one at a time to the clue giver. The clue giver silently reads the fact card, and then gives the player clues until he or she guesses the information. The clue giver can use the handout, if necessary to give clues from. If there are more than three players in a group, have them decide how they will rotate roles. The game is played in rounds of sixty seconds each. When the player correctly guesses information on a card, the teleprompter sets that card aside. Players or clue givers can pass on a card, in which case the card goes to the back of the deck. After each round, the groups count the player's correct answers and each group's score is recorded on the writing surface. With each new round, everyone in the group switches roles and the entire deck is shuffled for the new player. Play as many rounds as needed to allow each student to play each role once.*



Who has seen the game show \$10,000 pyramid? What happens during that game? One person gives clues and the other is the guesser and they're timed! In a few moments we are going to participate in our own version of \$10,000 pyramid! First, we need to look

through the content. Take a moment to read through the information on AS.C. Let me know if you have questions.

There are three roles to play in this game, a player, clue giver, and teleprompter. Each person will rotate roles so you will get to play each role at least once. The clue giver's job is to read the fact card and give clues to the player to guess what is on the card. The clues should be related to the information from the handout. Don't use any key words on the card! The player's job is to listen to the clue giver and quickly guess what is on the fact card without looking at the handout. The clue giver and player will sit across from one another, while the teleprompter will stand behind the player holding up the fact cards for the clue giver to read. Each player will have 60 seconds to guess as many fact cards as possible. I will keep time and tell you when the round is over. Keep track of how many fact cards each person guesses; we'll need a group total at the end. Who can review for us what the directions are for \$10,000 Pyramid?

*Allow for a student to repeat the directions back to the class. Be sure to clarify any missed or unclear points. Then, split students up into groups of 3-5 (ideas for grouping: alphabetically by last name, number off, clustering students who sit next to each other).*



Great! It sounds like we are ready to go. Let's split up into groups! Take 20 seconds to determine who will serve in each role first: Player, clue giver, teleprompter.

Each group needs a set of cards; teleprompters come up to get a set of cards for your group. Players, clue givers, and teleprompters get in place and we will get started! I'll be the time keeper and will say "Start" at the beginning of each round, remember each round is how long? (60 seconds) At the end of each round I will say "Stop" and groups should count up how many cards the player got right, record it somewhere, and then switch roles. What questions are there? Okay, "Start!"

*After groups have rotated so that each student has the opportunity to play each role, have groups add up all their points. If groups do not have an equal number of students, compute group averages by having each group divide by the number of students in the group and reporting the group average. If all groups are equal, report total group scores. Record these scores on the writing surface. The instructor may wish to provide a nominal award for the group with the highest average or total score. Conclude the activity by asking each group to communicate one important point from the content to the class.*



Awesome job! Players and clue givers, take a moment to calculate the group total. Teleprompters, please bring the deck of fact cards back to the front.

Okay, let's have each group report your total scores. We did a great job of reinforcing the material from the handout by playing \$10,000 Pyramid. Let's take a moment to see what we know. When I say "Think" each group will pick out one important point from the handout to share with the rest of the class. Choose one person in your group who will share this point with the rest of the class. What questions are there? "Think!"

*Have each group share their important point; the instructor should lead discussion further if necessary.*



As each group shares, make a star, highlight or underline the important point on your handout. Let's share what we think is important!

Great work choosing important points! We now have a better understanding of how the automobile industry is promoting the use of ethanol.

*Explain because of the drive for **economical** and **environmentally** friendly energy sources that Ethanol will continue to grow in the future.*



We talked earlier about two benefits of ethanol use; that it is more **economical** and **environmentally** friendly. Let's look now at why we can expect to see more ethanol burning vehicles on the roads in the future.



