Yale National Initiative to strengthen teaching in public schools®

Curriculum Units by Fellows of the National Initiative
2013 Volume V: Energy Sciences

Nihodzaan (Mother Earth)

Curriculum Unit 13.05.09, published September 2013
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Introduction

"Coal is the liver of our mother, leave it in the ground, keep her alive and healthy, protect and save Mother Earth!"(1) voiced the protester who stood outside of the Navajo tribal chamber in Window Rock, Arizona (the Navajo Nation's capital). Navajos residing on Black Mesa have been protesting since the establishments of the mines because of land desecration and the coal company's extensive use of the aqua filter. The Navajo Nation is the largest coal production Indian tribe in the United States; approximately 16 million tons are excavated from the land. The three mines that produce coal (the Black Mesa, Kayenta, and the Navajo) provide 32% of revenues (2). The Nation highly depends on the revenue from natural resources (coal, oil, natural gas, and uranium) to provide essential and basic government services and to improve the standard of living. Although the Navajo Nation receives revenues, the unemployment rate on the Nation is 47% and 37% are below poverty level, 38% lack electricity and running water, and 86% are without natural gas (3).

This six week curriculum unit is intended for students in the fifth grade. The fifty-five minute unit will guide the students to understanding the where and how fossil fuels are extracted and transported, and the impact of oil prices at the global level. Then at the national level they will create a living wall map of the United States' fossil fuel resources, and at that local level, students will create a poster display of each fossil fuel resource of the Navajo reservation and within the Colorado Plateau. The Dine' philosophy is an intricate part when teaching Navajo students about Mother Earth (Nihodzaan) and Father Sky (Yadilhil). The land (Keyah), mountains (dzil) and the Circle of Life integrate respect and the sacredness of the resources from Nihodzaan. Students will use the scientific inquiry process to demonstrate renewable resources like solar and wind energy to produce a solar lantern for home use and a windmill to measure wind speed during the course of the unit.

As a fifth grade English Language Learning (ELL) teacher in a self-contained classroom at Kayenta Middle School in Kayenta, Arizona, I find it challenging and rewarding because my students come to school each day from a variety of home situations (Dine traditional, Christian, and/or Contemporary) with varied academic levels. These students have various ranges of background knowledge and life experiences because some of them reside 15 to 60 miles from Kayenta. Some have strong family values and expectations to do well in school and others come from homes that lack parents. My classroom is predominately Dine' students and has varied socio-economic status, with different learning strengths and weaknesses. The school district is implementing the Common Core State Standards for English Language Arts & Literacy in History/Social

Studies, Science, and Technical Subject and this unit targets the science standards and integrates the ELL language strand which is composed of grammar, vocabulary, listening, speaking, reading, and writing skills ELLs need to acquire a proficient level.

Rational

When I was young, I remembered when my father used to come home from working in the mines. He used to come walking up the road with dust all over his clothes, face, hands, and his personal items. We used to ran to him and help him carry his jacket and old metal lunchbox back into the house, and then we'd run back to him and dust him off. We would take his clothes while he undressed and put them in a large trough like tub while he hosed himself outside at the water pump. My father would also spray us to get the fine dust off our arms, face, and shirt. I remember the fine yellow powder would trickle down the runoff onto the road. My mom would have his dinner ready, and then she would be washing his clothes in his trough.

We never knew we were exposed to uranium tailings from my father's clothing. If my father had lived longer than 33 years, he would have most likely had some type of cancer because he did not wear protective clothing. I know now what the yellow sand is and my mother had washed his clothes every other day by hand in the trough tub. She died of cancer and now I wait to see what side effect my siblings and I will have. Currently, the uranium site where my father worked is now covered and is inhabitable. There are numerous sites on the reservation which were uranium mines and some of them are less than a mile to nearby homes. I know a lot of people within my age have had contact with the yellow sand and have lost their parents. These companies did not follow procedures and guidelines which hurt a lot of families.

When I was young I saw mine companies come onto the Reservation, set-up their structures, take and use what they needed, and then leave. For example, uranium companies did not clean the area they used; now a lot of families are experiencing serious health problems. I share issues and my experiences of events that are happening within the Reservation to my students. Our children need to know their surrounding environment and global events of how, why, and where these natural resources are in demand. They need to know that the future generations need to change if we want to live on a clean Earth. Keeping the Earth clean begins in the home, then in the classroom and our children will begin to initiate his or her actions to conserve, to protect and preserve Nihodzaan. I want my students to use their cultural philosophy to learn, protect and respect Mother Earth.

I know our students are not informed of national and global issues of what other nations are doing to increase financial gains using oil and how countries are exporting oil with great risk because of civil war and political conflicts. They need to know the various resources different countries and nations are currently using to extract fossil fuels (coal, natural gas, and oil) from the Earth. They also need to know the benefits of other natural resources like solar, thermal, wind, and water energy because these resources do not cause excessive damage to the Earth. Our students need to know these issues because the fossil fuel prices are part of their livelihood when traveling to the border towns (100 to 180 miles one way) to shop for groceries and clothes shopping, even vehicle maintenance.

They know using gasoline is an efficient way of traveling place to place, but they need to know the benefits of renewable resources like solar and wind energy because it is accessible. They do not have to depend on big energy corporations to supply their needs. In our rural town of Kayenta, there are two small wind turbines functioning at the south end of the school campus and there are huge solar panels on the reservation in several rural towns, Chinle, Crownpoint, Fort Defiance, and in Shonto. I would like to tour these sites with my students.

