Teachers' Resources Booklet for Integrated Instruction in Sustainable Energy (Grades 5-7)

Organization of American States

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Introduction

There are a variety of factors that contribute to the Caribbean islands' dependency on imported fuels, placing the region in a vulnerable economic and ecological position. With this knowledge at the forefront of sociopolitical concern, the governments of the region have made it a priority to educate the upcoming generation regarding the principles of sustainable energy, and energy efficient practices.

Several multilateral agencies and regional organizations have been helping government officials increase the energy sector's sustainability by strengthening energy governance and management, and launching a full-scale market transformation of the energy matrix. However, sustainability is still limited and the movement needs further assistance. In order to redouble efforts toward this goal, it will be critical to improve infrastructure, including institutional framework; create favourable conditions for capacity building, and, in turn, ease and encourage the process of knowledge transfer; provide complementary financial tools and options; and implement educational and awareness programs.

In support of these, the Organization of American States (OAS), through its Department of Sustainable Development (DSD) is executing a four-year initiative called Caribbean Sustainable Energy Program (CSEP) funded by the European Union (EU). CSEP is jointly implemented by the Caribbean Community (CARICOM) Secretariat, the Caribbean Energy Utility Services Corporation (CARILEC), and the Renewable Energy and Energy Efficiency Partnership (REEEP), in close association with the Organisation of Eastern Caribbean States (OECS) Secretariat and the Caribbean Renewable Energy Development Programme (CREDP), which receives its financial support from the government of Germany and various Caribbean agencies.

CSEP and its partners, including Egis International (EI), have established the Caribbean Energy Education and Awareness Programme (CEEAP).

CEEAP is a regional energy communication and awareness strategy specifically tailored for the education sector. It targets personnel – students and teachers – in primary and secondary schools.

Through consultation with key stakeholders, CEEAP has recognized that based on the Caribbean's immediate need for a citizenry that understands and supports a regional movement toward sustainable energy; it is not practical to add the relevant information as an independent component of the formal educational curriculum.

During the consultation phase, CEEAP devised a more effective strategy, which involves integrating the relevant energy-related information into topics that already exist in the curriculum. To this end, teacher training programs and text book amendments were identified as viable first steps.

A number of teaching and learning materials (e.g. the Teachers' Resources Booklet and an educational energy kit for children) were produced in the framework of this initiative. Both the kit and the booklet were conceived with higher primary and lower secondary grade-level students as the principal target group.

The information provided in the Teachers' Resource Booklet for Integrated Instruction in Sustainable Energy (Grades 5-7) is intended to be complemented by other materials in the educational

package, for example, the Learn and Save DVD and booklet.

The OAS/DSD is incorporating additional educational resources from North American organization, KidWind, which has been assisting teachers and students with integrating renewable energy science into classroom lessons for nearly a decade.

The modules in this booklet are geared toward providing teachers with a useful guide to the integration of sustainable energy lessons into the content already included in the current OECS.

The modules in this booklet are geared toward providing teachers with a useful guide to the integration of sustainable energy lessons into the content already included in the current OECS Physical Sciences' curriculum for grades 4-6 as well as for the lower secondary school grades. The OAS has worked to respect the pre-existing structure of the curriculum (for example, the progression of topics) with the intention of incorporating relevant sustainable energy-related information into as many lessons as possible, specifically in those dedicated to alternative sources of energy, and energy efficiency and conservation.

Teachers should feel free to apply the suggestions as they deem appropriate in the unique context of their respective learning environments. Ideally, teachers will combine the booklet's suggested activities with those proposed in other CEEAP learning and awareness campaign materials.

General Objectives

Students should be able to:

1. Develop an awareness of the importance of energy to sustaining life.
2. Demonstrate an understanding of different energy sources and their respective environmental effects.
3. Develop an awareness of the importance of conserving and using energy efficiently.

Specific Objectives

Students should be able to:

1. Define energy, and identify its principal laws and forms.
2. Identify the different sources of energy.
3. Define non-renewable energy and identify the negative environmental effects associated with its use.
4. Define renewable energy and list the advantages and disadvantages associated with its use.
5. Discuss the uses of energy in our daily lives.
6. Define energy efficiency and energy conservation.
7. Knowledgably discuss methods of conserving energy.