**Objective 3.** Recognize that ethanol vehicles success will continue to grow in the future.

*This objective will present students with information on reasons why ethanol vehicle use will continue to grow in the future. Remind students what has been covered so far in objectives 1 and 2. Then guide students through a modified Picasso Moment using AS.D and AS.E below. The instructor will project TM.B on a screen for students to view. Students will use AS.D and AS.E to create a visual depiction of the content within the outlines of the United States and Brazil.*



So far, we've learned the need for developing ethanol and learned information about what automobile manufacturers are doing to put more ethanol vehicles on the road. Let's look now at some reasons why ethanol vehicle success will continue to grow in the future.

### Picasso Moment



Who has heard the name Pablo Picasso? What can you tell us about Picasso? Right, Picasso created abstract paintings, sometimes people have to think about what the artist wants us to see. As we look at the information on the success of ethanol, let's think in the mindset of Pablo Picasso.

### Display TM.B

III. Millions of cars powered by ethanol-blended gasoline are on America's roads, and the number continues to grow. American motorists have driven more than one trillion trouble-free miles on ethanol-blended gasoline.

- A. Ethanol's original use was as a gas extender when foreign oil prices skyrocketed in the 1970s. As a result of the phasing out of leaded fuel, ethanol became popular as a high-quality octane booster.
- B. Ethanol-blended gasoline sales represent over 15 percent of all automotive fuels sold in the United States.
- C. Many Midwestern states and federal government vehicles operate on variable fuel vehicles in their fleets. These vehicles are capable of operating on E85, a blend of 85 percent ethanol and 15 percent unleaded gasoline. The small percentage of unleaded gasoline in E85 fuels enhances starting in extremely cold weather.
- D. Brazil is the largest transportation fuels market in the world for ethanol.
  - 1. Brazil has used ethanol blends since 1939. High oil prices in the 1970s prompted a government mandate in Brazil to produce vehicles fueled by pure ethanol in order to reduce dependence on foreign oil and provide value-added markets for its sugar cane producers.
  - 2. Today, there are more than 4.2 million ethanol-powered vehicles in Brazil that consume nearly 4 billion gallons of ethanol annually.
- E. Two of the oxygenates used in reformulated gasoline that is required in certain ozone nonattainment areas in the U.S. are Ethanol and ETBE.



Take a moment to look at the information you see projected. *Pause, allow students time to read.*

If you were an artist painting a picture, how you would represent this information? What would be included in the picture? How would you portray the relationships that exist in this information? *Elicit responses for each question.*

*Pass out AS.D and AS.E to students.*



Great! Since we are thinking like Picasso, we don't necessarily want to draw literal pictures of the information. We can really have fun with this! Our task is to create two "modified" Picasso paintings, one for the United States and one for Brazil. Using the content from objective 3 you see projected, we will create two paintings that will help us understand why ethanol use will continue to be successful. Don't feel constrained by the outlines of the countries, Picasso probably wouldn't stay within the lines, and we don't need to either! The outlines are just a starting point for our creations. When we are finished, we will display our creations around the room for others to see. We'll use *(markers, colored pencils or crayons)* as our paint today while the activity sheets are like our canvas. Let's take about 15 minutes to "paint". Questions?

*The instructor should circulate through the room to assist students and provide guidance and suggestions for students who need assistance with the activity. The instructor should gauge time allowed as more time may be necessary. When students are finished, have students affix their "paintings" to the wall. Then, have students perform a gallery walk so they are able to view other students' work.*



I see some awesome Picasso-like creations as I walk through the room! As we finish up, let's create an art gallery so we can share with each other. Tape your masterpieces to the wall, spacing them around the room, then return to your seat. *After students have displayed their work, explain what the gallery walk will look like.*

Who has been to an art gallery or museum? What are some of the norms people follow when they're in an art gallery? *Elicit student responses.*

One of those norms is that people are usually silent as they look at the works of art. In a moment, we will perform a gallery walk so we can see the works of art our classmates created. As we look at the different "paintings" imagine what each component represents in relation to the material that is projected at the front. Think about what each person was thinking when they made their masterpiece and how it relates to the future success of ethanol. Just as if we were in an art gallery, think about each piece silently.