Background Information

In order to teach this unit, there are basic resources knowledge students need to know. The first concept is **fossil fuels**. Fossil fuels are **coal, petroleum**, and **natural gas** and these fuels are found in various parts of the world and are extracted and transported to provide energy to the consumer. The second concept is **renewable energy.** Renewable is energy that can be continually replenished like the **sunlight, wind, geothermal** and **biofuels.** Renewable energy is capable of supplying human energy for about another billion years. The third concept is the **Dine' Philosophy** of Education about how **Nihodzaan** (Mother Earth) and **Yadilhil** (Father Sky) represent balances of all moving elements. Mother Earth is the form of Changing Woman, because she nurtures life and Father Sky provides life-giving rain.

Fossil Fuels

Fossil fuels contain high amounts of carbon and were formed naturally in the Earth by the decomposition of dead organisms from millions of years ago. They take millions of years to form by heat and pressure in the Earth's layers, and are depleting faster than it takes the Earth to replenish them. An estimation of over 80% of the energy that is consumed in the world comes from fossil fuels, and carbon dioxide gas is emitted into the atmosphere causing the Earth's temperature to rise contributing to global warming which is an environmental concern.

Coal

Coal formation began during the Carboniferous Period which was about 360 million years ago (4). It is the remains of ancient plant life that originally accumulated in swamps and peat bogs that was then transformed by the pressure and heat within the plate movements. The sediments build-up with tectonic movements pressed down deep into the Earth's crust twisting and shearing creating physical and chemical changes in ancient plant into peat (organic soup), then with more time and pressure it converted the residue into coal. Coal is a combustible, composed of carbon, hydrogen and oxygen. The quality of coal deposit is determined by temperature, pressure, and the length of time in formation, known as 'organic maturity'.

Peat is converted into lignite or 'brown coal' it is a coal type with low organic maturity. Lignite is soft and its color ranges from pitch black to various shades of brown. An additional million more years with the continuing effects of pressure and temperature, the lignite changes into materials known as 'sub-bituminous' coals. As more chemical and physical change occurs, the coals become blacker and harder forming 'bituminous' or 'hard coals'. As additional changes increase and progress with the right conditions, the organic maturity of the coal continues and finally forms anthracite.

Coal is found in almost in every country in the world and the largest reserves are in the China, India, Russia, and the United States. During the centuries of explorations, the features, locations, and sizes of the coal reserves were discovered in various countries. The accessibility and size of the coal reserves in the ground were debatable because variables were involved like is the reserve abundant and is it economically and technically extractable. A geological map of the area was created and analyzed, then geochemical and geophysical surveys are conducted, and finally an exploration drilling is done. This process gives an accurate picture of the land to be developed. The area will establish a mine if the coal has a large amount and sufficient quality; then mining operations can begin.

The two methods to obtain coal are by **surface mining** and **underground mining**. The type of mining depends upon the geology of the coal deposit. Based on the coal production timeline, underground mining currently outputs a larger share of the world coal production than surface mining. But, coal production countries have a common mining preference; they preferred surface mining because it extracts more coal.

Surface mining is also known as opencast or open-cut mining and is economical when the coal layer (seam) is near the surface. 90% or more of the coal can be extracted compared to underground mining. Large opencast mines use very large equipment, machines, and vehicles to remove the overburden (top layers of the soil and rocks) and to transport the overburden and coal.

Underground mining operations have two methods of mining, the room-and-pillar and long-wall mining. The room-and-pillar mine is the oldest mining method. The coal deposits are mined at the coal seam into grids like a tic-tac-toe line. The lines are the tunnels and the spaces in between are the pillars. This mining method leaves 40% of the coal in the seam. Longwall mining encompasses the total extraction of coal from a long seam by sections. A self-guiding hydraulic power jack would hold the ceiling while another machine called the shearer extracts the coal. After the section of coal is extracted, the ceiling is allowed to collapse. The Longwall mining method extracts more coal than room-and-pillar. These machines are state-of-the-art equipment and miner personals need to be highly skilled and well-trained when using technological machineries underground.

Coal is traded and transported globally by barges, pipelines, ships, and trains. Depending on the distance, trucks and conveyors are used for short distances.

Petroleum

Petroleum is 'rock oil,' associated with crude oil and natural gas. Petroleum is found in most oil fields or reservoirs with natural gas which is a lighter gas above the petroleum, then crude oil and saline water at the bottom. It is discovered in pockets, seams, and in underground pools below the Earth's crust. Petroleum is a compound mixture of hydrocarbons and paraffin formed from decomposition of ancient animal and vegetation life usually found in deep rock bands at various levels. When fissured and refined, it produces petrochemicals that convert into thousands of products. These petroleum products are commonly put into barrels and one barrel of petroleum equals 5604 cubic-feet of natural gas, 1.45 of liquefied natural gas (LNG) (5).

Crude oil has varied appearance and composition, from black to dark brown and some may be yellow, red or green. It is found in semi-solid form mixed with sand and water, like **bitumen** which is a sticky, black tar-like form which is very thick and heavy. The Athabasca oil sands in Canada have crude bitumen sand oil. The Orinoco oil sand in Venezuela has a large amount of extra heavy fluid sand oil. This oil sand is called unconventional oil because they have different processes when extracting it, unlike the traditional oil well methods.

