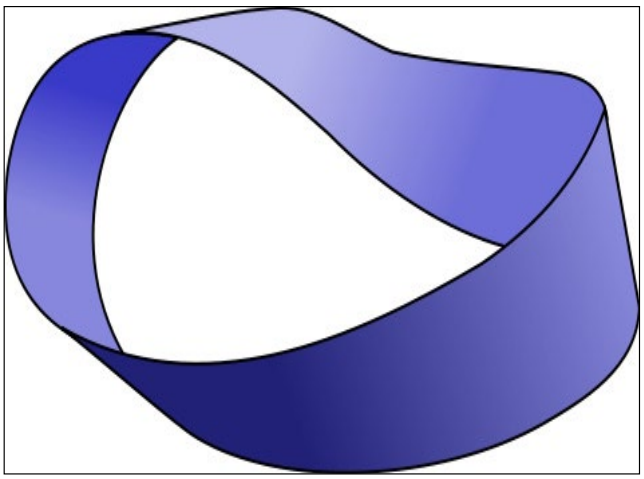

National Farmers Union

"Renewable Energy: Sustainable, Responsible, Affordable"

Grades 9-12

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Lesson 1: Long-Term Benefits and Possibilities

Unit Objective: To build awareness of and understanding why renewable energy must be a priority in our personal lives, our hometown communities, and our national policies. And, to develop an appreciation for how all forms of energy have an impact on the environment.

Grades: 9-12

Length: 2 hours, with breaks built in at approximately 25 minute intervals.

Materials Needed: A white board, copies of the **Agree** and **Argue** and **Fact** and **Feeling** signs, **Do The Math** worksheets, **Essential or Convenience** worksheets, a balloon, three clear drinking glasses, a box of CoCoa Puffs, one bottle each of 7-Up and Coke, a fragile jar filled with dirt and artificial plants, clear plastic bag, hammer, a small cardboard box, and appropriate snacks.

Preparation Needed: A standard classroom setting, preferably using round tables. Print out enough **Agree** and **Argue** and **Fact** and **Feeling** pages below for each student, along with the **Essential or Convenience** sheets and **Do The Math** sheets.

Background: Energy is essential to life. Reliable and affordable energy is critical to support civilization. This lesson will challenge students to consider where energy comes from, how it is used, what happens when we use more energy than we produce, and why renewable energy is becoming both essential to and popular with consumers.

Teaching Strategy:

1. *Life depends on energy. The earliest sources of energy used by humans includes sunlight itself, which provided heat and also stimulated plant growth. Plants were a source of food for humans, and many plants were eaten by animals that also served as a source of food and clothing for humans.*
2. *Early humans used wood to provide heat with which to cook foods. Wood is portable and it provided heat and light at night and during winter months when the sun's energy was relatively weak.*
3. *Human civilization was (and continues to be) built because of access to energy, which is essential to life and increasingly is a convenience. What is the difference?* Pass out the one-page **Essential or Convenience** worksheets to your students.
4. *I will give you a few moments for you to list five ways energy is essential to human life, and five ways energy is a convenience. What could we live without, and what do we really need to survive? In fact, you can answer these questions at the bottom of your sheet.* Allow them three to four minutes for this portion of this exercise. *Now, with the rest of your group at your table, select the top five in each category through discussion and consensus.* After three to five minutes, ask each table to report their conclusions. Look for commonality among responses and use it to reaffirm how energy is both essential for life, and has made virtually all conveniences in life possible. Refer to the **Discussion Guide**.
5. *Adequate energy fuels manufacturing, employment, economic growth, health care, food production, national security, technology, education, and civilization. It is essential to our way of life. Abundant energy means music and movies, cell phones and computers, air conditioning and cruise ships. None of these items are essential, in fact some of these conveniences have only been in common use for one or two generations. Life is much easier and enjoyable because we have developed reliable and affordable sources of energy.*
6. *Many of you have experienced what it is like when the power is out. Our lives come to a complete stop. Power outages are rare and often short in duration. Yet without power for a few hours we are figuratively and literally in the dark, disconnected, and uncomfortable. After a few days without power, such as following a major weather disaster, we suffer more significant effects. This is when we learn that not having a cell phone pales in comparison to the closing of hospitals and grocery stores, or the inability to use cars, buses and trains to get around.* Pause and ask them if they might change some items on their Essential or Convenience sheet. *What will happen when we do not have enough energy? In fact, it has happened. In the 1970s, the United States endured an energy crisis. America for decades has been using more energy than it could produce. This means we need to buy energy from other countries. Much of this energy is in the form of oil, and some of that oil comes from the Middle East. In 1973 the Arab members of OPEC (Organization of the Petroleum Exporting Countries) decided to embargo the amount of oil it would sell to the U.S. This embargo was to punish the U.S. for lending support to Israel after it was attacked by Egypt and Syria. This drove prices sharply higher and led to shortages. For example, the government imposed rationing of gas in an attempt to create a sense of stability, if not civility, at the pump. This resulted in long lines and often people could only buy a limited number of gallons. Waiting in line made people irritable. Rationing was meant to add a measure of fairness in providing access to fuel. Everyone had an equal chance to buy a limited number of gallons of gas. In an otherwise free market, the price could have doubled or tripled and only wealthy people would have been able to buy fuel. Most teenagers would have been forced to park their cars and walk. Can you image that?* (Pause and study their reaction).
7. Ask your students to write down any four numbers on a piece of paper. Tell them to make the numbers in a large size, at least ten inches tall. Then have them line up holding their paper displaying their numbers in front of themselves. Have those with odd numbers move to one line, with the even numbers forming a second line. *Here is how rationing works. Today only cars with even number plates can buy fuel. All the odd number license plates can sit down.* Walk along the even number plates. Before you get to the end, pick a place separate the line. *Sorry, but all of you in line after this point are out of luck. We have sold all the gas we have available today. Come back in two days and do your best to be at the front of the line.* Ask your students to return to their seats.
8. *Can you see why not having enough energy is harmful to the nation's economic health? Higher fuel prices led to an economic shock and rapidly increasing inflation. Right now, inflation is of minimal concern. In the 1970s, inflation approached 20 percent annually. Put another way, if you were earning $10,000 a year, that income would have the buying power of only $8,000 one year later. Companies kept increasing prices to keep up with cost of inflation, which rippled through the economy. Homes, schools, and businesses could not easily reduce the fuel they used. They had no choice but to pay higher prices. The additional spending for energy left far less money with which to buy consumer goods. Just as during World War II or the Great Depression, or the recent Great Recession, people had to live with less.*
9. *Another reason OPEC's actions hurt America is that so many consumer goods are made from oil. Carpet, clothing, plastics, and paints are just a few of the thousands of consumer goods made from oil. OPEC could use the threat of future embargoes to try to influence U.S. policy and, not surprisingly, also used limited production to control crude oil supplies in order to increase the price of oil and profits to OPEC members.*
10. *Americans had to deal with even bigger questions about rationing. Think about this: should limited supplies of fuel go to farmers, or to trucking companies, railroads, and airlines, or hospitals and nursing homes, or to the military? Without adequate supplies of energy, we quickly put aside convenience for what is essential. Many homes in the 1970s used heating oil, especially in the populous Northeast. In addition to rationing, the government promoted conservation. President Carter set the thermostat in the White House at 68 degrees and began wearing sweaters. The need for alternative fuels was obvious. The most immediate solution, however, was to use conservation to reduce the amount of energy being used.*
11. *All these extremely upsetting disturbances to the American way of life occurred for two key reasons: one, America relied (and still does) on oil as the main source of fuel for cars and trucks; two, America relied (and still does) on importing oil from Canada, Mexico, and from the Middle East, although hydraulic fracturing in North Dakota, Texas, Pennsylvania and other states is increasing the supply of domestic oil and reducing the imports of foreign oil. The good news is the energy crisis led to much better conservation in buildings and homes, and better fuel economy in cars. Construction of new buildings placed greater emphasis on using insulation and better windows to reduce heating and cooling requirements. Congress in 1975 enacted the first fuel economy standards for automobiles. President Carter in 1977 formed the Department of Energy to focus federal resources on this topic. And, OPEC's action to raise oil prices inevitably led to competition. Other nations around the world ramped up their oil production to capture market share in a now profitable industry. The result was that oil prices ultimately moderated and then fell in the early 1980s as supplies increased and the U.S. used conservation methods and economy cars to reduce energy needs which effectively created a surplus. Since then, the economies of India, China and other nations have been growing, leading to more worldwide demand and competition for energy resulting in higher prices.*
12. *What lessons should we have learned from this crisis?* Ask each table to discuss what actions Americans could have

taken following the energy crisis to prevent another. After five minutes (add time, if necessary), ask each table to report their conclusions. Use these responses to guide a brief back-and-forth open discussion on this topic. Consult the **Discussion Guide** for additional examples.