*If time allows, have students pair up and explain to one another how their artistic creation represents the content.*



Our time spent as artists has allowed us to understand this information in a different way. Great job! Let's take some time to review.

**REVIEW/SUMMARY**

*Use the student learning objectives to summarize the lesson. Have students explain the content associated with each objective. Student's responses can then be used to determine which objectives need to be clarified and which objectives are fully understood.*



Let's think back to our first objective for today. Think about the key terms and how they are important to the need and desire to develop vehicles that run on ethanol. Who can share with us some of those key terms?

Who can help us connect these terms to the importance of ethanol?

*Show students the clue fact from the \$10,000 Pyramid E-moment. Lead them to think back to what each fact means in relation to the content for objective 2 by holding up the card and asking them to think about the clues they were given for that fact and how it relates to the automobile industry and ethanol.*



Great! Let's look at objective 2. As I hold up each fact card, think back to the clues you were given. In your mind, think about how the clues and the fact relate. Think about other clues we could create for this fact. Also, think about why each fact is important to the automobile industry and ethanol.

*Hold up each fact card, allowing students time to process each.*



Finally, we considered why the use of ethanol vehicles will continue to be successful. From our seats, let's take another look at the pictures we see posted around the room. Pick out one major point from the drawings and record it on a piece of paper. Take a moment to share what you recorded with a neighbor.

We've done a great job of examining vehicle technology related to ethanol. We've learned about the need and desire for ethanol, what manufacturers are doing to develop ethanol vehicles, and reasons why ethanol vehicles will be successful in the future. Let's show what we know by taking the evaluation for this lesson.

### APPLICATION

**Extended classroom activity:** *Students are to price hybrid automobiles online. Using the information found for pricing and efficiency (as reported by the manufacturers), students will pick three manufacturers and three vehicle types (economy, family sedan, SUV) and gather information for all nine automobiles.*

**FFA activity:** *Using data gathered on hybrid automobiles, students will discuss and create opinion statements for or against the purchase of hybrid automobiles. This activity could be tied to the Ag Mechanics Career Development Event or the Ag Issues Forum.*

**SAE activity:** *Students with an ag mechanics SAE project can examine the differences between standard gasoline engines and flex fuel engines and the use, availability, and benefits of flex-fuel engines. The student could prepare an article for the local newspaper educating the public on the findings.*

**EVALUATION**

Assess. A

**Answers to Assessment:**

1. C
2. E
3. A
4. E
5. B

## TM.A

I. There is a growing need to find more \_\_\_\_\_ and \_\_\_\_\_ friendly ways to power the world's fleet of automobiles.

A. E85 **ethanol** contains far fewer potential \_\_\_\_\_ than found in gasoline.

1. The U.S. Department of Energy says vehicles fueled with E85 **ethanol** have lower \_\_\_\_\_ and \_\_\_\_\_ emissions than conventional gasoline or diesel vehicles.

2. **Ethanol** reduces exhaust VOC emissions by 12%.

3. **Ethanol** reduces toxic \_\_\_\_\_ by 30%.

B. Reduces the consumer \_\_\_\_\_ of gasoline by extending the \_\_\_\_\_

C. Provides an alternative to costly \_\_\_\_\_ oil. Today, **ethanol** reduces the need to \_\_\_\_\_ 128,000 barrels a day of oil and the fuel additive. Just 23.8 gallons of **ethanol** can replace one barrel of \_\_\_\_\_ oil.

D. Gives leverage to independent gasoline marketers competing against larger, more powerful integrated oil companies

**TM.B**

Recognize that **ethanol** vehicles success will continue to grow in the future.

III. Millions of cars powered by **ethanol**-blended gasoline are on America's roads, and the number continues to grow. American motorists have driven more than one trillion trouble-free miles on **ethanol**-blended gasoline.