The formation processes of petroleum were from organisms that came from single cell organism known as plankton, diatoms, and blue - green algae. These simple organisms were abundant during ancient times, about 550 million years ago. Rapid burial of the single-celled organisms within fine-grained sediments preserved them. This provided the organic materials called protopetroleum, which progressed into petroleum by a series of biological, chemical, and physical changes. The protopetroleum begins to chemically rearrange converting organic matter into kerogen. This dark colored, insoluble bacteria-altered kerogen is the source of hydrocarbons. Biogenic methane is one hydrocarbon generated and it is initiated by the process of decomposition of organic matter by anaerobic microorganisms (able to live in absence of oxygen).

Depending on the depth, temperature, geological age, maturation stage, amount and type of organic matter, kerogen begins oil generation and it occurs by thermal degradation and cracking (heavy hydrocarbon molecules are broken up into light molecules). Specific temperature and depth create variations of gas, like wet gas. This type of gas contains liquid hydrocarbons known as LNG.

Petroleum is collected in traps within the Earth's layers known as structural and stratigraphic traps. The basic characteristic of a trap is any shape like a closed, inverted container. A structural trap is formed by tectonic movements, fold or fault rocks. The most common structural traps are anticlines, an up-fold of rock bands that are like oval shapes on geologic maps. About 80% of the world's petroleum was found in anticline traps. Another kind of structural trap is the fault trap, this is when a fault line slips and moves the rock bands and forms a barrier to enclose the petroleum. Other structural traps are formed with salt domes and are formed by the upward movement of the salt masses which usually occur along the fold or fault line.

A second major type of oil trap is the stratigraphic trap; it is similar to sediment deposition or erosion. When tectonic movements control deposition and erosion in sedimentary basins, stratigraphic traps are formed. When fossil carbonate reefs, marine sandstone bars, and deltaic distributaries are buried they create a potential reservoir which is usually surrounded by fine grain sediments that act as a cap rock. When sediments deposit into the sea, it changes the course land to fine grain sand and in time changes the permeable sediments to an impermeable barrier that eventually traps migrating petroleum.

Liquid petroleum is easily transported and everyday 80 million barrels of oil are moved from producers to consumers. Offshore oil production accounts for about 30% of the total world oil production and about half of the world production of natural gas. Most countries that have coastline will have offshore oil or natural gas production rigs. Offshore drilling for oil and natural gas on the continental shelf is conducted deep in the water over 2,200 meters deep. Many of these rigs are movable and can float while being moved and while drilling. The functioning span of a rig is usually about 20 years and portions of the rig can be reused or the whole rig can be redeveloped and if not, it must be decommissioned.

The search for natural gas and oil is extremely costly, difficult, and often unsuccessful. Locating gas or oil reservoirs and extracting them is difficult because the waters may be stormy and very deep. The potential reservoirs are identified by using and analyzing a survey; it determines if the seam contains gas or oil and is unknown until the drill bit penetrates the cap rock. Direct drilling to a specific location a few kilometers away requires sophisticated computer technology. Just above the drill bit a navigation device is installed to send feedback information to find the exact position of the well to be measured and monitored. Four types of offshore rigs use the drill to locate wells: the submersibles, jack-ups, drill ships, and semi-submersibles.

Submersibles are rarely used and can be used on shallow water. Jack-ups are usually towed to a location. Then the legs are lowered to the seafloor and the hull is jacked up to the sea surface. A drill ship looks like ordinary ships but has a derrick on top which drills through a hole in the hull. It is anchored or positioned with computer controlled propellers along the hull which constantly corrects the ship's drift. Semi-submersible is a mobile structure with its own locomotion. Superstructure rigs are supported by columns sitting on hulls or pontoons which are ballasted below the water to provide stability in rough, deep seas.

When gas or oil is discovered, the drilling rig is replaced by a production platform. The production platform is constructed at the site using a barge equipped with heavy cranes. Depending on size of the discovered field, water depth, and distance from the shore, the size, shape, and type of platform will constructed. The platform is constructed of steel and secured to the seafloor with steel piles and will house all equipment and accommodate about 80 workers. There are concrete structures which are big enough to store oil and gravity holds them onto the sea floor. The world's biggest platform is bigger than a football field and rises above the water as high as a 25 story building, housing 500 workers. When an oil field is discovered in shallow water and near land or another platform, a smaller remote controlled monopod platform is used. Another type of floating structure is a Floating Production Storage Offloading (FPSO) vessel. The Tension Leg platform is another type of platform used for deep water production which is assembled from steel or concrete and then anchored to the sea floor with vertical tendons (reinforced strand in prestressed concrete).