Attitudes and Skills

Respect for evidence:

Provide evidential support for their results and conclusions.

Listen to other students' evidential support for their results and conclusions.

Respect for living things:

Show sensitivity to other living organisms.

Cooperation:

Share with others.

Work well with others.

Observe:

Use as many senses as are appropriate and safe to gather information.

Identify differences and similarities between objects and events.

Perceive and pay attention to the sequence of events.

Measure:

Use simple measuring instruments or models of measuring instruments. Begin with comparative terms i.e. "bigger" and "smaller"; graduate to using actual figures.

Communicate:

Talk freely about their activities and the ideas, whether or not they are making a written record.

Use appropriate vocabulary to describe observations.

Listen to others' ideas and engage with their results.

Report events via demonstrative presentations, role play, simple drawings, paintings, and/or simple sentences.

Experiment:

Freely ask a variety of questions and suggest how they may be answered.

Suggest investigation plans to find out answers to questions.

Module 1.

Energy basics

LESSON 1. DEFINITION AND FORMS OF ENERGY

1.1. General Objectives:

-Provide an understanding of the different forms of energy

-Introduce the law of conservation of energy: Energy can neither be created nor destroyed… but it can be converted.

1.2. Specific objectives:

-Identify different forms of energy.

-Draw a one-step flow chart to represent an energy conversion.

1.3. Process skills:

-Observation, communication, and drawing.

1.4. Content summary:

-Energy is in everything. It makes changes possible.

-The main characteristic or law of energy is that it is neither created nor destroyed.

-When energy is used, it does not disappear; it changes from one form of energy into another, as demonstrated in the following examples:

When you ride a bike, your body converts the chemical energy of your muscles to produce into mechanical energy.

Wind turbines use air flow to generate electricity.

POTENTIAL

Chemical Energy
Is energy stored in the bonds of atoms and molecules.

Mechanical Energy
Is energy stored in objects as a result of tension and compression.

Nuclear Energy
Is energy stored in the nucleus of an atom, where it holds the nucleus together.

Gravitational Energy
Is energy stored due to an object's position above the surface of the Earth, or its height. The amount of gravitational energy an object contains increases in proportion to its height and weight – so the higher and heavier is an object, the more gravitational energy it contains.

KINETIC

Radiant Energy
Is electromagnetic energy that travels in transverse waves.

Thermal Energy
Is the vibration and movement of atoms and molecules through a medium.

Motion Energy
Is energy stored in the movement of objects. The faster they move, the more energy is stored.

Sound
Is the movement of energy through substances in longitudinal (compression/rarefaction) waves.

Electrical Energy
Is delivered by tiny charged particles called electrons, typically as they move through a wire. Lightning is an example of electrical energy in nature.

1.5. Activities:

1.Display pictures and ask students to identify the forms of energy represented i.e. elastic, kinetic, gravitational, heat, sound, chemical, electrical, nuclear, light, wind, and wave energy.
2.Draw a flow chart to show how energy that begins as solar light and heat can power a refrigerator in your home. Describe the energy transformations that make that possible.
3.Display pictures of different devices and ask students to identify the form of energy each device is designed to produce and insert the answers into the following table:

Machine / Device	Form of energy is designed to produce
Generator	Electricity
Car engine	Movement

4.Ask some exploratory questions (see suggestions below). Be sure to complement each question with a demonstration:
- Q: If a basket ball and a tennis ball are each about to be dropped from the same height, which will have more potential energy? (A: the basket ball) Q2: What about kinetic energy? (A2: the basket ball)
- Q: If I drop 2 tennis balls from different heights which will have more potential energy? (A: the higher one)
- Q: If I am holding two tennis balls at the same height and I drop one down, but throw the other, which will have more kinetic energy? (A: the thrown one)

LESSON 2.
HEAT AS A FORM OF ENERGY.

2.1. General objectives
-Recognize heat as a form of energy.

2.2. Specific objectives
-Identify the uses of heat in our daily lives.
-Identify devices in the home that produce heat.
-List common heat sources.
-Explain the uses of common heat sources.
-Describe some of the effects heat energy can have on different materials.