13. *Did we learn anything as a nation? Did this economic shock change our culture? When gas prices leveled off at around a $1.40 per gallon from 1987 through 2000, the sales of large SUVs essentially tripled during this same period of time. American auto makers of the early 1970s were criticized for building 5,000 pound, high-horsepower cars that got perhaps 10 miles per gallon. In response, the car companies said they built cars that buyers wanted. Back then, fuel was 33 cents a gallon. Is there a parallel in the situations of the early 1970s and late 1980s? Work in your groups to come up with three examples of lessons we have learned, and three examples of lessons we have not.* After the alloted time, ask each table of students to share their findings. Consult the **Discussion Guide** for examples that may not have been mentioned. Use this time to consider what we have and have not learned regarding fuel use in individual terms, and as a nation. This is important as it sets the theme for the next session.
14. BREAK: Five minutes. Provide appropriate snacks and beverages, if possible.
15. *You just had something to eat. In effect you are fueling your bodies with calories that you convert to energy. What happens if you quit eating?* Pause and wait for the obvious answers: we grow tired, we lose strength, we eventually die. *Our bodies need fuel. If you run out of food, you run out of energy. Is food a renewable resource?* Listen to the responses. *Food, of course, is a renewable resource. Are some types of foods better for us? What happens if we eat too much fuel? What happens if we eat the wrong kinds of fuel?* Listen to their answers.
16. *A resource includes materials or conditions that humans use to make their lives better. Natural resources such as deposits of coal, iron ore, and old-growth forests were critical assets that helped build America. Natural resources include rivers as well, as they provided the earliest and easiest highways of commerce far inland from coastal cities and ports. Heavy manufacturing industries such steel and automotive depend on affordable and accessible supplies of natural resources.*
17. *Let's think about this from a different point of view. What is the difference between renewable and fossil fuels?* Use this leading question to engage your students in an open discussion, the purpose of which is to allow every student to have a chance to share his or her thoughts, and to consider the comments of other students.
18. *Fossil fuels formed over a period of many million years. As the name suggests, fossil fuels were formed from the fossilized remains of plants and animals that accumulated in large volumes over millions of years and subsequently were compressed and heated within the Earth's crust. Fossil fuels contain high percentages of carbon. Coal, crude oil, and natural gas are leading fossil fuels. Recoverable fossil fuels are found in numerous regions across the globe, usually in concentrations such as seams of coal, pockets of gas, and underground reservoirs of crude oil. These concentrations have made it easier for companies to develop and use fossils fuels whose hydrocarbon chains are refined for specific uses. Yet when fossil fuels are gone, they are gone forever.*
19. *Another downside of fossil fuels is the chemical processes involved in using them releases carbon dioxide, about 22 billion tons a year, according to the Energy Information Administration* (NOTE: As mentioned in the teacher's guide, these statistics vary according to the input values being used). *Natural processes including the growth of plants and trees can absorb about one half of this amount, leaving 11 billion tons to accumulate each and every year. Carbon dioxide is a greenhouse gas: it builds up in the Earth's upper atmosphere and effective traps solar radiation, resulting in increasing temperatures. Think of how a car with its windows up will become uncomfortably warm until someone opens a window or door to allow the equalize. Earth does not have such a convenient way to release heat. Nor can we reduce greenhouse gas concentrations quickly.*
20. *Some people argue that climate change or global warming is not happening. Scientific research and actual changes in global weather patterns, however, support the conclusion that greenhouse gases are negatively affecting weather worldwide, which is directly impacting life. For example, glaciers are melting at alarming rates, storms and droughts are becoming more severe and are appearing more frequently "outside" of normal seasons and regions, and polar ice caps are shrinking causing sea levels to rise.*
21. Blow up a party-type balloon to the size of a baseball. *This represents 11 billion tons of carbon dioxide released into our atmosphere this year.* Blow the balloon up again. *Here is another year's worth of carbon dioxide.* Blow it up again, and again. *Notice how it keeps getting larger?* Blow it up one more time. *At some point, the accumulation will lead to changes that will cause significant negative impacts to life on earth. This ongoing condition can go beyond all hope of recovery.* Let go of the balloon.
22. *Another major concern relating to fossil fuels is the environmental impact that occurs during the drilling, mining, processing, refining, and transporting steps. Mountain top mining in Appalachians has caused significant impacts to the environment. This type of mining results in consequential damage to rivers, which often are filled with silt and metals that harm wildlife. These impacts are difficult if not impossible to reverse. The clean up costs are enormous and typically shift to the taxpayers rather than the companies that did the damage. Oil drilling also damages land and threatens wildlife. In 2010 a BP rig in the Gulf releases millions of gallons of crude oil that washed up on beaches and impacted sea life along, and the fishing and tourism industries of, Louisiana, Mississippi, Alabama, and Florida. Eleven people were killed in the explosion. It took 87 days to stop the underwater flow of crude oil. At least 210 million gallons of oil flooded the ocean and the ecologically sensitive shallow waters along the coast. The spill resulted in consumers questioning the health hazards of oil in America's seafood supply. In 1989 the Exxon Valdez, a bulk oil tanker, broke open on rocks of Prince William Sound off the south coast of Alaska, dumping more than 11 million gallons of crude oil killing orcas, seals, sea otters, bald eagles, and diminishing the salmon that sustain killer whales. The University of North Carolina determined it would take 30 years for the ecological health of the area to recover.*
23. Hold up a glass jar half-filled with dirt and a few small artificial plants. Explain that the glass represents the atmosphere that protects our plant. Place the jar inside a clear plastic bag, and then inside a small cardboard box. Use a hammer to break the jar through the box. Hold up the clear plastic bag containing the remnants of the jar and let your students study it for a few moments. *This is a simplistic demonstration. It is meant to show you that intentional human activity (hold up the hammer) has caused damage to Earth's environment. It would be impossible to restore this glass jar to a reusable condition. Humans for years have been intentionally damaging the environment.*
24. *In the former Soviet Union, the Aral Sea was once one of the four largest lakes in the world, much like one of our Great Lakes. In the last 60 years its waters were diverted to irrigate crops at least 90 percent of the lake has disappeared. A healthy fishing industry was lost and the remaining water now has high concentrations of chemicals that make it poorly suited for any use. Hotter summers and much colder winters in the area are being attributed to the mostly dry lake bed.*
25. *Humans literally killed off the dodo and the passenger pigeon and nearly killed off the North American bison, all due to hunting. The point is, human activity has lead to the extinction of some species. We actually have the ability to purposely poison or otherwise ruin our environment. It is possible we could cause our own extinction.*
26. *The good news is we also have taken action to protect and preserve environments, and we have been successful in helping endangered species recover. The American bald eagle is one bird that once was threatened with extinction until the United States banned the use of DDT, a pesticide used to kill insects that also wound up in the eagles' food chain.*
27. *How does this relate to renewable fuel? These examples show human actions can and do have a serious negative effect on the environment. Effects can that cause both health and economic concerns for humans and dramatically change the balance of nature.*
28. *What is a renewable fuel?* Allow your students to respond. Write down their examples on a white board. Ask for three volunteers for the next demonstration. Place three clear glasses on a desk at the front of the room. Ask your three volunteers to line up behind the glasses. In one glass pour 7-UP or a similar clear beverage. In the second glass pour Coke or a similar dark beverage. In the third glass place CoCoa Puffs cereal or similar dark, dry edible snack. Invite one student to drink the 7-UP, the next student drink the Coke, and the third to eat the cereal.
29. *The cereal represents coal. Other than mining, is there any way for us to replace this coal once it is used? Can we manufacture it?* The answer from you students should be "no." *Coal takes millions of years to make using processes we are unable to replicate on an effective scale. The Coke represents oil. Other than drilling for it, can we create it from scratch? Again, the answer is "no." When our reserves of these two fossil fuels are gone, they are gone. We will have to learn to live without them. That brings us to the 7-UP. It represents ethanol, a renewable fuel we make from crops.* Refill the glass with 7-UP. *We can make this fuel from crops, for example. The bottom line is fossil fuels will run out, or will become too expensive to extract, or whose environmentally damaging side effects will no longer be acceptable. It is important to note that all fuels, even renewable fuels, cause some measure of environmental impact. That said, the question becomes: do renewable fuels cause less of a negative impact that fossil fuels and if so, does it make sense to begin using more of such fuels?*
30. BREAK: Tell your students to take a 10 minute break. Provide them with appropriate snacks and drinks.
31. *Let's pick up where we left off. Fossil fuels were formed over tens of millions of years. We are depleting our supplies with no way to recharge them. This is a fact. Will will run out of certain forms of energy. Also, populations worldwide*

continue to grow at significant rates and as more countries develop their industrial abilities and improve their way of life it will result in increasing demand for energy.

