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?

5. 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. 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.

6. Many of you have experienced what it is like when the power is out. Our lives come to a complete stop. Winter months when the sun’s energy was relatively weak.

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 at 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. You can 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. Home, 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.

12. 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.
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 been made it easier for companies to develop and use 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 effectively traps solar radiation, 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 effectively traps solar radiation, leading to changes that will cause significant negative impacts to life on earth. This ongoing condition can go beyond all reasonable terms, and as a nation. This is important as it sets the theme for the next session.

20. 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 do the damage. Oil drilling also damages land and threatens wildlife. In 2010 a BP rig in the Gulf released 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 sea, 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.

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.

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.

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 purposefully 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 eagle’s food chain.

27. How does this relate to renewable fuels? These examples show human actions can and do have a serious negative effect on the environment. Effects that can 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 substance. Carbon dioxide builds up in the Earth’s upper atmosphere and effective traps the 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.

29. 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 already 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. Warmer temperatures have lead to changes in the balance of nature.

30. BREAK. Tell your students to take a 10 minute break. Provide them with appropriate snacks and drinks. After the break, 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.

31. Let’s pick up where we left off. Fossil fuels were formed over tens of millions of years. We are depleting our supplies without any way to recharge them. This is a fact. We will run out of certain forms of energy. Also, populations worldwide are shrinking causing sea levels to rise. Warmer temperatures have lead to changes in the balance of nature.
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 for industrial manufacturing. The first year, you sell one ton. You estimate that you have 2,000 tons of coal. Based on your supply, how many years will your mine run out to 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, if 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 than 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 the 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

36. 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 temperatures between 66 to 78 degrees, depending on personal preferences.

37. 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. The report suggests average temperatures are increasing. Colorado historically has not had sufficient water to meet its needs. At this 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.

38. 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 feeling 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 fuel 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 glass bowls, 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 of 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 you 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 do not even count 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. was much more dependent on foreign oil than other countries were. When the price of oil rose, we simply 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 proven 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 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, when done responsibly, is 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 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 store energy 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 in 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 3-45 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 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 fine 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 kernels and seeds burn. 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. 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 – that is, 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. The first forms of hydropower were water wheels that date back hundreds of years. Water wheels were used to power grist mill 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 irrigated crops in arid regions; and as homes for ducks and fish. In power generation it made it possible to manage the generation of hydropower, although at a price. The reason 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?

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 grist mill 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 irrigated crops in arid regions; and as homes for ducks and fish. In power generation it made it possible to manage the generation of hydropower, although at a price. The reason 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 fact, 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 alcohol, is made by fermenting and distilling starch crops including corn and sugarcane. Do you know what car company built the first five-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. In 1940, the U.S. government required these cars pay their parents and grandparents faced a serious situation when America was subjected to an energy shortage. America was greatly 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.

25. 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.

26. 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
Thanks in part to federal tax credits encouraging investment in wind farms across America, there are more than 34,000 turbines generating electricity. A megawatt is equal to one million watts. For comparison, a coal-fired power plant may generate 600 or more megawatts.

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.

At wind farms, 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. Battery 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 the way it can with a power plant. Wind power has to be managed to meet demand. 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.

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 50,000 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.

Solar energy may bring to mind photovoltaic or solar cell generating electricity from rooftop arrays, 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.

Wind energy and wind turbines are in the last clear cut. 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.

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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. Volcanic 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 their 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 civilizations 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 sweeter technologies such as nuclear are expensive 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 in 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 national 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. Conveniences: 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, boxes 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 compromis-es 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.

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 hand 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 Checklist. 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

1. 
2. 
3. 
4. 
5. 

### Convenience

1. 
2. 
3. 
4. 
5. 

One use of energy I could live without:

One use of energy I really need:

## Do the Math

<table>
<thead>
<tr>
<th>Year</th>
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<th>Tons remaining</th>
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<td>Year 15</td>
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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.
<table>
<thead>
<tr>
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“Green” Mandates
The Pros
1.
2.
3.
The Cons
1.
2.
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The Recommendations
1.
2.
3.

Biomass
The Pros
1.
2.
3.
The Cons
1.
2.
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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.

Economic Impact
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.

Coal
The Pros
1.
2.
3.
The Cons
1.
2.
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The Recommendations
1.
2.
3.

Nuclear
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 pursue these career opportunities. These lists are changing month by month. To learn more, log on to Google 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

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 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. Pedal-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