2.3. Process skills
-Observation, communication, and manipulation.

2.4. Content summary
-Heat is a form of energy that is useful in many different ways, for example: for cooking our food, for melting various materials, for keeping our houses/buildings warm, for drying various materials, etc.
-Some natural organisms and matter produce heat, for example: combustible fuels, the sun, and our bodies are all heat producers.
-Humans have invented various devices that conveniently and safely provide heat in our daily lives e.g. stoves, ovens, irons, coal pots, etc.

2.5. Materials you will need
-Thermometer
-Pictures of devices and appliances that produce heat e.g. stove, transformer, light bulb, fan, etc.

2.6. Activities
1. Display a picture of a few common devices (e.g. oven, iron, radio, heater, etc.) and have students decide which ones are sources of heat. After they have identified the heat sources, ask them to distinguish between the natural heat sources and the artificial or man-made ones.

2. Combustible fuels and the sun are both sources of heat. Ask students to discuss the way these two sources of energy power our daily lives.

3. The human body regulates its own temperature. Ask students to start discussions using the following prompts: Question: What is the normal temperature of our bodies? Exercise: With a thermometer, compare the temperature of the students' bodies with the temperature of the room. Ask students to think of the ways people cool and heat their houses.

4. Ask students to name some man-made devices that make it easier for us to heat our homes.

5. Encourage students to discuss cases where heat is produced by common devices (i.e. fans, transformers, and light bulbs) as a by-product that is wasted instead of actually being used.

6. Arrange students in research groups and have them find invention dates and inventors for the heating devices they have identified. Encourage each group to draw a timeline and present to the rest of the class.

LESSON 3.
LIGHT AS A FORM OF ENERGY

3.1. General objectives
-Recognize light as a form of energy.

3.2. Specific objectives
-Identify and understand some uses of light in our daily lives.
-Identify common devices that use and/or produce light.
-List some common sources of light.
-Distinguish between natural and artificial light sources.
-Explain the uses of some common light sources.
-Identify devices that rely on light energy to work.

3.3. Process skills
-Observation, discussion, and inference.

3.4. Content summary
-Light is a form of energy.
-We need light in order to see things.
-Some devices, such as solar panel calculators rely on light energy to work.
-Many objects, both natural and man-made, produce and/or emit light.
-Artificial light has made it possible for us to work and play during nightfall or in otherwise dark places.

3.5. Materials you will need
-Objects that produce/emit light.
-Pictures of persons engaged in activities during nightfall using artificial light i.e. working, playing soccer/cricket, reading/studying, etc.

3.6. Activities
1. Divide students into small groups. Take each group into a dark room for a short while and ask the members to note any three objects or visual characteristics they can identify in the room.
Once all students have done this, let each group share its findings with the rest of the class. Repeat the activity with the lights in the room turned on. Afterwards, engage students in a discussion about the usefulness of light.

2. Display pictures and have students describe the activity taking place in each picture. Engage them in a discussion aimed at establishing the importance of light to these activities. Questions such as these may be used as prompts:
- What is happening in this picture?
- At what time of day is this activity taking place?
- How is it possible for this to happen at night?
- If the lights were to go out, how would that affect the activity?

3. Ask students to list some objects in their environment that give off light.

Module 2.

Electricity

LESSON 1. ELECTRICITY AS A FORM OF ENERGY

1.1. General objectives

-Recognize electricity as a form of energy.
-Identify and understand some uses of electricity in our daily lives.

1.2. Specific objectives

-Identify some common devices that are powered by electricity.
-Understand and explain how we produce and distribute electricity.
-Name appliances in the home that transform electrical energy to other forms of energy, and explain these transformations/changes.
-Draw a flow chart to show the different phases of power generation and distribution i.e. from a primary energy source to electrical appliances at home.