32. Hand out the **Do The Math** worksheet. *Think about this. You own a coal mine that is near the surface of a rural field. It is the only source of coal available to your community. It is used for heat, to create electricity, to plant and harvest crops, and as a source of power for industrial manufacturing. The first year, you sell one ton. You estimate you have 2,000 tons of coal. Based on your supply, how many years will your mine meet demand?* (2000 years) *The next year, you sell two tons. The third year, you sell four tons. You double your sales each year. This is known as exponential growth and to you this certainly is a measure of success. Customers who need energy are committed to you as their source of energy. Based on your growth doubling each year, in how many years will your mine run out of coal? (*The answer is Year 12) *Now what do you do? What do your customers do?* Use your questions to build discussion among your students. *Do you have any responsibility to encourage your customers to conserve so the supply lasts longer? Do you ration your supply? If so, how do you decide what are essential uses and who can do with less or without? As coal is in limited supply, can you sell it at a higher price? What would you do if in Year Six one of your customers begins telling people the coal is going to run out? Others call this person an alarmist. Would you as a coal seller want new forms of energy to compete with your sales? What if you were buying coal, instead? Would you want someone to begin developing an alternative source of energy, even if it might be higher in cost that coal? What might happen if you discover another 1,000 tons but it is much deeper and more dangerous to mine. It will triple the cost of coal and supply less than one year's supply. Is it worth extracting? What if it amounts to 4,000 tons? What difficulties will occur for the businesses and people using coal from this supplier?*
33. *Now, play out this same scenario on a global level. Is it possible some nations will benefit and others will suffer? Will poor countries be able to buy coal? Is it possible some countries will use military action to secure their supply of coal? Do some nations have a natural advantage because they have domestic supplies of coal, especially in reserves well beyond what their current and future demands seem to require?*
34. *The major forms of fossil fuels are coal, oil, and natural gas. Each has unique advantages and disadvantages when it comes to economics, convenience, true costs, and environmental impact. Renewable fuels also have unique advantages and disadvantages when it comes to economics, convenience, true costs, and environmental impact. Each source of fuel will have individuals, organizations, businesses and scientists that support it and others who will object to its use.*
35. *For now, lets consider a fuel source that, in theory, should have been renewable. Long before electricity was available for home lighting, Americans used to burn oil in lamps to provide nighttime lighting. Does anyone know the source of this oil?* Pause to consider any answers your students may offer. *From 1820 to 1865 - the year the Civil War ended - Americans burned whale oil in their lamps. Initially, whales made an easy target for sailors, especially large, slow whales that spent their lives near the surface of the ocean.* Draw the outline of a whale on the whiteboard. It does not have to be accurate; it should be large. *In a short time, the largest whales had been killed and the average size of the whales being hunted became smaller while at the same time their populations, began to decline.* Draw the outline of a smaller whale inside the original. Keep drawing smaller and smaller whales to illustrate the decrease in size. *Bowhead and right whales were hunted nearly to extinction. Bowhead whales are around 20 years old before they began producing calves. They can live to 100 years of age and grow to more than 75 tons. Were they a renewable fuel? No, not at this rate of consumption. They were an unsustainable source of fuel. Ultimately, commercial whaling would have continued until there were no whales left, especially as the free market of that period did not have rules to follow that would have given whales protection to reproduce and mature. Nor would any such rules have been easy to enforce given the resources of the day. Does it make sense to completely consume a resource without making any plans for what happens once it is gone?* Facilitate a discussion of this topic among your students.
36. *In the case of whale oil, Americans began using a new source of energy that had more advantages. That source was kerosene, which comes from crude oil. Just a couple of years before the start of the Civil War, the first oil well was drilled in Pennsylvania. After the Civil War the oil industry developed into a leading source of energy that ultimately would fuel the rapid expansion of the automotive industry. An entirely new energy industry was able to grow and replace a previous source of energy that was limited in availability and caused significant environmental damage in the form of potential extinction of several species of whales.*
37. *Often one seemingly small actions by man can and will cause a ripple effect whose overall impact is substantial. Actions taken by individuals and companies can and do have unintended consequences. For example, in 1910 an avalanche killed 96 people when it hit a stranded passenger train in the Cascade Mountains. The railroad had clear cut the forest of trees above the slide area to provide lumber for building the railroad line. The railroad's own earlier actions set up the conditions which contributed to the loss of life. At the time the trees were cut, few people were aware of the potential impact the action might have regarding holding back, slowing down, or actually causing avalanches to accelerate down the mountain just above the rail line. An easier solution would have been to leave the forests uncut in areas where snow slides were most likely.*
38. *One of the consequences of burning fossil fuels is that we are depleting the coal, oil, and natural gas reserves at a rate which will not be sustainable. An initially unrecognized consequence is the release of carbon dioxide, a greenhouse gas that has been and is accumulating in Earth's atmosphere. Climate change or global warming is a controversial topic. Some say it is not happening. Others say it is happening, but human activity is not causing it. These opposing viewpoints may have to do with the political or philosophical beliefs or the economic interests of each individual. Most scientists agree that global warming is occurring based on actual data collected over several centuries and on actual observations. What is the difference between weather and climate? Weather is what is happening outside today. Climate is overall weather patterns over much longer periods of time such as 30 years. Any 30-year period will indicate if temperatures are warming or cooling, if rainfall is increasing or decreasing, if wind patterns and intensities are changing in a specific region, and worldwide. When someone jokes on a particularly cold day that global warming isn't happening, they may not understand the difference between weather and climate. Records taken over centuries will show any specific day in a certain location will have a record high, record low, and overall average. When the averages begin to dramatically increase or decrease over 30 years or 100 years it indicates a long-term change is under way.*
39. *Here is another example of unintended consequences. Colorado has had ten years of warmer than average temperatures. A Colorado State University report links this to climate change. The report suggests average temperatures are increasing. Colorado historically has not had sufficient water to meet its needs. As this is written, Colorado is experiencing an ongoing multi-year drought, aggravating already existing water shortages. During the past ten years, warmer overall winters have allowed the mountain pine beetle to spread across Rocky Mountain forests. Pine beetles are killed by extremely cold temperatures sustained over several days. Such cold snaps are - were - common at higher elevations. But the warmer overall average temperatures have prevented such cold snaps, allowing the beetles to continue to kill tens of thousands of pine trees. This dramatically increases the possibility of forest fires that officials believe will be larger and burn longer because of the vast areas of dead trees. Following these fires, any rainfall will cause significant erosion which will choke mountain streams with debris and negatively affect water quality, thus further reducing water supplies during the drought. This, in fact, has already occurred.*
40. *The initial impacts of climate change have the potential to trigger thousands of subsequent impacts which may not be obvious for years to come. A single degree or two of increasing average temperature may not feel like much to humans, but it can have a significant impact on plants, animals, and weather patterns. It can compromise growing conditions leading to lower crop yields and resulting in higher prices for food. In reality, humans themselves are comfortable in a relative narrow range of ambient temperatures between 66 to 78 degrees, depending on personal preferences.*
41. BREAK: Five Minutes, provide appropriate snacks and beverages.
42. *We've covered a lot of information in this section. It's is time to put it to use. It is time for you to think for yourselves. Your group will have 10 minutes to research and report on your assigned* **Think For Yourself** *topic. I will call on each group to stand up and report its conclusions. You are free to use your cell phones, tablets or laptops to access the Internet as a research tool.* Hand out one set of "**Fact**" and "**Feeling**" and one set of "**Agree**" and "**Argue**" to each student.
43. At the end of 10 minutes, ask the students at one table to stand up and tell the class how they answered their questions. As they give their reports, look for opportunities to have others students comment on whether the students are presenting facts, or are presenting feelings. *When I ask "Fact or Feeling" the rest of you will hold up the sign that shows your response to their comments.* When the students give their conclusions, ask the rest of the class if they agree or disagree with the findings, and why. *When I ask you "Agree or Argue" you will hold up the sign that shows how you stand on their conclusions. If you are willing to argue, please be ready to state why you are taking a different position.* Continue this process table by table.
44. *The purpose of this exercise is to encourage you to work in a group and also to think for yourselves. It is important in life to know what you believe in, to be open to changing your point of view based on new information, and to intelligently defend your point of view when you find others whose opinions are based on feelings rather facts.*

Lesson 2: Why Is It Taking So Long?

Unit Objective: Students will increase their awareness of the challenges to attaining energy self sufficiency, the need to deal with limited reserves of fossil fuels, and the concerns of how various sources of energy can harm the environment. Each of these areas are driving the current renewable fuels movement. And, students will consider the pros and cons of both fossil fuels and renewable sources of energy.

Grades: 9-12

Length: 2 hours, with breaks built in at approximately 25 minute intervals.

Materials Needed: A white board, four clear and two dark-colored large glass bowels, dark food coloring, a box of CoCoa Puffs or similar cereal, a box of "Snakes" from a fireworks supplier, at least two full water pitchers, a set of **It's In The Cards**.

Preparation Needed: A standard classroom setting, preferably using round tables. Print out the **It's In The Cards** and cut them out. You may want to enlarge the cards so each one is the size of a single 8.5 by 11 inch sheet of paper. You will want to be at your own table at the front, where you will locate your demonstration materials.

Background: High school students are growing up in a world that embraces renewable energy as a way of life, rather than the novelty it was one generation earlier. Wind turbines, hybrid cars, and solar panels are commonplace for them. Some of these technologies have been around for decades and only now are being integrated into today's culture. For renewable energy to truly prove its worth, it will need to mature in a culture of meeting or exceeding expectations. This lesson will introduce the history of renewable energy, the need to adapt, and challenge students to use critical and analytical thinking to support renewable energy.