Drilling for oil is called "spudding." It is the initial stage of drilling, when the drill is lowered onto the sea floor. Two types of bits are used, a roller cone shape rock bit with three cone steel or tungsten carbide (an inorganic chemical 3 times stronger than steel or titanium) teeth, or a diamond bit which is embedded with small industrial diamonds. The drill bit (about 21 to 91 cm) is attached to a drill pipe and is rotated by a turntable on the platform floor. As the drilling deepens into the sea floor, extra lengths of pipe are attached. Drilling takes many weeks or months before the targeted area is reached. The weight of the drilling fluid acts as the first line of well control by keeping underground pressure in constant check. If an influx of pressurized gas or oil occurs during drilling, a well control is maintained through the rig's blowout prevention system (BOP). The BOP is a set of hydraulically operated values and other devices that seals off the well and routes the wellbore fluids to a specialized pressure controlling area. Well trained personal operate highly reliable equipment to minimize the possibility of a blowout or uncontrolled fluids flowing from the well. Directional drilling is when drill bits are steered laterally several kilometers towards the petroleum reservoir. One production platform will drill a number of wells in variety of directions and inclinations until a target is found. When the well has been drilled and target found, a production casing is set and cemented. Tubing is lowered into the hole with "packers" that seals the space between the tubing and the casing. At the end of the well, the casing is perforated at predetermined depths by small explosive charges. The small holes in the casing allow the gas or oil to flow to the surface using its natural pressure. If a drilled hole is dry and not worth developing, it is plugged using cement and then abandoned.

Pipelines, marine vessels, tank trucks, and rail tank cars are used to transport oils, compressed and liquefied hydrocarbon gases, liquid petroleum products and other chemicals from the site to pipeline terminals, refineries, distributors and consumers. Crude oils and liquid petroleum are transported, handled, and stored in their natural liquid state. Hydrocarbon gases are transported, handled, and stored in both the gaseous and liquid state. It must be completely confined in pipelines, tanks, or cylinders prior to use. Liquefied hydrocarbon gases at -162 °C are stored, handled, and shipped as liquids, taking up a small amount of space. When it is released into difference storage, the atmospheric temperatures cause the liquid to expand and become gas.

Natural Gas

Natural gas is a combustible mixture of hydrocarbon gases, containing methane with other hydrocarbons like ethane, propane, butane, carbon dioxide, oxygen, nitrogen, hydrogen sulfide, and rare gases. It exists in the form of gas fields in formations of porous rocks as gas caps above the crude oil or in crystalline forms. Scientists who study the interior parts of the Earth and petroleum have theories of how thermogenic methane is formed. Organic particles, time, pressure and high temperatures deep beneath the earth break down the carbon bonds. The deeper the natural gas is discovered, the purer the gas (methane) because the increase of pressure and the hotter temperatures form more natural gas than oil. However, natural gas can also be cooled to about -162 °C (-260 °F) and converted into liquefied natural gas (LNG). While in liquid form, natural gas takes up only 1/600 of the volume of its gaseous state and it is stored and transported to places that do not have pipelines (6).

Natural gas is commonly extracted by **drilling vertically** into the Earth's surface. A single vertical drill well is limited to the gas reserves it encounters. Today, **hydraulic fracturing** or **fracking** is preferred when extracting natural gas because wells drill horizontally and acidizing processes are used to access large amounts of gas. Horizontal drilling is drilling straight down from the surface, and then the drill can be directed to go sideways. Acidizing is a process of dissolving acidic components then inserting them into the gas well to dissolve rocks that block the flow of gas. Hydraulic fracturing is a process that separates open rock formations with high-pressure streams of water, chemicals, and sand. The sand props open the rocks allowing gas to escape. It is then stored and transported. Using the fracking process requires huge volumes of water. A community that utilizes the water table would be unwise to use this process.

After natural gas is extracted, it is commonly transported through pipelines that can be from 2 to 60 inches in diameter (7). The United States has more than 200 pipeline systems that are made up of about 500,000 kilometers (300,000 miles) of conducting pipelines that transfer gas to all 48 states. This system requires more than 1,400 compressor stations to ensure that the gas continues on its path, 400 underground storage facilities, 11,000 locations to deliver the gas, and 5,000 locations to receive the gas (8).

Natural gas is measured in normal cubic meters or standard cubic feet. In 2009, the United States Energy Information Administration (EIA) estimated that the world's proven natural gas reserves are around 6,289 trillion cubic feet (tcf) (9). Most of the reserves are in the Middle East, with 2,686 tcf in 2011, or 40 percent of total world reserves (10). The US has just over 4% of the world's natural gas reserves.

Renewable Energy

Renewable energy is any energy source that comes directly or indirectly from natural processes. Renewable electricity can be produced from **solar** (sunlight) **energy** and **photovoltaic cells**, **wind energy, geothermal,** and **biofuels**.

Sunlight energy

Solar energy is the radiant energy produced by the sun. The sun with other solar powered resources such a wind and water are a majority of the renewable energy on the Earth. The Earth receives 174 pet-watts (PW) of solar radiation at the upper atmosphere, 30% is reflected back into space and the rest is absorbed by clouds, oceans, and land (11). The land surfaces, oceans, and the atmosphere absorb solar radiation which increases their temperature. Humans utilize solar energy in different ways: heating and cooling, lighting, cooking, and cleaning. Solar technology captures, converts, and distributes energy using passive or active methods. Active solar techniques use photovoltaic panels and solar thermal collectors to accumulate the energy. Passive techniques involve positioning a building to the sun, selecting materials with thermal mass properties, and using materials with light dispersing properties (12).

A photovoltaic cell (PV) is a device that converts light into electrical currents using photoelectric reactions at the atomic level. Photoelectric effects absorb light and release electrons; then, released electrons are captured creating an electric current that is used as electricity. The photoelectric effect was first discovered by a French physicist, Edmund Bequeral, in 1839. He discovered certain materials would produce a small amount of electric currents when exposed to light. Then, in 1905, Albert Einstein described the nature of light and the photoelectric effect on which photovoltaic technology is based, for which he later won a Nobel Prize in physics (13). Eventually, the advances of photovoltaic technology gained recognition; space programs and the energy crisis crunch in the 70's opened the doorway by exposing solar technology to the people.