A. **Ethanol**'s original use was as a gas extender when foreign oil prices skyrocketed in the 1970s. As a result of the phasing out of leaded fuel, **ethanol** became popular as a high-quality octane booster.

B. **Ethanol**-blended gasoline sales represent more than 15 percent of all automotive fuels sold in the United States.

C. Many Midwestern states and federal government vehicles operate on variable fuel vehicles in their fleets. These vehicles are capable of operating on E85, a blend of 85 percent **ethanol** and 15 percent unleaded gasoline. The small percentage of unleaded gasoline in E85 fuels enhances starting in extremely cold weather.

D. Brazil is the largest transportation fuels market in the world for **ethanol**.

1. Brazil has used **ethanol** blends since 1939. High oil prices in the 1970s prompted a government mandate in Brazil to produce vehicles fueled by pure **ethanol** in order to reduce dependence on foreign oil and provide value-added markets for its sugar cane producers.

2. Today, there are more than 4.2 million **ethanol**-powered vehicles in Brazil that consume nearly 4 billion gallons of **ethanol** annually.

E. Two of the oxygenates used in reformulated gasoline that is required in certain ozone nonattainment areas in the U.S. are ethanol and ETBE.



## AS.A

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D. Gives leverage to independent gasoline marketers competing against larger, more powerful integrated oil companies

AS.B

|                |  |         |
|----------------|--|---------|
| Henry Ford     |  | 250,000 |
| E85            |  | 1998    |
| 2 million      |  | 400,000 |
| 29             |  | 250,000 |
| Yellow gas cap |  | Model T |

## AS.C

II. E10 unleaded is approved under the warranties of all domestic and foreign automobile manufacturers marketing vehicles in the United States.

A. Henry Ford built an **ethanol**-burning Model T before World War I, and over the years, thousands of fleet vehicles were modified to run on **ethanol**-based blends.

B. U.S. automakers began making E85 **ethanol**-compatible components standard on certain models in 1998.

1. America's top three automakers, Daimler-Chrysler, Ford and General Motors recommend the use of oxygenated fuels such as **ethanol** blends because of their clean air benefits and performance qualities. These manufacturers say they plan to put a combined total of 2 million additional E85 **ethanol** flex-fuel vehicles on the road each year starting in 2007.

2. For 2007, 29 different models for sale in the U.S. are E85 **ethanol** flex-fuel capable. That's up from 20 for the 2006 model year.

a. GM will offer 17 E85 **ethanol** flex-fuel models totaling about 400,000 vehicles. GM identifies its E85 **ethanol** flex-fuel vehicles with yellow gas caps and "Flex Fuel E85" badges.

b. Ford expects to sell 250,000 E85 **ethanol** flex-fuel models.