Teaching

1. Set up the four glass bowls on a table in front of your students. In the first clear bowl, add water and a few drops of dark food coloring. *This represents oil. It already is here, underground, having been formed from organic materials - yes, dinosaurs and plants - that were compressed and heated over millions years.* Use a one-quarter cup measuring cup to remove "fuel" out of a clear bucket and pour it into the colored bowl so it "disappears" from view. *When we first started using oil as a fuel, there were no cars. Oil was used as a lubricant and to make kerosene for reading lamps. Remember, this was long before homes had electricity. Oil became a viable commercial industry during the Civil War. Fifty years later, the automobile industry took shape. In 1901 U.S. car companies combined made just over 3000 cars. In 1965 our country made more than 11 million vehicles and production in 2000 came close to 13 million. Think about this. Today there are more than 250 million cars on U.S. roads. China, for comparison, has more than 240 million vehicles. Add in South America, Australia, and Europe. And during much of the last century, Americans used fuel oil to heat their homes.* Pause to let them consider these facts.
2. *In a span of 100 years, our use of oil has exploded. Today, on average, Americans alone burn 19 million barrels of oil a day. A barrel contains 42 gallons of crude oil, which yields about 19 gallons of gas in the refining process. Diesel fuel accounts for another nine gallons, followed by heating oil, jet fuel, and other products. This is just oil consumption, we are not even counting coal or natural gas. And this is just in America.* Using a one-cup measuring cup remove that much "oil" and dump it into the dark bowl. *We have a limited reserve of fuel, but are now using more and more of it every day. China and India also are using crude oil to fuel their growing economies, which is one reason gasoline has more than doubled in price in the past few years.* Pick up a large glass (about two cups in capacity) and scoop out more "oil" and dump it in the dark bowl. *What happens when we use all of the oil that we can economically extract from the earth?* Dump the rest of the "oil" into the colored bowl. *Now what do we do?* Pause to let your students consider this question.
3. *Of course, it is much more complicated than this. Cars and trucks account for much of our oil consumption. Increasing the average fuel economy of these vehicles means we can stretch our supply of oil, providing there is no increase in overall miles driven and no additional vehicles are put into daily service. Conservation is another option. By reducing the number of miles driven also can reduce the demand for fuel. And, we can begin transitioning to renewable fuels such as ethanol to stretch the supplies of oil.*
4. *Over half of known oil reserves are in the Middle East, with Canada and Russia also holding significant supplies as well. The U.S. uses much of the world's energy as measured among all countries and per person. Because we have not had enough oil to fully meet that demand, the U.S. has had to import oil. This began in 1948 and continues today. In fact, the United States uses much more oil than it produces. Rather than having a surplus, we have a deficit of a critical resource. The end result is that our dependence on foreign oil in some years has topped 70 percent: put another way, in some years more than two of every three gallons of oil used in the U.S. had to be bought from another country.*
5. *When will the available oil fall short of actual demand? U.S. production of oil peaked in 1970, and has been in decline. Worldwide, supplies likely will peak between now and 2040. It is difficult to know true measure of available supplies as most reserves now are controlled by governments which conceal or misstate their reserves for political objectives or to create price volatility from which they profit. Plus, technology is not able to give us a truly clear image of how much oil lies below us.*
6. *Projections can vary widely among scientists and also year by year due to the selections or omissions of assumptions, trends of the day, and other inputs for each study. Often, technological advances will completely change the outcomes almost overnight.*
7. *Note that supply of oil does not necessarily run out, it simply becomes too expensive to recover, leaving other more affordable or practical fuels to take its place. In the past four years, however, U.S. imports of oil have been dropping. Does anyone know the primary reason?* Pause here and listen to any answers (horizontal drilling and fracturing are the primary reasons). *We are importing less than 50 percent and economists predict the U.S. may actually begin exporting more oil than it uses within a few years. A process known as horizontal drilling and "fracking" is making it possible for oil companies in the U.S. and Canada to extract crude oil from rock formations deep underground. Fracking is slang for "fracturing," a process by which water and chemicals are injected under high pressure into wells. The fractures caused by this process provide pathways for oil and natural gas to flow back into the horizontal pipe. Although the process has been known for years, recent improvements in drilling technology have made fracking more cost effective and practical. It has significantly increased U.S. oil and gas supplies, effectively reducing the need to import oil from other nations. One little-known downside of fracking is that the additional recoverable energy is diverting attention away from renewable fuels.* Many question whether fracking may cause large-scale harm to water supplies and aquifers .
8. *Fracking has both proponents and opponents. There is no question fracking is greatly expanding the recoverable oil and natural gas reserves within the United States. And, it is reducing America's dependence on foreign oil. The economic activity and lowering trade deficit are huge benefits. Yet, the process of fracking has raised numerous and serious concerns regarding the impact to the environment and to the hometown communities at the heart of these operations. A few of the leading concerns of fracking being raised by people include the potential for releasing toxic chemicals, the use of millions of gallons of water required to fracture each well, and damaging effects from heavy truck traffic and disruptions to local economies and ways of life.*
9. *Fracking, whether once sees it as good for the nation's economy, bad for the environment, or both, may well be introducing a golden age for natural gas. Although fracking is releasing new supplies of oil it is also unlocking new supplies of natural gas. In general, oil finds it way to gas stations, coal finds its way to power plants that generate electricity, natural gas finds its way to home heating systems and power plants. Compared to coal, natural gas burns more cleanly, emitting just one-third as much nitrogen oxides and 43 percent fewer carbon emissions than coal or oil. Companies that run power plants want fuels that are reliable, stable in terms of supply, and convenient to burn.*
10. *AT&T, Ryder, and UPS, among others, have modified thousands of trucks to burn natural gas instead of diesel fuel or gasoline. Fuel costs and especially maintenance costs are much lower for natural gas, plus these companies like being able to say they are using green technology. Railroads have been testing using natural gas as a locomotive fuel. Both diesel and gas engines can be converted to natural gas.*
11. *Why not cars? The main reason goes back to why gasoline is a logical fuel for light vehicles. Gas delivers a high amount of energy per gallon, or pound, depending on how one measures it. Gas engines can deliver more acceleration and relatively longer range than most other fuels. And, nearly 160,000 gas stations are found coast to coast. Compare that to the 1,000 or so fueling stations that provide specialty fuels such as natural gas. Finally, natural gas tanks storage need to*

be larger to allow vehicles to have significant driving range between refueling stops. Trucks have room for larger tanks, cars. Finally, it is cost effective for companies with fleets of trucks to install their own natural gas fueling stations.