The basic structures of photovoltaic cells are made of a semiconductor material known as silicon. A thin semiconductor is coated with a film of silicon to form an electric field with positives on one side and negatives on the other. When the photons (particles of solar energy) hit the cell, some are reflected, some pass right through and others are absorbed. Only the absorbed photons will generate electricity, and this is when electrons are knocked loose from the atoms in the semiconductor. Electrical conductors attach to the positive and negative sides will form an electrical circuit. When the electrons leave their position, gaps are formed and when many electrons carry a negative charge they travel to the surface of the cell causing an imbalance of charge between the negative and positive lines. When the two surfaces are connected to a load, such as an appliance, then electricity will flow through the connection. The demand for more electric flow created a bigger frame called a photovoltaic module; this is when multiple cells are added to a larger frame to supply more electricity at a certain voltage. Bigger modules can be combined to form multiple arrays to make a larger structure producing direct-current electricity. Today, photovoltaic cells have multiple junctions stacked upon each other to capture high-energy photons and to concentrate electricity.

Solar thermal energy uses the sun's rays to heat liquid at very high temperatures. The liquid is circulated through tubes so it can transfer heat into the water, thereby producing steam. In turn, the steam is converted into mechanical energy by using a turbine to generate electricity. It is similar to a coal generating plant; instead the thermal energy plant uses heat collected from the sun. The three types of solar thermal power systems are: parabolic trough, solar dish, and solar power tower. A parabolic trough is a long parabolic shaped reflector that focuses the sun's rays as it moves east to west during the day. It's unusual shape can focus the sun to 30 to 100 times its normal intensity on the receiver pipe located along the focal line of the trough achieving operating temperatures over 750 °F (14). Heated fluid is circulated through pipes transferring heat to water, producing high-pressure superheated steam. The steam passes through the heat exchangers and cools down then it recirculates through the pipes and is heated up again. Parabolic troughs are aligned in numerous rows called a "solar field" and are aligned on a north to south horizontal axis operating at full power using solar energy.

Solar dish systems use solar rays to collect intense heat onto collectors while tracking the sun. The dishes are constantly facing the sun to concentrate energy at the focal point of the dish. A solar dish's central temperature ratio is higher than the parabolic trough. In the dish, a mechanism converts heat by compressing a cold fluid then the fluid heats up and expands through a turbine or a piston to produce work. The engine is attached to an electric generator to change the mechanical power to electric power. The solar dish is ideal and suitable for remote and rural areas where electricity is difficult to obtain.

A solar power tower is a central receiver surrounded by hundreds to thousands of flat sun-tracking mirrors called heliostats. The power tower must be a large structure to collect and produce solar energy from the many heliostats. The heliostats reflect and concentrate the sun's energy into the tower by about 1,500 times to heat fluids within the tower. The heated fluids will transfer into a steam drum and then into a turbine that will produce electricity. After the steam cools, it becomes fluid and is transported in a steam condenser. Then, it is transferred into the tower continuing the cycle. This system is unique because it has the ability to store solar energy and is able to transmit electricity when needed, even at night or during cloudy days. The southwest states are ideal places to establish a solar power tower because of the abundance of land acreage and a tower can produce enough electricity for about 50,000 homes.

Wind energy

Wind is the movement of air caused by the gases of the Earth's atmosphere moving with the sun's heat on the surface of the Earth. As long as the sun shines, the wind will blow causing hot air to rise and cooler air moving beneath. Today more and more people are using wind turbines as their energy producer for electricity. The energy hungry countries favor these giant white pinwheels because wind is free and can produce thousands of megawatts of electricity. These turbines can be as tall as a 20 story building and usually have three 60 meter long blades that are connected to a generator that produces electricity. The turbines look like giant propellers on a long pole. A huge turbine can generate enough electricity to support 600 homes. Certain areas with high wind frequency have wind farms encompassing ten to hundreds of wind turbines lined together. Not only are wind turbines on land, but they are on offshore waters. Currently these offshore turbines are mainly in Europe. Globally there are about two hundred thousand wind turbines operating. In addition to these huge pinwheel giants, smaller wind power systems are produced to generate power to individual homes and in isolated rural communities. Small wind turbines are able to power equipment like parking meters, street lights, wireless internet, and traffic lights.

There are various types of wind turbines, some rotate horizontally or vertically. The horizontal axis turbines have a rotor and electrical generator at the top of the tower. Majority of them have a gear box which connects the large blades rotating quickly to the electrical generator. The turbine is usually positioned upwind because the rotating blades produce turbulence behind it. The blades are stiff because extreme winds cannot push them into the tower. They are also positioned at a designated distance in the front of the tower. The wind turbines have three components on a horizontal axis turbine; first is the rotor and the blades, second is the generator component, the control electronics, and the gear box, third is the tower and rotor mechanism. These monolith blades and towers are white because aircraft are able to view these high pinwheels during daylight.

The vertical axis turbines have the rotor shaft structured vertically and these turbines do not need to face the wind to be effective. These turbines can be mounted on rooftop buildings and will redirect the wind and will double the wind speed. A majority of these vertical turbines are small and are used on homes, low towers, rural schools and medical facilities. Many of these small wind turbines are used off-grid, or where there is no electricity or where the grid is unstable.