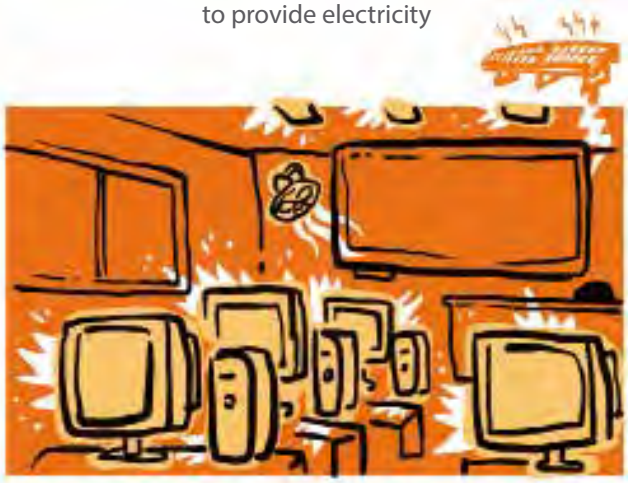
1.3. Process skills

-Observation, communication, manipulation, and design.

1.4. Content summary

-Electricity is the flow of electrical power.
-Electricity is both a basic component of nature and one of our most widely used forms of energy.
-Electricity is classified as a secondary energy source because it is obtained as a result of the conversion of other sources of energy i.e. combusted coal, nuclear energy, or solar energy.
-The aforementioned energy sources are all classified as primary sources, which can be renewable or non-renewable. However, electricity itself is neither renewable nor non-renewable.
-We use electricity to power electrical devices in our homes, schools, commercial buildings, etc.
-Many man-made devices change electrical energy into other forms of energy. For example, a light bulb changes electrical energy into heat and light; a television changes electrical energy into light, sound, and heat; an electric iron changes electrical energy into heat; an electric fan changes electrical energy into kinetic energy (or movement), sound, and heat.

Fossil fuel power plants are the primary sources to provide electricity



Solar panels are the alternative source to provide electricity

1.5. Materials you will need

-Learn and Save interactive DVD
-An incandescent bulb
-Diagram representing the method by which electricity is produced and distributed.

1.6. Activities

1. Have students work in groups to explore the history of energy timeline on the Learn and Save interactive DVD. Ask them to compile a list of scientists and/or events that they consider to be the most significant. At the end of the exercise, have each group discuss its choices with the rest of the class.
2. Engage students in a discussion about why electricity tariffs vary from country to country and why some countries' tariffs rose during the 2005-2006 period of high oil prices. You can use real-world values such as 0.11 EC$ /kWh (Trinidad and Tobago), 0.65 EC$ /kWh (Barbados) and 1 EC /kWh (Dominica).
3. Let students examine a bulb and point out its main components. Let them touch the bulb prior to and after the activity and note any differences in temperature. Establish that some forms of electrical energy produce heat as a by-product. Let them give examples of other devices that change electrical energy to heat.
4. Ask students to list some electrical devices they have encountered at home and explain the energy transformations associated with these devices.
5. Display a diagram representing the method by which electricity is produced (drilling, generation, transmission, and distribution) and ask students to discuss the way in which electricity is transported to our homes.
6. Have the students to discuss why, when and where the use of candles and wood ovens are still practices in use in their homes.

LESSON 2. ELECTRICAL CIRCUITS

2.1. General objectives

-Develop an understanding of how electricity flows in a circuit.
-Identify the sources of electricity as well as the energy transformations that are associated with electricity flowing through a circuit.

2.2. Specific objectives

-Distinguish between conducting and insulating materials.
-Set up simple electrical circuits.
-Identify each component of a simple electrical circuit.
-Understand and be able to explain the function of each component of an electrical circuit.
-Describe the energy transformations that take place in specific electrical circuits.

2.3. Process skills

Observation, communication, manipulation, inference, drawing, and problem-solving.

2.4. Content summary

-The path taken by an electric current is called a circuit. In a circuit there must be a source of electricity, connecting wires, and an electrical appliance that can use the current.
-A dry cell (what we commonly call a battery) is a source of electricity. It contains chemical energy, which it changes to electrical energy.
-The connecting wires provide a path through which the current passes.
-A bulb changes the electrical energy to light and heat energy.
-The current will flow only when all these parts are correctly connected, or in other words, when the circuit is closed.
-Some materials allow electrical current to pass through easily while others do not. Materials which allow electrical current to travel through them easily are called conductors. Those which do not are called non-conductors or insulators.
-Metals are good conductors of electricity. Copper is a common metal used to make electrical wires.
-Insulators are important because they can help prevent electrical shock. Insulating materials are used to cover conducting materials i.e. those through which electricity passes. Plastic and rubber are two common insulators.