12. *How does natural gas fit into the energy infrastructure? More than one-third is used to generate electricity. Natural gas increasingly is displacing coal as the fuel of choice for electric power plants, and has been since 1990. This is due to lower costs, lower greenhouse gas emissions, and increasing supplies. For similar reasons, natural gas is a popular choice of industrial, commercial and residential customers: altogether, these four end users account for more than 90 percent of the natural gas consumption in the U.S. Natural gas is delivered via pipelines directly to the end users.*
13. *Coal is the first fossil fuel that gained widespread usage in America. Coal seams were plentiful in the Appalachian mountains across Kentucky, New York, Pennsylvania, and Virginia and West Virginia – just where the early population centers took root. Coal was relatively easy to mine and transport to major markets. It required little in terms of technology to use. Anthracite, also called hard coal, is the "oldest" and is valued for having least 85 percent carbon content, little moisture content and 25 million BTUs per ton. Anthracite supplies have been exhausted, largely during America's early industrial development. Bituminous coal found in large amounts in Montana and Wyoming is 45-85 percent carbon, and yields 24 million BTUs per ton. Sub-bituminous coal found in Illinois and Ohio is 34-45 percent carbon, and produces up to 18 million BTUs per ton. Lignite, which is found in several western states is 25-35 percent carbon and has an energy content of 13 million BTUs per ton.*
14. *The U.S. has more than 25 percent of the world's reserves of coal. As simple as coal may seem as a fuel, it is much more complex. Mining costs, transportation costs, and environmental costs all affect which type of coal will be used in power plants. The Clean Air Act of 1970 and subsequent federal laws have been enacted to reduce harmful emissions from coal-fired power plants. The sulfur content of coal was linked to acid rain, which was causing significant damage to forests and buildings. Since then, the government has invested more than $3 billion to develop clean coal technology to reduce emissions. Coal itself does not make a good fuel for cars. Despite the vast reserves of coal that potentially could last for hundreds of years, it will eventually run out and concerns over greenhouse gas emissions remain.*
15. Pour the CoCoa Puffs into a clear bowl. Use a one-cup measuring cup to remove the cereal and pour it into the second, empty dark bowl. *Originally, we used coal to heat our homes, provide fuel for steam locomotives on railroads, and power heavy manufacturing of steel and other goods.* Pick up another cupful of cereal and dump it into the dark bowl. *For the past two generations, we have been using coal to make electricity. And our appetite for electricity grows in step with our economy and our population. More households have televisions, sound systems, air conditioning, and computers compared to when your parents or grandparents were your age. All these devices demand more electricity.* Scoop up and pour more cereal into the dark bowl. The United States has significant supplies of coal. So to do other nations, such as China. Coal is readily available and readily converted to electricity. It will run out, eventually, yet it will be a source of energy for decades to come.
16. OPTIONAL: Open a box of snakes and select one. Place it on a fire resistant surface and ignite it with a grill lighter. Let it burn itself out. *When coal is burned, it releases greenhouse gases and leaves ash that contains toxins, which are chemicals that pose health and environmental hazards.* Now put the entire box of Snakes on the surface. As more and more coal is burned, it releases more and more gases into the air. Ignite the remaining Snakes and let them burn. *Notice how our room is full of smoke and fumes? Open a window and use a fan to draw out the smoke. The atmosphere that surrounds our planet is much like this room. It holds in all the smoke we have created over centuries. We do not have a window and fan to vent off the accumulation. Our only solution is to reduce the amount of smoke we create.*
17. *Is nuclear power renewable? No, although some suggest nuclear power could be considered renewable as breeder reactors create fuel material that can be recycled as additional fuel. Nuclear power really speaks to the uranium fuel used to generate electricity. Estimates suggest we have enough nuclear fuel to last 1,000 or more years. Coal, natural gas, and oil all can be burned to create heat that boils water to make steam. In turn, this steam is used to drive turbines – think of fan blades – that spin an electric generator. Nuclear fuel can create a lot of heat from a very small amount of fuel. The downside is spent nuclear fuel rods are radioactive and release dangerous radiation for thousands of years. Still, nuclear fuel emits no greenhouse gas emissions. Opposition to nuclear power is strong for several reasons: no real solution has been found to deal with radioactive waste; the process can be used to make materials for nuclear weapons, and several notable accidents in the U.S. (Three Mile Island), Ukraine (Chernobyl), and Japan (Fukushima) have shown that nuclear power plants are not foolproof and can release radioactive materials due to both human and natural causes.*
18. BREAK: 5 minutes.
19. *We have spent a lot of time talking about the leading fossil fuels. Now we will consider the leading forms of renewable sources of energy. Note I said source, not fuel, as many renewable forms of energy do not require the burning of a fuel and subsequently do not emit greenhouse gases during actual energy production.*
20. *Renewable means we can replace the fuel in our lifetime. Sunlight is replenished daily, water can deliver a never-ending supply of energy, biofuels can be replenished every crop season, and the tides run in and out every day.*
21. *It may not be as obvious today, yet hydropower is a renewable form of energy. In fact, hydropower predated coal and oil. The first forms of hydropower were water wheels that date back hundreds of years. Water wheels were used to power grain milling operations. This form of power is only as strong as the flow of the river that turns the wheel. Spring run off typically provided a lot of power, while late fall and winter flows might be too weak to turn the wheel. The solution to this variable were dams, which could store and release water as needed. Dams across the U.S. have been built for many reasons: to provide for flood control, to maintain enough water depth for barge traffic, to provide water supplies for large cities and for agricultural irrigation, and for recreation purposes such as boating and fishing. In practice, dams make it possible to manage the generation of hydropower, although at a price. The reasons for building dams can and do often create conflict between upstream and downstream stakeholders. A dam may hold back water for upstream use during a drought, yet that same water may be needed downstream to keep the river channel deep enough to maintain barge traffic. How do we decide which needs are true priorities?*
22. *The first serious application of hydropower to generate electricity was not a dam, it was a waterfall. Specifically, Niagara Falls in 1881. In first half of the 20th Century, hydropower generated more than 40 percent of America's electricity. The federal government supported major projects to dam rivers and generate electric power. The Tennessee Valley Authority, the Pick-Sloan Flood Control Act, Hoover Dam, and the Federal Columbia River Power System are among the large-scale efforts to build America's hydropower infrastructure. Today, hydropower produces less than 10 percent of America's electricity, mostly because coal-fired power plants were built to meet America's increasing need for power. Large dams and storage reservoirs are not likely to be built again due to the opposition to flooding of river valleys and loss of their ecosystems. However, there is good potential to enhance existing dams to generate additional electric power.*
23. *Hydropower is renewable in that it uses the force of water as it flows downhill. The water cycle recharges the system, so to speak, through upstream rainfall and snowfall at higher elevations. Reservoirs store this potential energy during times of low rainfall. Water has been referred to as white coal. Another usable form of hydropower can be found in tidal action along coastal shorelines. Ocean tides are caused by the gravitational pull of the moon. Tidal cycles are reliable and strong enough to spin underwater turbines to create electricity. This technology is in the early stages of development. Challenges to using this form of renewable energy include preventing salt water corrosion to equipment and finding ways to minimize the impact to sea life.*
24. *Among the most obvious forms of green energy are biofuels, including ethanol and biodiesel. Ethanol, or ethyl alcohol, is made by fermenting and distilling starch crops including corn and sugarcane. Do you know what car company built the first flex-fuel vehicle made in the U.S.?* Pause to see what answers you might get. *More than 100 years ago, the Ford Model T was originally designed to run on gasoline, kerosene, or ethanol made from corn alcohol.*
25. I*n the early 1970s, your parents and grandparents faced a serious situation when America was subjected to an energy shortage. America's was heavily dependent on oil from the Middle East. In response to U.S. foreign policy supporting Israel, OPEC curtailed the amount of oil it would sell to the U.S. The short-term shock to the U.S. economy – and the American way of life – was staggering. In response, the U.S. began serious efforts to develop alternative fuels along with encouraging conservation programs to reduce dependence on foreign oil and other forms of energy. Ethanol was an obvious and already proven way to literally grow fuel from the ground up.*
26. *Another advantage for ethanol was that lead was being phased out as an additive to gasoline. Lead was recognized as a serious health hazard and laws were passed to limit its use in paint, gasoline, and other products. In gasoline, lead was used to create higher octane fuel that could be used in high compression engines. Ethanol also increases octane. And, during winter months ethanol prevented fuel lines from freezing up.*
27. *Ethanol initially was blended with gasoline, typically in a ratio of 90 percent gas and 10 percent ethanol. Car manufacturing companies began revising fuel systems and computer control software to take advantage of ethanol. Higher blends are possible. Common blends include E15 (15 percent ethanol) and E85 (85 percent ethanol). E85 does require additional modifications to the engine and fuel system. The first factory ready E85 car was the 1996 Ford Taurus. The*

use of computer controlled fuel injection has made it easier for car companies to offer "flex fuel" vehicles that can run on various ethanol blended fuels.