Geothermal energy

Geothermal energy is stored in the form of heat deep beneath the Earth's surface. It emits almost no greenhouse gases and provides a continuous uninterrupted supply of energy that will heat homes, buildings, and generate electricity. The word geothermal originated from the Greek language, geo meaning "Earth" and theme meaning "heat." The interior of our Earth contains a huge source of geothermal energy and people have been using it for centuries, like the natural heated spring groundwater and the steam for geysers that was trapped within hot rocks below the Earth. This happens when groundwater seeps below the earth near a dormant volcano, and the water is heated by pools of molten rock at depths of 3,000 meters. When groundwater remains under the Earth's surface it is known as a geothermal reservoir. Certain locations on the Earth's crust near volcanic activity have deep fractures that cause molten rocks to seep close to the surface heating groundwater. It is a reliable resource because it is limitless and can be found anywhere on the Earth. The country of Iceland is known to have an abundance of geothermal energy resources.

As man probes deeper in the Earth's core and upper mantle (lithosphere) more thermal energy will be used. When extracting the heat within the lithosphere a process needs to be established. First, a borehole is drilled into the fractured rock down to the level of temperatures of 150-200 °C. Next, water is pressured into the existing fractures to the reservoir and hot rocks. When water pressure is removed a slight opening remains due to the water permeating into porous rocks. The fractured reservoir is monitored by micro-seismicity equipment. Then a second borehole is drilled into the existing fractured reservoir and cold water is pumped into the first borehole. The cold water is heated and exchanged heat happens in the reservoir; then it is abstracted to the surface where it is used for electricity.

Biofuels

Biofuels are fuels made from living organisms, and are clustered into three categories: first generation biofuels are mainly made from sugar, starch and vegetable oil, the second generation biofuels are made from nonedible plants, and the third are made from algae and other microbes. The primary component of the first generation of biofuels is ethanol, and most gasoline sold in the United States contains ethanol. The second and third generation biofuels are known as "advanced biofuels."

Biofuels are fuels from biomass like living organisms or any organic matter from decomposing matter to plants, animals, woods, agricultural crops, and even manure. Biofuels have been steadily increasing during the last decade. Today, biofuels provide about 3% of road transport fuel globally.

Ethanol fuel is the most commonly used biofuel globally. It is an alcohol fuel produced by fermentation of sugars stemmed from any sugar or starch product like wheat, corn, sugar cane, sugar beets potatoes and any fruit waste. The method of producing ethanol is to break down sugars from starches known as enzyme digestion, fermenting sugars, distillation (requiring heat), and drying. In addition to ethanol, propanol and butanol are other alcohols.

Biodiesel, green diesel, and vegetable oil are other types of oils and fats used to run automobiles, commercial trucks and city buses. Oils and fats are hydrogenated oils that can blend with diesel fuel. Gases like bioethers, biogas, and syngas are other biofuel products. Bioether is an oxygenated fuel that acts as an octane enhancer. Biogas is methane produced by anaerobic digestion from biodegradable waste like landfill gas and manure from cattle farms. Syngas is a mixture of gases (carbon monoxide, hydrogen, and other hydrocarbons) produced for internal combustion engines, turbines, or wood gas generators. Another first generation fuel is solid biofuels which is raw fuels like wood chips, sawdust, grass trimmings, manure, and other agricultural waste. These raw fuels are ground into concentrated fuel products like wood pellets that then are used to fuel boilers and wood stoves in residential homes.

Second generations biofuels are currently in study and still developing like cellulose, algae, hydrogen, and mixed alcohols. Working with cellulose is difficult because it is a slow process and researchers are analyzing cattle's digestive system and using it as a comparison to laboratory production. Various countries are currently researching this process, too.

There are pros and cons connecting to biofuels like the "food vs. fuel" discussion, the sustainability, the production of biofuel, the water resources, and energy balance. Looking more into the second generation biofuel may be part of the solution, like algae. Looking for the perfect fuel will not solve energy global issues but man can and needs to balance the trade-offs. As the population expands and the demand for energy increases, we will need every available form of energy from the gifts of the Earth and the sun. These gifts need to be environmentally and economically sustainable.

Dine Philosophy

The concepts of Western and Dine' philosophies have varied contrasts about how we view Mother Earth. As Dine, we ask Nihodzaan (Mother Earth) for her permission when we take a part of her and, in return, we give a gift as a sign of respect. It is believed the Holy People taught the Dine' to live in harmony with Mother Earth, Father Sky, and the elements like the land, the water, the air and all beings. This is why mountains and water are sacred, endowed with strength, wisdom, and teachings man can access for strength and resources; they represent thinking (nitsahakees), planning (nahat'a), life (iina), and contentment (sahasin). This is an area of knowledge, rest and reverence for all creation (Haa'ayiih doo hodilzin).