AS.D

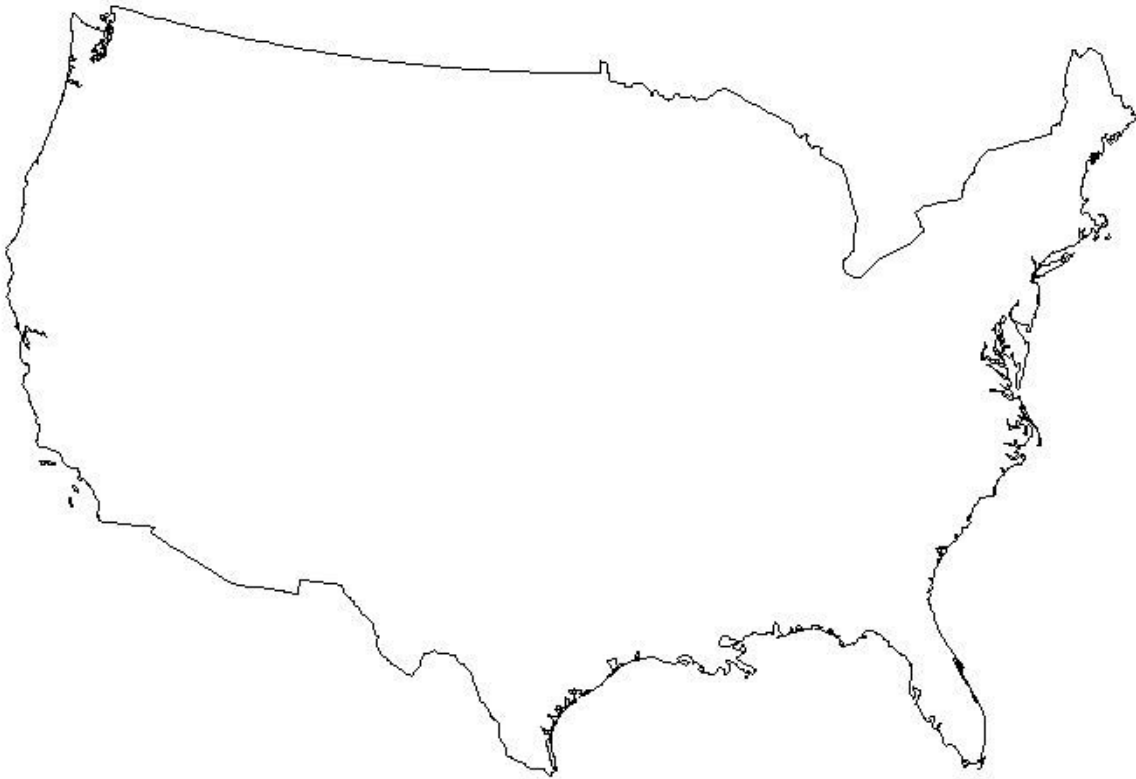


Image obtained from: <http://geography.about.com/library/blank/blxusa.htm>

AS.E



Image obtained from: <http://geography.about.com/library/blank/blxbrazil.htm>

## AS.F

1. Go to [www.e85refueling.com](http://www.e85refueling.com) and locate the nearest station to your home. List the two closest stations to your home or school.
2. Go to [http://www.pbs.org/newshour/indepth\\_coverage/science/alt\\_fuels/comparison.php?y=2005&f=-1&m=FORD&c=4177](http://www.pbs.org/newshour/indepth_coverage/science/alt_fuels/comparison.php?y=2005&f=-1&m=FORD&c=4177)

Enter yours or your parent's vehicle year, make, and model and get the comparison ratings.

Fill in the chart as follows:

| Match       | Fuel                   | Car Type | Cost | Co2 Emission Level |
|-------------|------------------------|----------|------|--------------------|
| Your Choice | Gasoline               |          |      |                    |
|             | Biodiesel              |          |      |                    |
|             | Electricity            |          |      |                    |
|             | Hydrogen               |          |      |                    |
|             | Compressed Natural Gas |          |      |                    |

**Assess.A****Multiple Choice:**

Circle the best answers the question in the blank provided at the left of each question.

1. Which of the following statements are true?

- A majority of auto dealers use **ethanol**-blended gasoline.
- A majority of independent automotive technicians use **ethanol**-blended gasoline.

- A. Only statement I is true.
- B. Only statement II is true.
- C. Both statements are true.
- D. Neither statement is true.

2. E10 Unleaded gasoline is approved under the warranties of:

- A. Chrysler
- B. Ford
- C. General Motors
- D. Toyota
- E. All domestic & foreign car manufacturers

3. True or False. All vehicles can accept E10 blends of fuel.

- A. True
- B. False

4. Which of the following statements are true?

- A. **Ethanol** reduces exhaust VOC emissions by 12%.
- B. **Ethanol** reduces toxic emissions by 30%.
- C. **Ethanol** reduces the consumer cost of gasoline by extending the supply
- D. Answers A and C are true.
- E. All of the statements are true.

5. True or False. Millions of cars powered by **ethanol**-blended gasoline are on America's roads, but the number continues to decline due to the number of vehicles available.

- A. True
- B. False