28. Pour clear water into an unused clear bowl. Using a one-quarter cup, remove some water and place it in the last unused clear bowl. *Our use of renewable fuels is very small compared to fossil fuels. We are making progress in using more renewable fuels to replace fossil fuels. Remove another cupful of water and pour it in the last clear bowl. Whether it is wind, water, ethanol or sunlight, renewable fuels come full circle. They do not disappear forever.* Pour the water from the last clear bowl into the bowl that represents renewable fuels. *We can make more ethanol and biodiesel from crops that grow in a short time. Those same plants could, of course, be converted to coal and oil, but we would have to wait millions of years before we could use those fuels.*
29. *The use of ethanol has proponents and opponents. Proponents focus on how ethanol burns cleaner than regular gas, provides farmers with a new market for their crops, creates significant economic activity and employment in rural communities, and reduces our dependence on foreign oil. The opponents say ethanol will cause farmers to raise more corn at the expense of other crops and may raise food prices. It is important to recognize that oil companies view ethanol as cutting into their market share, and food companies want to pay farmers as little as possible for their crops. The type of corn being grown to make ethanol is different than corn grown for food use, which confuses many people who are not well versed in energy or agriculture. In effect, ethanol will have opponents regardless of whether it is a viable alternative fuel to gasoline.*
30. *Biodiesel is made from vegetable oils such as from soybeans, animal fats, and even recycled cooking grease, all of which are forms of biomass. As with ethanol, biodiesel is sold in blends that contain percentages of both renewable and fossil fuel, the latter in the form of diesel fuel. B20 is 20 percent renewable fuel and 80 percent diesel fuel. By using blended fuels Americans are reducing noxious emissions and stretching the supplies of fossil fuels. Biofuels are sometimes called carbon neutral because plants such as corn and soybeans use consume carbon dioxide in the growing process and release it when the fuel is burned. However, biofuels do have a carbon footprint due to the processing and transportation involved. That said, fossil fuels also have a carbon footprint for the same reasons. The question becomes which fuels have the least overall negative impact to the environment, and which fuels have a better overall value to U.S. security and economic stability. Fossil fuels require significants amount of energy to obtain, to refine, and to transport. Renewable fuels also require energy to obtain, to refine, and to transport.*
31. *The U.S. Congress in 2005 adopted a Renewable Fuel Standard which was updated in 2007. The policy sets annual targets of the production of renewable fuels and also sets limits on the amount of corn that can be used to make ethanol. Research is under way to develop switchgrass as a feedstock from which to refine ethanol. Switchgrass promises to deliver more fuel while requiring fewer inputs.*
32. *Ethanol and biodiesel are made from biomass. The oldest source of biomass used by humans is wood. Commonly used in fireplaces and furnaces to provide heat, wood may come from cutting down trees or from harvesting dead wood that accumulates on forest floors. Wood chips and other biomass byproducts from lumber and paper mills. Additional usable sources of biomass include industrial and consumer waste. Farms in Europe and America are installing methane digesters to convert waste from livestock into a source of usable energy. European culture and policies embrace renewable energy and sustainable living.*
33. W*ind is another form of renewable energy. It is among the most visible form of green energy thanks to the numerous wind farms that have been installed across the nation. More are in the works. As with many forms of renewable energy, wind turbines are not new. Windmills were being used to pump water and mill grain hundreds of years ago in England and Holland. Windmills ran water pumps for ranchers and railroads. Before rural electrification programs, farmers and ranchers used a form of wind turbines to generate limited amounts of electricity used to charge batteries and operate simple radio sets and a few light bulbs. These small generators produced from as little as a few hundred to 3,000 watts of electricity. A light bulb may use from 25 to 100 watts of electricity.*
34. *Thanks in part to federal tax credits encouraging investment in wind farms across America, there are more than 45,000 turbines generating electricity. Today's wind turbines are large in size and generate 1.5 megawatts or more of electricity. A megawatt is equal to one million watts. For comparison, a coal-fired power plant may generate 600 or more megawatts.*
35. *Today, wind turbines are designed using computer modeling to take full advantage of wind flows. Developing a wind farm requires using advanced scientific tools, adhering to zoning requirements, and drawing on past experiences. Wind farms often are located in farming communities. Single wind turbines also may be found powering small businesses. And, floating wind turbines have been and continue to be located along coastal areas where sustained winds are put to good use.*
36. *Wind turbines of 1.5 megawatt capacity have three blades, each 116 to 189 feet in length spinning at the top of a tower more than 200 feet tall. The top states for installed wind generation capacity in order are Texas, California, Iowa, Illinois, and Oregon. At least 39 states now have utility-scale wind farms.*
37. *As with all forms of energy, wind is not without its downsides. Wind itself cannot be stored. Wind turbines will not work if the wind is too fast or too slow. Moving electricity to markets requires large transmission lines. These lines are expensive to build and maintain, and are subject to opposition long before they are built. Few people want these large lines to run across their property. Yet without transmission lines the nation's economy would quickly come to a halt. Electricity is not easily stored. Batteries work well for small applications but do not offer a solution when the watts involved run into the hundreds, let alone the millions. One of the biggest drawbacks to wind turbines is that the power output cannot be increased to meet peak demand while a power plant can be managed to meet demands. Wind power cannot completely replace other forms of power. Wind turbines are proving themselves to be a viable source of energy that complements our current electrical system.*
38. *As with all forms of energy, there are people who are against wind power due to their political or personal beliefs, or because they profit from other forms of energy. For example, some people and organizations look at wind farms and assume they must be fatal to birds. In 2006 the National Academy of Sciences estimated that 3 of every 100,000 birds are killed by wind farms. An estimated 10,000 to 40,000 bird deaths annually are attributed to wind farms. Compare this to more than 60 million killed by cars and trucks, more than 100 million killed by flying into windows of buildings and homes, and hundreds of millions killed by feral and domestic cats. Communications towers and power lines cause the deaths of another 140 million birds. And, for comparison, an estimated 60,000 birds, along with dolphins and endangered sea turtles were killed as a result of the BP drilling platform explosion and subsequent oil spill in the Gulf of Mexico. Some organizations put the dead animal count much higher, along with noting the spill affected shrimp, plankton and other smaller organisms that are at the foundation of the food chain. The spill also affected the commercial fishing and tourism industries. Every source of energy will have pros and cons. Every one will impact the environment. A single argument for or against any form of energy lacks the overall perspective required to make good decisions.*
39. *Solar energy may bring to mind photovoltaic or solar cells generating electricity from home rooftops, commercial parks, and even from pocket-sized cellphone chargers. Existing solar facilities in the U.S. generate more than 7,700 megawatts, enough to power 1.2 million homes. Solar cells convert sunlight into electricity. Currently, electricity from solar sources cost five times as much as that from coal. Yet the overall costs have been coming down as technology improves and large-scale installation lowers the costs of solar cells and related equipment. Solar is renewable every day. Solar installations work best in areas that have a lot of sunny days and have longer days of sunlight. Arizona, California, and Texas are among the leading states that produce electricity from solar installations. Since 2007, the U.S. has increased its solar production capacity by a factor of ten.*
40. *Solar energy is not limited to solar cells that convert sunlight into electricity. There are active and passive solar systems that contribute to heating homes and businesses. The windows in your own home can be used capture solar heat by selectively using curtains or blinds to let sun in during the winter months. The sunlight helps warm the house, even more so if the windows direct sunlight to floors or walls of dark rock that absorb the heat and release it at night. Active solar heating may use valves, tubing, and pumps to manage the storage and release of heat. Water running through tubes within a solar collector will be heated and stored for later use.*
41. *This brings us to geothermal energy, a renewable energy that is the least visible of all forms of renewable energy. This comes as no surprise because on the surface geothermal looks and acts so much like other sources of energy. The source of heat comes from below the frost line. For residential use, geothermal provides heating and cooling using heat pumps. The ambient air temperature outside a house may range from 30 degrees below zero to 110 degrees above. Yet just a few feet down, the earth maintains a stable temperature summer or winter, usually around 50 to 60 degrees. Heat pump systems use underground lines to transfer heat to or from buildings. Heat pumps greatly offset the use of fuels or electricity to do the same job. Like using solar heat to warm water, geothermal heat is used to warm water which is then circulated above ground. In summer, heat from inside a building is circulated below ground to cool the structure.*