The Dine' tradition believes we appreciate and respect for ourselves and we exist according to the creator, Mother Earth and the Universe. As a Dine, we acknowledge reverence and assurance to the creator by offering white cornmeal (t'adidiin) while anointing yourself from the sole of your feet and upwards to the top of the head. This process is to acknowledge your spatial existence, you're sacred name by offering to Mother Earth, the Universe, the cardinal directions, the environment in sacred places like the mountains and nature before acknowledging yourself as a human being as Bila' ashla'ii and Nohookaa' Dine'e. This is a psychological reverence meaning you acknowledge your well-being, to exist and to live a long extended life in Sa Baahozhoonii (old age with guidance) and in Sa'ah Naaghei Bik'eh Hozhoon and to eventually attain the virtues of Yis'ah Na'ada (life's longevity and acumination of all knowledge and wisdom within in one's life time). As a Dine, Bila'ashla'ii, your personal awareness is revered toward the sacredness of nature within the environment, the birds, the animals, and your pathway in life. Others often ask why do you pray to the mountains, the birds, the animals, and why you begin your prayers as "Hozhoo dooleel Shima Nahasdzaan and Shitaa' Yadilhil. The answer is, you are a child of Mother Earth and the Universe is your father and it is an essential right that is practiced according to the standards established by the Holy People.

Activities

The activities will lead the students to learn about fossil fuels and renewable energy while creating a living wall, a clan diorama, tour a wind turbine near the school campus, tour a solar panel site, build a solar lantern, and a windmill.

Activity 1: Students will create a global living wall with the major continents and oceans. They will add the sketches of fossil fuels and renewable energy countries export and import with a brief explanation about the sketch. During the unit teaching, students will review and add more information onto the wall. As the unit progresses, pictures, vocabulary words, and reinforcement of the theme come alive with student input. The wall is discussed and highlighted daily while students add their learning which makes the wall interactive and alive.

Activity 2: The clan diorama requires a home-school connection involving parent input. The student will require information from their parents about their four clans. The clans will be the foundation of the hoghan representing Mother Earth and the outer parts of the heavens like the sun representing Father Sky. Students will use the four stones, specific rocks, color sand, dowel stick and symbols like the arrowhead, the rainbow, the mountains, and certain animals while creating their diorama. Students will explain their diorama and how it connects to Mother Earth.

Activity 3: The class will tour a wind turbine site near the school campus within walking distance. They will listen and ask questions about the function, purpose, benefits and drawbacks of the turbine. Students will use note-taking skills during the tour; upon returning from the tour, students will write about their learning and experience about the facility and the turbine. The following day the class will tour a solar panel site and the green building that utilizes the energy. The class will use note-taking skills while touring the solar site.

Activity 4: Students will build a solar lantern using a photovoltaic cell from a simple outdoor solar light stick. Then students will take the lantern home and will use the lantern as a night light to complete their homework. The students will keep learning by writing about their experience using the lantern at home.

Instructional Strategies

The unit will begin by providing the students with background knowledge the structure of the earth and the many resources she provides like fossil fuels (oil, coal, natural gas), solar, water, and wind from the various countries and nations. A topic will be given to groups of four and students within their group will brainstorm, creating a web about the uses like an inquiry of science. This will break down the components of each topic, oil, coal, natural gas, solar, water, and wind from global, national, and the reservation.

As the unit advances the Dine' Philosophy of Education will be integrated focusing on Mother Earth (Nihodzaan). Students will learn about self as a Dine' and how the Circle of Life: Thinking, Planning, Life, and Happiness connect to all beings and all movement on the Earth and Sky. They will create a diorama of their four clans and how their clans connect to Nihodzaan.

After a week, the students will be focusing on the United States' and Colorado Plateau's & Navajo Reservation's resources. They will create comparison maps of the plateau and the reservation pinpointing mines, power plants, oil refineries, hydro-dams, wind turbines, solar panels, and other energy resources available. The maps will consist of closed and current facilities and they will discuss the pros and cons of the functioning services. They will research the Navajo Nation government to find out what our nation is doing in connection to resources like the environmental protection agency and the division of natural resources (land, water, archaeology) in comparison to the United States' agencies.

The main outcome of the unit is to teach students how the global and national events relating to resources will change their future, and they need to keep the balance with Nihodzaan. We will explore the renewable energy focusing on solar and wind because the southwest region is an ideal area for the two resources. They will create a scientific inquiry and a model of how solar or wind will help them at home in terms of saving energy.

Whole class direct instructions, team tasks cooperative learning, and individual independent learning are the grouping structures that will be utilized while teaching the unit. Visuals, pictorials, poetry chants and songs, color coding, and power point presentations are classroom input while learning about the unit.

Work Cited

A. Marketing Resource Center. "World and U.S. Fossil Fuel Supplies." ww.agmrc.org. www.agmrc.org/renewble_energy/energy/world-an-u-s-fossils-fuelsupplies (accessed July 13, 2013).

Barringer, Felicity. "The Energy Challenge-Navajos Environments Split on Power Plant." www.nytimes. www.nytimes.com/2007/07/27/vs/27navajo.html?r=1& (accessed July 13, 2013).

Battiest, Terry. "Navajo Nation Renewable Energy Initiatives." nau.edu. ww4.nau.edu/tribalclimatechange/resources/..../res_830BattiestNavajo. (accessed July 12, 2013).

Busby, Jonathan. "Geothermal energy | Renewables and energy security | British Geological Survey (BGS)." British Geological Survey (BGS) | A world-leading geoscience centre. http://www.bgs.ac.uk/research/energy/geothermal/ (accessed August 5, 2013).

Fossil Energy Office of Communications. "How fossil fuels were formed." U.S. department of energy. DOE-Fossil Energy (accessed July 12, 2013).