2.5 Materials you will need

-A pre-constructed circuit with bulbs, cells, connecting wires, and a testing gap; bits of materials such as insulated wire, paper, strips of aluminium foil, iron nails, strips of plastic, strips of rubber, match sticks, etc.
-A pair of scissors
-Pliers

2.6. Activities

1. All the time safety precautions in using electrical appliances
2. Encourage students to construct a simple circuit using connecting wires, a dry cell, and a bulb.
Ask them to explain how the components of the circuit work together to produce light. Pay particular attention to the filament. Establish that the bulb changes the electrical energy to light. As electricity travels through the filament, it causes the filament to glow. This is how the bulb's light is produced. Ask students to identify other devices which convert electrical energy to light.
3. Replace the bulb in the circuit with a small electrical motor. Ask students to identify the energy transformation that occurs i.e. movement-kinetic energy and sound energy. tt
Let them give examples of other common devices that change electricity to movement and/or sound.
4. Let students examine and account for the structure of a piece of insulated electrical wire. This may be done as a group activity. Use the following questions as prompts:
- What is the wire made of?
- Why is there a metal wire inside?
- Why is there plastic around the metal wire?

5. In groups, have students conduct an experiment using the circuit with a testing gap. Ask them to test the conductivity of the outer covering of the piece of insulated wire, and then the inner wire. Repeat this procedure using the other bits of materials in the collection. Let students complete the following table on a prepared work sheet.

Material	Conductor
Plastic	
A metal paperclip	
Paper	
A metal coin	

6. Discuss the results of the activity, making sure to establish the functional importance of the rubber or plastic covering of insulated electrical wires.

7. As a homework activity, ask students to find out what materials are used to make plugs, switches, electric iron handles, etc., and why these particular materials are chosen.

LESSON 3. ELECTRIC POWER.

3.1. General objectives

-Develop a working knowledge of electrical power, with specific attention to a definition.
-Learn how to read an electricity meter.

3.2. Specific objectives

-Identify the different units of measurement associated with electrical power.
-Distinguish between power and energy.
-Learn how to identify the power ratings of electrical appliances by reading their labels.
-Learn how to read an electricity meter and quote how much electricity was consumed.
-Explain how the total on an electricity bill is calculated.

3.3. Process skills

Observation, communication, and calculation.

3.4. Content summary

-Power is defined as the rate of doing work or the rate of converting energy from one form to another.

-The SI unit for power is the watt (W), which is equal to one joule per second (J/s).

-The rate at which electrical energy is converted into another form of energy is called electrical power.

-Electricity passes through an electricity meter before entering the consumer unit. The meter records the amount of electrical energy passing through it. Digital displays on the meter show the number of units of electricity used.

-A kilowatt-hour (kWh) is equal to an hour's worth of work done by the energy contained in 1000 watts.

-The amount of electricity used and its cost is calculated using the following equations:

Electrical energy consumed (kWh) = Power (kW) X Time (h)

Cost of electrical energy = Electrical energy used (kWh) X Cost per unit

-Keeping a record of monthly kWh consumption is a good way to establish an electricity saving plan.

3.5. Materials you will need

-Pictures of electricity meters with different readings

3.6. Activities

1. As homework activity, ask students to determine and note the power ratings of different electrical appliances in their homes. In class, compare the figures and explain why devices have power ratings.
2. Ask the students to work in pairs. Distribute images showing electricity meters with different readings at different times. Ask each pair of students to calculate an electricity bill total based on the meter readings using the current national per unit cost of electricity.
3. Distribute worksheets and ask students to read the electricity meter at their homes once a week for a period of one month. Compare the results. You can have the students repeat the exercise with the school's electricity meter.
4. Conduct a field trip to a power plant.

Module 3.

Non-renewable - Energy Sources

LESSON 1.

DEFINITION OF NON - RENEWABLE ENERGY SOURCES

1.1. General objectives

-Distinguish between renewable and non-renewable energy sources.
-Develop an awareness of the environmental consequences of using fossil fuels.
-Demonstrate an appreciation for the use of alternative energy sources in the Caribbean.