42. *Geothermal can and does generate electrical power in commercial operations. These facilities are located in western states along with Alaska and Hawaii. The majority of these facilities are in California. A downside to geothermal sources of power capable of generating electricity is that they are in fixed locations. The facility has to be located at the point of access to geothermal power. Heat pumps, however, can be used almost anywhere.*
43. *Whether the source of energy is coal, oil, natural gas, geothermal, or nuclear, almost all ways of generating electricity require a source of energy to heat water to make steam. This steam runs turbines that generate electricity. Dams too provide the force necessary to spin turbines. Voltaic or solar cells use a different process to produce electricity. The bottom line is, all of these ways of making electrical power have benefits and drawbacks, all have economic, social, and environmental costs. This also applies to sources of energy that are used for transportation.*
44. BREAK: 10 minutes. Serve appropriate drinks and snacks.
45. *We have reviewed in brief major fossil fuels and renewable sources of energy. As you are learning, there are numerous complications and many options when it comes to generating electrical power and creating portable fuels to run cars, trucks, planes, and trains. We must also consider sheer practicality as well. Wind power does not work for cars, at least not as well as it does for sailboats. Yet wind turbines can generate electricity for certain cars that need to recharge their batteries. Coal was used briefly in steam-powered cars about 100 years ago, and was used to fuel steam locomotives on railroads until as late as 1960. Coal does not fit well into today's transportation system. Nuclear power is used by military submarines and ships, which are large enough to house the reactors and turbines required In France, most of the high speed trains use electricity provided by nuclear power plants. In Brazil, cars run on ethanol made from sugar cane. In China, the Three Gorges Dam just went on line as the world's largest hydroelectric power generating facility. Worldwide, energy production and use is taking on new forms.*
46. *We use energy for heating and cooling, for power to do work, for cooking, planting and harvesting crops, and processing and transporting and refrigerating food, for entertainment, and for light. Energy is essential to support human life. It makes civilization possible. Energy is a convenience, too, making music and movies and amusement parks possible.*
47. *Why has it taken so long for renewable energy to become mainstream? Well, here are a few possible reasons for you to consider.*
48. ***Historic momentum:** Coal was a dominant source of energy to make electricity and heat. It was widely available, used basic technology, and was affordable. At the time, few people gave much consideration to the environmental damage coal mining and burning would cause. Once in place, coal had the advantage over other forms of energy. Newer and untested technologies such as nuclear are expense to develop. Gasoline and diesel fuel are the fuels of choice for transportation. Few convenience stores will make space for E85 fuel because they sell so little of it. Consumers will not buy cars that use E85 fuel because there are few places to refuel. This means the growth of E85 as an optional fuel takes a very long time to develop.*
49. ***Economics:** New technologies are expensive to develop. They face opposition from established industries that have something to lose (profits and market share) and from people who do not want change for personal or professional reasons. Transportation variables, local and regional policies and preferences, environmental concerns, and natural advantages all can have an impact on the economic advantages of different forms of energy. Most new homes do not use heat pumps and solar panels to provide heat and electricity because the equipment is more expensive to install than gas furnaces and commercial electricity. Over time, however, the operating costs of heat pumps and solar panels is less expensive than gas furnaces and commercial electricity.*
50. ***Mandates:** Local, state, regional, national, and even international policies and agreements adopted by government and/or industries do affect the use of renewable energy. Renewable fuel standards, green initiatives, conservation programs, and economic incentives are among the tools used to increase the use of renewable energy. Some people object to mandates as interfering with the laws of supply and demand, or free markets, and others are opposed to mandates because they have something to lose or they have philosophical disagreements with mandates. That said, mandates are adopted for the common good, and often are necessary to encourage cultural changes regarding attitudes toward new ways of doing things. Consider this: the use of seat belts, child safety seats, and air bags in cars all are a result of mandates. Many communities and states are choosing to require reductions of fossil fuels emissions while increasing the use of renewable fuels and conservation. Tax credits can help individuals and companies manage the costs of these actions over the short term to allow long term benefits to take root.*
51. ***Culture:** The collective attitude of some communities supports renewable energy: other communities support the status quo. People decide what their individual and communities priorities will be. Companies that take pride in being green do so because the owners and managers have made it a priority. Political parties will support or oppose policies based on their economic and social attitudes. The mayors and city councils in many large cities found themselves under pressure to reduce the use of coal because the dust and smoke upset housewives. Why? Housewives 100 years ago washed clothes and hung them outside on balconies and fire escapes to dry. There were no electric dryers. The clothes would be covered with smoke and other air pollution that accumulated in concentrations in large cities. The culture supported a change. New York and other cities required railroads to use diesel or electric locomotives rather than steam engines to haul trains.*
52. ***Convenience:** Hybrids and electric cars can be more expensive, have less power, and have much shorter ranges than gas-powered cars. Few mechanics are trained to service these cars, so reliability also becomes a factor. An electric car may need to be recharged every 100 miles, yet a gas-powered car may travel 500 or more miles before needing refueling. Such inconveniences can be overcome in time. The first gas-powered cars were unreliable, had short range between refueling, had little power, and mechanics were few and far between. At that time, horses were more reliable and convenient. Times do change.*
53. ***Competition instead of cooperation:** Public policy is meant to serve the common good, while providing a measure of balance between big and small businesses and encouraging cultural change for safety, economic, environmental, and other reasons. This is cooperation at its best. However, each energy industry does not want to lose profits or market share to competing industries. They will advocate for policies that benefit their own interests at the expense of others. Federal and state policies designed to find an energy balance will have winners and losers. Getting people to agree on the overall good is difficult, at best. Oil companies will naturally discourage the production of ethanol. Coal companies (and the railroads and power plants that rely on coal) will object to wind turbines. Environmentalists will object to dams that flood ecosystems. A balanced policy requires all interested individuals and institutions to explore and accept compromises in order to achieve overall results. The alternative is a stalemate (gridlock in Congress) and the likelihood that the adoption of renewable fuels will go slow unless a major energy crisis forces quicker action.*
54. BREAK: 5 minutes
55. Pass out the **It's In The Cards**, one card to each group. Or, as an option, tape the cards to the whiteboard and let your groups choose their topics. *This is a quick exercise we call "It's in the cards." You will have ten minutes to research and analyze your topic. Please use your smartphones, e-tablets or laptops to access the Internet. When the time is up, I will call on each group to report on their topic. Please write your findings on the card you have at your table. For the topics of economic and environmental impact, focus on how these questions may be answered if Americans use more renewable energy in place of fossil fuels.*
56. When 10 minutes have passed (add additional time, if necessary), call on one group to report on its topic. Use your position as class facilitator to ask questions of others in the group to assure everyone has an opportunity to participate. Also, after each group completes its report, ask the rest of the class if they have anything to add. Continue this process with each group.
57. *I will collect each of your cards and post the findings at the National Farmers Union Facebook page.*
58. *Renewable energy is a part of our culture. Individuals, companies, communities, organizations, the military, and local, state, and national governments all are taking serious steps to reduce the use of energy, develop renewable energy, and find ways to minimize the environmental impact of energy production and consumption. You have both a right and a role in making sure your generation's energy will be cleaner, safer, and more reliable than what we have had to live with. You have the power to make a difference.*

Lesson 3: Renewable Energy Up Close

Unit Objective: Students will tour a renewable energy facility or similar "green" operation.

Grades: 9-12

Length: 2 hours (excluding transportation): this may vary depending on the size of the facility and the size of your group.

Materials Needed: Transportation, **Name Tags**, pens, clipboards with **Fact Sheets**, the **Discussion Checklist**; copies of the career page; enough coolers with drinks and snacks for the size of your group.
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Preparation Needed: You will need to choose a renewable energy site and make arrangements for a tour. The tour should last approximately 60 minutes, leaving 15 minutes for initial preparation and introductions, plus 45 minutes for discussion following the tour. Possible tour sites include wind farms, ethanol refineries, solar installations, dams with electrical generation equipment, or other similar facilities. A web search should identify numerous potential tour sites within a reasonable distance of your community. Rural electric cooperatives, county and state Extension Service departments, and business development centers all may be of use in identifying potential tour sites.

As an option, you may also consider touring a business that embraces "green" operations, a city or county government facility that uses "green" technology, or a renewable energy research department at a land grant university. For example, the Website www.greentowns.com makes it possible for you to learn about the actions of 15,000 towns that have renewable energy initiatives and is researchable by ZIP code.

In advance, arrange for transportation to and from the tour site. Students may do this themselves, parents may assist, or an institution such as a school or community sponsor may underwrite the cost of a bus. Be sure to understand the liability issues relating to insurance. Make sure students know in advance of any requirements regarding clothing limitations, the use of cameras, and whether tour routes may include numerous stairs as well as areas some may find uncomfortable due to heights, confined spaces, or noise.

Call at least one month early to schedule a tour and determine any conditions or requirements of the participants. Request a suitably-sized meeting room (if available) to hold a 45 minute discussion session following the tour. If no space is available, this exercise may be held on a bus, or back at the meeting point. Check to see if releases need to be filled out in advance. If so, obtain copies and have your students fill these out en route to the facility. Also, prepare a clipboard for each student that contains a **Name Tag** or **Guest Visitor Badge**, a **Fact Sheet** about the facility your students will visit, the **Clipboard** and **Discussion Checklist**, and the **Green Careers** page. You will need to work with your host to develop the **Fact Sheet**, which should contain information and facts about the facility and its purpose. Attach a pen to each clipboard (your host may have "logo" pens for this purpose).

If you have a large group, you may want to arrange for chaperons to accompany your group.

Background: Among the most educationally valuable experiences for students are on site tours of facilities. This kind of real world instills a tangible value to classroom study topics. Renewable energy becomes much more serious and substantial when students are able to tour a facility whose purpose is to be successful.

Teaching

1. Meet your students at the point of departure and ride with them to the tour site. Be at least 20 minutes early. Introduce yourself, pass out the clipboards to your students, and give them a brief description of the operation you will tour. Have them to fill out their name tag, the releases (if required), and review any safety or other rules that apply. Advise your students to make notes on their **Discussion Checklist** during the tour and let them know you will have a brief discussion period following the tour.
2. At the site, follow the directions of your host as prearranged. Have your students line up and put on their name tags or guest visitor badges. You will want to work with the host to provide leadership for your group . If you have chaperons, assign one to be last in the line and spread any others out within the group. You may need to divide your students into several smaller groups depending on the number of participants and the physical and/or staffing limitations of your tour facility. Introduce your host by name and job title.
3. Encourage your students to ask questions during the tour, or to write down questions to be asked during the discussion period following the tour. Keep your students in line figuratively and literally.
4. Following the tour, you and your host will meet with your students in a designated area. The host is there to answer questions, you are there to facilitate the conversations and discussions. Begin with the Q&A session. *"NAME OF HOST is here to answer the questions you wrote down during your tour. We will begin our discussion by answering your questions. Please raise your hands to be recognized."* Start the Q&A. Facilitate the give and take between your host and your students. Once all the questions have been asked, thank your host and ask your students to show their appreciation with applause.
5. You will lead the discussion on what your students learned during the tour based on their **Discussion Check List**. Use an open format to build a dialogue with your students as you review how they responded to their questions. As students ask new questions, invite the other students to respond. This exercise is meant to challenge a group with common interests to learn from each other.
6. Invite the students to select snacks and drinks from the coolers.
7. Pass out the **Green Careers** page and allow students to study this information.
8. Collect clipboards for use on future tours.
9. Before leaving the facility, arrange your group in front of the facility and take a photo. Submit this photo to your local newspaper as well as to National Farmers Union for possible use on the organization's Website or Facebook page.
10. Be sure all your students are accounted for when you return to your departure point.

The Value Of Energy

Essential	Convenience
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

One use of energy I could live without:

One use of energy I really need:

Do the Math

	Tons of coal sold	Tons remaining
Year 1:		
Year 2:		
Year 3:		
Year 4:		
Year 5:		
Year 6:		
Year 7:		
Year 8:		
Year 9:		
Year 10:		
Year 11:		
Year 12:		
Year 13:		
Year 14:		
Year 15:		

Fact

Feeling

Think For Yourself

As a group, consider the statement you have been assigned. Do you agree or disagree?
Using consensus, develop a logical and rational response to your statement.
Be prepared to both report and defend your response.