Geology News and Information. "Oil and Gas | Geology.com." Geology.com: News and Information for Geology & Earth Science. http://geology.com/oil-and-gas (accessed August 5, 2013).

How to Make Your Own Solar Powered Lantern for Under $10, http://green.thefuntimesguide.com

Institute for Energy Research. "Institute for Energy Research | Hard Facts: An Energy Primer." Institute for Energy Research. http://www.instituteforenergyresearch.org/hardfacts/ (accessed July 14, 2013).

International Energy Agency. "Harnessing Variable Renewables A Guide to the Balancing Challenge." iea.org. www.iea.org/publications/..../Harnessing_Variable_Renewables2011.pdf (accessed July 13, 2013).

Knier, Gil. "How do Photovoltaic Work?." ScienceNASA. news/science-at-nasa/2002/solarcells/ (accessed July 12, 2013).

MacKay, David. "David MacKay FRS: Sustainable Energy - without the hot air: Contents ." David MacKay FRS: Sustainable Energy - without the hot air: Contents . http://www.withouthotair.com (accessed August 4, 2013).

McNeley, James. "The Navajo theory of life and behavior." http://scholrspace.manua.hawaii-ed. scholarspace.manua.hawaii-ed. (accessed June 30, 2013).

National Geographic. "Environment Facts, Environment Science, Global Warming, Natural Disasters, Ecosystems, Green Living - National Geographic." Environment Facts, Environment Science, Global Warming, Natural Disasters, Ecosystems, Green Living - National Geographic. http://environment.nationalgeographic.com/ (accessed August 5, 2013).

National Geographic. "Biofuel Facts, Biofuel Information - National Geographic." Environment Facts, Environment Science, Global Warming, Natural Disasters, Ecosystems, Green Living - National Geographic. http://environment.nationalgeographic.com/environment/global-warming/biofuel-profile (accessed August 5, 2013).

Navajo Nation Division of Natural Resources. "Navajo Nation - Office of Natural Resources Revenues." http://dnrnavajo.org. www.onrr.gov/....pdfdocs/....AAOO%20Navajo%20Nation%20Commen (accessed July 12, 2013).

Semken, Steven, and Fram Morgan. "Navajo Pedagogy and Earth Systems." http://semkin.asu.edu/.

semken.asu.edu/pubs/semken97_npes/pdf (accessed July 9, 2013).

The NEED Project. "Natural Gas." need.org. www.need.org/neepdf/infobook_activties/Scecinf/NGasS.pdf (accessed July 16, 2013).

The Navajo Division of Economic Development. "Natural Resources." www.navajoadvantage.com. www.navajoadvantage.com/pages/naturals.htm (accessed July 13, 2013).

U.S. Department of Energy . "Solar Power Towers." U.S. Department of Energy Waste Isolation Pilot Plant. http://www.wipp.energy.gov/science/energy/powertower.htm (accessed August 5, 2013).

US Energy Information Administration. "EIA Energy Kids - Energy Kids: Energy Information Administration." U.S. Energy Information Administration (EIA). http://www.eia.gov/kids/energy.cfm?page=solar_home_basics (accessed August 5, 2013).

Vogelbacher, Jutta. "Navajo Philosophy and its application in education." http://homepages se.edu. homepages.se.edu/nas/files/2013/03/navajophilosophy.pdf (accessed July 9, 2013).

Walker, David. "Energy, Plants and Man." http://books. Google. www.hansatch-instruments.com (accessed June 11, 2013).

The Colorado River Commission of Nevada. "World Fossil Fuel Reserves and Projected Depletion." htt://cc.nv.gov/docs/. crc.nv.gov/docs/world%20fossil%20reserves.pdf (accessed June 30, 2013).

State Standards

Strand One is the inquiry process, students use the scientific processes of questioning, planning and conducting investigations using appropriate tools and techniques to gather data, think critically and logically about relationship and evidence and explanations, and communicating results.

Strand Two is History and Nature of Science, students will learn about the contributions of scientists and the role they play in the development of various cultures, plantations, and communicating results, the inclusion of historical perspective and the advances of new development bring to technology and human knowledge.

Strand Three is Science in Personal and Social Perspective emphasizes on developing the ability to design a solution to a problem, to understand the relationship between science and technology, and the impact of science and technology on human activity and the environment. It will give the students the opportunity to understand their place in the world as living creatures, consumers, decision makers, problem solvers, managers and planners.

Notes

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1. Navajos & Hopis fight office of surface mining's decisions on Peabody Coal's Black Mesa project, www.culturechange.org

2. Navajo Nation – www.navajoadvantage.com

3. The Energy Challenge – Navajo and Environmentalist Split on Power Plant

4. What is coal? The Coal Resources: A Coal Comprehensive Overhead of Coal pp.3

5. The Crude Oil Extraction, Oils.gpa.unep.org/facts/extraction.html

6. Natural Gas pp. 1-2, www.NEED.org

7. Natural Gas pp. 1-2, www.NEED.org

8. Natural Gas pp. 1-2, www.NEED.org

9. Natural Gas pp. 1-2, www.NEED.org

10. Natural Gas pp. 1-2, www.NEED.org

11. EIA Energy Kids-Solar, www.eia.gov/kids/energy

12. EIA Energy Kids-Solar, www.eia.gov/kids/energy

13. How do photovoltaic work? NASA Science, science/nasa.gov/science

14. EIA Energy Kids-Solar, www.eia.gov/kids/energy