1.2. Specific objectives

-Differentiate between renewable and non-renewable resources.
-List some examples of fossil fuels.
-List some of the environmental consequences of using fossil fuels as energy sources and, specifically, of using uranium in electricity generation and transportation.
-Identify alternative sources of energy and their viability in the Caribbean region.

1.3. Process skills

Observation, investigation, and discussion.

1.4. Content summary

-Energy sources have been classified into two groups: non-renewable and renewable.
-Renewable energy sources can be replenished in a short period of time.
-Non-renewable energy sources cannot be replenished quickly. Fossil fuels, for example, are formed by natural processes over hundreds of millions of years. We use these much faster than they can regenerate.
-The table below shows different types of non-renewable and renewable energy sources.
-Oil, natural gas, and coal are all fossil fuels. A fuel is any substance/material that is burned to produce energy.
-Several kinds of fuels are used in our homes and communities to generate energy. For example, liquefied petroleum gas (LPG) is used in some cookers to produce heat for cooking and baking; kerosene is used in some stoves to produce heat for cooking; gasoline and diesel are used by motor vehicles to provide the energy they need to travel; diesel is used in generators to produce electricity; and charcoal and wood are used in some homes to provide heat for cooking and baking.
-Because fossil formation is not sustainable, when our present supply of fossil fuels has been depleted, human beings will be forced, quite abruptly, into a transition to sustainable energy sources. It is more practical for us to start making that transition now.
-The burning of fossil fuels contributes to various negative environmental effects i.e. air pollution, oil spills, deforestation, acid rain, global warming, etc.
-As a consequence of global warming, Earth may experience unusual climate change, which would be particularly threatening to vulnerable regions like the Caribbean.
-With all the impending environmental threats to the world as we know it, alternatives to fossil fuels are receiving a great deal of attention. Alternative energy is not only renewable, it has fewer environmental consequences.

1.5. Materials you will need

-Learn and Save interactive DVD.

1.6. Activities

1. Ask students to complete the table of renewable and non-renewable sources of energy.
2. Display pictures of pieces of equipment that use the different fuels. Let students identify each piece of equipment, the fuel(s) it uses, and the equipment's function(s).

3. Display pictures of industrial plants and vehicles emitting pollutants into the air. Use the images as stimuli for a discussion on the ill effects (i.e. pollution) associated with the burning of fossil fuels.
4. Lead a discussion about the way in which we can reduce our dependency on fossil fuels.
5. In groups, students should research the interaction between the environment and non-renewable energy sources.
6. Have students use the Learn and Save interactive DVD to organize their ideas regarding the viability of alternative energy sources in the Caribbean.

LESSON 2. DEFINITION OF OIL

2.1. General objectives

-Develop an awareness of the role of fossil fuels in the Caribbean with a focus on prevalence and uses.
-Demonstrate an appropriate appreciation for the specific consequences the Caribbean region could face as a result of unnatural climate change.

2.2. Specific objectives

-Explain why oil is classified as a non-renewable source of energy.
-Explain how fossil fuels are formed.
-Outline the various processes used in the crude oil industry.
-Identify the uses of refined oil products.
-Demonstrate a working knowledge and appropriate appreciation for the environmental consequences of reliance on crude oil products.

2.3. Process skills

Observation, investigation, and discussion.

2.4. Content summary

-Oil was formed from the remains of marine animals and plants that died millions of years ago and were, over many geological ages, covered by layers of sand and silt. The heat and pressure exerted by these layers turned the organic residue into crude oil.
-The crude oil industry performs three industrial processes: drilling, refining, and storing.
-Oil is the world's primary transportation fuel.
-When present in the atmosphere in a naturally-occurring proportion, greenhouse gases act like a blanket around Earth, trapping a layer of heat energy that causes the planet to warm. This phenomenon is called the greenhouse effect and is natural and necessary to support life on Earth. However, the build-up of greenhouse gases in the atmosphere (caused by a high volume of man-made greenhouse gas emissions) can change Earth's climate, having undesirable consequences for our planet's ecosystems as well as for human health and welfare.
-Humans have released large amounts of carbon dioxide and other greenhouse gases into the atmosphere, the majority of these being emitted as a result of burning fossil fuels to produce energy. Other sources are related to deforestation, industrial activity, and certain agricultural practices.
-With the exception of Trinidad and Tobago and to a lesser extent Belize, the Caribbean islands are net importers of crude oil and refined oil products. These are imported largely from extra-regional vendors.
-The Caribbean islands consume approximately 240 000 boepd1, and nearly 95% of this is derived from fossil fuels.
-Trinidad and Tobago is the biggest oil producer in the Caribbean. The biggest local oil vendor is the state-owned Petroleum Company of Trinidad and Tobago (Petrotrin). Other large producers include BP Trinidad and Tobago and BHP Billiton.