Group 1: Americans have a responsibility to explore alternative sources of energy.

Group 2: Some forms of energy have more negative environmental consequences than others.

Group 3: The true cost of energy is hidden because each link of the supply chain protects its own interests rather than what is best for those farther up or down the chain.

Group 4: Renewable energy is worth pursuing only if it can be proven to reduce greenhouse gases causing climate change.

Group 5: Getting Americans to support a policy for the common good is difficult because of people who are extremists, uneducated, choose to be selective of the facts, or are unwilling to compromise which effectively supports the status quo.

Group 6: There is no need for renewable energy as long as the U.S. has a 200-year supply of coal.

Group 7: The cheapest form of energy is the best, regardless of the environmental cost.

Group 8: U.S. energy policy should be independent of what other countries are doing worldwide.

Group 9: Building codes should be changed to require new home and business construction to include solar heat and electricity if the added cost is less than five percent more of the home itself.

Agree

Argue

Wind

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Hydropower

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Solar

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Geothermal

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

“Green” Mandates

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Biomass

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Crude Oil

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Natural Gas

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Environmental Impact

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Economic Impact

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Coal

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Nuclear

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Conservation

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Natural Gas

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Free Market

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Green Incentives

The Pros
1.
2.
3.

The Cons
1.
2.
3.

The Recommendations
1.
2.
3.

Clipboard Discussion Checklist

What is one positive impact of this operation?

What is one negative impact of this operation?

What value does this operation have that is not obvious or appreciated?

Is this operation use green practices in other ways?

Can you think of businesses or groups that would support this operation?

Can you think of businesses or groups that would oppose this operation?

What kind of help did this operation need to get started?

Do you expect this operation to be the same, larger, or smaller 10 years from now?

Questions I have about this operation:

Green Careers Are Fueling The New Global Economy

Renewable energy and sustainable living are fast becoming a way of life in the United States, Europe, China, and South America. Worldwide, companies and cultures are incorporating renewable energy into their daily operations. National policies adopted by governments and a demand for green energy from consumers is creating thousands of new jobs each year. Here are a few lists of potential career paths you may want to consider. Colleges and universities can further guide you in the educational requirements to puruse these career opportunities. These lists are changing month by month. To learn more, log on to Goggle and search for "green," "sustainable," or "renewable energy" jobs.

Forbes List of Six-Figure Green Jobs
1. Chief Sustainability Officer (Chief Environmental Officer/ Chief Green Officer)
2. Environmental Lawyer
3. Environmental Engineer
4. Climatologist/Environmental Meteorologist
5. Renewable Energy Manager
6. Environmental Specialist/Scientist
7. Senior Urban Planner
8. Commercial/Industrial Designer
9. Conservation Scientist
10. Senior Hydrologist

Forbes List of Green Jobs with Growth Potential
1. Emissions Trader
2. Bio-Mimicry Engineer/Biologist
3. Sustainability Coordinator
4. Environmental Architect
5. Sustainability Analyst
6. Renewable Fuels Engineer/Biologist
7. Climate Risk Analyst
8. Ecological Economist
9. Lobbyist

GreenTech Media Top 10 Green Jobs for The Future
1. Construction
2. Sustainability Officer
3. Biologist
4. Chemist
5. Land Use Planner
6. Garbage Consultant
7. Interior Designer/Building Operations Manager
8. Interface Designer
9. Foot Massager
10. Food Scientist

E Magazine 10 Great Green Opportunities List
1. Green Globetrotters: Travel and Hospitality
2. Sustainability Stewards: Planning and Land Use
3. Complementary Care: Health and Medicine
4. Power Pushers: Energy and Renewables
5. Planet Protectors: Legal Careers
6. Green Geeks: Information Technology (IT)
7. Eco Educators: Green Learning
8. Better Builders: Design and Construction
9. Improving Industry: Corporate Social Responsibility
10. Organic Occupations: Food and Farming

Career Builder List of The 25 Green Careers with Promise
1. Hydrologist
2. Environmental Engineer
3. Pest Control Technician
4. Conservation Biologist
5. Science Teacher
6. Toxicologist
7. Pollution Control Technician
8. Fund-raising Director
9. Ecologist
10. Camp Counselor
11. Business Manager
12. Economist
13. Forester
14. Environmental Attorney
15. Community Affairs Manager
16. Environmental Health and Safety Technician
17. Landscape Architect
18. Waste Disposal Manager
19. Environmental Chemist
20. Corporate Waste Compliance Coordinator
21. Urban and Regional Planner
22. Agricultural Inspector
23. Wastewater Water Operator
24. Wildlife Biologist
25. Pollution Control Engineer

The Green Economy Post Green Jobs Meta-List
1. Agricultural Inspector
2. Architect (Environmental /Sustainable Design)
3. Bicycle / Scooter Technicians
4. Biologist (Conservation)
5. Building Operations Management
6. Business Manager
7. Camp Counselor
8. Career Consultants (Green)
9. Car Manufacturing (Green)
10. Chemist (Environmental)
11. Climate Risk Analyst
12. Climatologist/Environmental Meteorologist
13. Community Affairs Manager
14. Complementary Health and Medical Care
15. Construction (Energy Efficiency – Green Building)
16. Corporate Social Responsibility Professional
17. Ecologist
18. Economists (Environmental)
19. Educators (Ecological)
20. Emissions Manager
21. Emissions Trader
22. Energy Manager (Renewable)
23. Engineers (Environmental / Pollution Control)
24. Engineers and Developers (Sustainable Energy)
25. Engineer/Biologist (Renewable Fuels/ Bio-Mimicry)
26. Entrepreneur (Green)
27. Environmental Health and Safety (EHS) Technicians
28. Fashion Designer (Green)
29. Financial analyst/adviser specializing in socially responsible investing
30. Foot Massager
31. Food Scientist
32. Forester
33. Fund-Raising Director
34. Furniture Builder (Eco-friendly)
35. Green Travel and Hospitality
36. Heating, air conditioning and refrigeration mechanic and installer
37. Hydrologist / Environmental scientist
38. Industrial Designer (Sustainable)
39. Interface Designers
40. Interior Designer (Green)
41. iPod/ iPhone Doctors
42. IT Specialists (Green Software and Hardware Developers)
43. Landscape Architect (Green)
44. Lawyer (Environmental)
45. Lobbyist
46. Organic Food and Farming Production Specialists
47. Pest Control Technician
48. Pollution Control Technician
49. Protection Technician
50. Scientist (Environmental)
51. Solar Installation
52. Sustainability Specialists
53. Toxicologist
54. Urban Gardeners
55. Waste Management
56. Wind Energy Developers and Construction Professionals

Renewable Energy Is Hardly Trivial

(It's not as tough as you think, especially if you use common sense)

Renewable Energy can come from:
A. Garbage
B. Ocean waves
C. Passive solar home design
D. Active solar home design
E. All of the above

Which statement is true:
A. Sunlight is not renewable as it sets every night
B. Hydropower is limited to large rivers
C. Humans have been using wind and water to generate renewable power for hundreds of years
D. Coal is renewable because we continue to mine it and it has yet to run out
E. Renewable energy has value only is if fossil fuels are more expensive.

Coal remains in use because:
A. Power plants now in operation were set up to use it
B. It is affordable and in plentiful supply
C. It is cheap to transport thousands of miles to markets.
D. Both A & B
E. Both B & C

Gasoline became the leading fuel for automobiles because:
A. No one knew what else to do with it
B. It has a high energy content per gallon meaning more power and longer range between refueling
C. It is easily squeezed from solid coal
D. Kerosene was in high demand as the favorite fuel for railroad steam engines
E. Crude oil was being used by the newly emerging jet aviation industry

The Moon can be a source of renewable energy because:
A. It reflects sunlight
B. Its gravity causes tidal surges which can power generators along coastal areas
C. The soil can be used in lunar batteries if returned to Earth
D. Both A and C
E. Both B and E

America suffered an energy crisis in the 1970s because:
A. Battery production moved to China
B. Oil exporting nations in the Middle East cut back production
C. Motorists doubled the miles they were driving each year
D. More fuel was being used by the space program
E. Europe was hit by an unusually cold winter

The benefits of renewable energy include:
A. New jobs
B. Less damage to the environment
C. Less chance of another energy crisis
D. Less dependence on foreign sources of energy
E. All of the above

Ethanol is commonly made from:
A. Sweet corn
B. Popcorn
C. Field corn
D. Corn Puffs
E. Corn chips

Hybrid cars are powered by:
A. A combination of electricity and a gas engine
B. Solar and wind power
C. A particle mass accelerator and kerosene
D. Pedals-powered sprockets and fuel oil.
E. None of the above

Fossil fuels are:
A. Plentiful in supply
B. A significant source of air pollution
C. Always the cheapest source of energy
D. Easy to make in small batches
E. Environmentally friendly

Before fossil fuels were widely used, people used these sources of energy:
A. Nuclear
B. Electricity
C. Chemical Corrosion
D. Lava flows
E. Wind and water