2.5. Materials you will need
-Learn and Save interactive DVD

2.6. Activities
1. Ask students to examine this scheme of fossil fuel formation:

PETROLEUM & NATURAL GAS FORMATION

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of silt and sand.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through layers of sand, silt, and rock to reach the rock formations that contain oil and gas deposits.

Source: U.S. Energy Information Administration (Public Domain)

2. Have students create a scheme showing the three processes performed by the crude oil industry. Ask them to list as many oil products (and their uses) as they can.

3. Display pictures of some environmental disasters that resulted from/were contributed to by the production and use of oil products. Assign each student to a group of two and encourage them to engage in a discussion using the images as prompts.

4. In groups, students can research the role of oil in generating electricity in the Caribbean region and, specifically, in your country.

5. Have students view the Learn and Save interactive DVD to find out more about this topic.

LESSON 3. DEFINITION OF COAL

3.1. General objectives
-Demonstrate an awareness of the environmental consequences of producing and burning coal with attention to the specific concerns of the Caribbean region.

3.2. Specific objectives
-Explain why coal is classified as a non-renewable source of energy.
-Understand and explain the processes performed by the coal industry.
-Develop a working knowledge of the composition of coal.

3.3. Process skills
Observation, investigation, and discussion.

3.4. Content summary
-Coal is a combustible black/brown-black sedimentary rock composed primarily of carbon and hydrocarbon.
-Coal is a fossil fuel that is formed in a manner similar to the way oil (a fellow fossil fuel) is formed.
-There are four types of coal: anthracite, bituminous, subbituminous, and lignite.
-Underground mining (also called deep mining) is used to extract coal that is buried several hundred feet below the surface.
-Typically, after the coal is extracted from the ground it is transported via conveyor belt to a preparation plant located at the mining site. The plant cleans and processes the coal to remove non-coal rocks, dirt, ash, sulfur, and other unwanted materials, thereby increasing the heating value of the coal.
- Without proper care, mining has the potential to negatively impact nearby ecosystems, affecting water quality and detrimentally altering landscapes and scenic views.

-Surface mining (e.g. mountaintop removal) can produce debris that has the potential to infiltrate or "choke" mountain streams.
-Underground mining is associated with the harmful drainage of acid contaminated water into surrounding areas.
-Burning coal produces numerous emissions that adversely affect both the environment and human health. The principal emissions produced by the combustion of coal are sulfur dioxide (SO2), nitrogen oxides (NOx), carbon dioxide (CO2), mercury, and other heavy metals derivatives.

3.5. Materials you will need

-Images representing the different types of coal
-Learn and Save interactive DVD

3.6. Activities

1. Ask students to describe coal formation, and then compare it with the process by which oil is formed.
2. Display images representing the different types of coal and have students identify each one, giving some of its properties.
3. In groups, students can research the interaction between the production and prevalent use of coal as a source of energy and the environment.
4. What is the difference of coal and charcoal or coals
5. Have students watch the relevant sections of the Learn and Save DVD to learn more about this topic.

LESSON 4. DEFINITION OF NATURAL GAS

4.1. General objectives

-Develop an awareness of the environmental effects of producing and using natural gas.
-Develop a working knowledge of the role of natural gas as an energy source in the Caribbean.
-Develop an understanding and an appropriate appreciation for the specific environmental concerns of the Caribbean region with regards to the use of natural gas as an energy source.

4.2. Specific objectives

-Explain the processes performed by the natural gas industry.
-Identify the uses of natural gas.
-Explain why natural gas is classified as a non-renewable source of energy.

4.3. Process skills

- Observation, investigation, and discussion.

4.4. Content summary

-Methane is the main component of natural gas.
-Once natural gas is located underground, it is transported to the surface by a well. Thereafter, it flows into large pipe-lines.
-Some by-product gases (that is, those produced along with methane e.g. butane and propane) are separated and cleaned at a gas processing plant.
-Natural gas has many properties that make it an efficient, relatively clean, economical source of energy.
-There are, however, environmental and health issues associated with its production and use. Many of the natural spaces being considered or developed for natural gas production are either untouched or still relatively pristine. Should natural gas production dominate these natural spaces, there could be dire consequences for wildlife and human populations.

4.5. Materials you will need

-Pictures of ecological catastrophes associated with the production and/or use of natural gas
-Learn and Save interactive DVD

4.6. Activities

1. Have students create a scheme showing the different processes involved in industrial natural gas production.

2. Display pictures of ecological catastrophes that occurred as a result of the production and/or use of natural gas. Encourage students to discuss the topics in groups of two, using the images as prompts.
3. In groups, students can research the prevalence and impacts of natural gas production and use in the Caribbean region, and then, specifically, in your home country.
4. Allow students to find out more about this topic using the Learn and Save DVD.

LESSON 5. DEFINITION OF URANIUM

5.1. General objectives

-Develop a working knowledge of the environmental effects of reliance on nuclear energy.
-Develop an awareness of the use of nuclear energy around the world and its viability in the Caribbean.

5.2. Specific objectives

-Explain how fission and fusion allow us to extract the energy contained in uranium atoms.
-Explain how a nuclear plant works.
-Identify the uses of nuclear energy.
-Explain why uranium is classified as a non-renewable source of energy.

5.3. Process skills

Observation, investigation, and discussion.

5.4. Content summary

- Energy is stored in the nucleus of atoms. It can be released through two processes: nuclear fusion (that is, combining or fusing two or more atoms to form a larger atom) and nuclear fission (that is, splitting atoms apart).
- Nuclear energy is created when uranium atoms are split in a process called fission. Fission is used by power plants to generate heat for producing steam. The thermal energy contained in the steam is used to power an electricity generating turbine.
- Unlike power plants that rely on fossil-fuel, nuclear reactors do not produce air pollution or greenhouse gas emissions while operating. However, necessary processes like mining and refining uranium and making reactor fuel consume large amounts of energy.
- The main environmental concerns associated with nuclear power are related to the damage that can be caused by improperly handled radioactive waste (i.e. uranium mill tailings, spent/used reactor fuel, etc.) These materials can remain radioactive and therefore dangerous to human health for thousands of years.
- Even though the risk is very low, one instance of an uncontrolled nuclear reaction in a nuclear reactor has the potential to result in the radioactive contamination of air and water for hundreds of miles around the reactor.

5.5. Materials you will need

- Learn and Save interactive DVD

5.6. Activities

1. Ask students to create an annotated visual representation (chart/diagram) of nuclear fusion and fission.
2. Have students draw a scheme to depict the way a nuclear plant works.
3. Display pictures of environmental catastrophes related to nuclear power. Have students discuss the topic in pairs, using the images as prompts.
4. In groups, have students research the history of nuclear power, with specific attention to how it was discovered (landmark dates, contributing scientists, etc.) and the pertinent details concerning nuclear disasters in different parts of the world.
5. Allow students to find out more about the topic using the Learn and Save DVD.

Module 4.

RENEWABLE ENERGY SOURCES

LESSON 1. DEFINITION OF SOLAR

1.1. General objectives

-Develop an appreciation for the environmental effects of using of solar energy.
-Develop a working knowledge of the advantages and disadvantages of using the sun as an energy source in the Caribbean.

1.2. Specific objectives

-Explain how solar energy can be harnessed and utilized.
-Explain how living organisms use solar energy in natural processes.
-Identify ways in which the sun can be used to produce electrical and heat energy.
-Explain why solar energy is classified as a renewable source of energy.

1.3. Process skills

-Observation, investigation, and discussion.

1.4. Content summary

-Solar energy is the radiant heat and light energy produced by the sun. Along with secondary solar-powered resources such as wind and wave power, this energy accounts for the majority of Earth's renewable energy.
- Solar technologies are characterized as either passive or active depending on the way the energy is captured, converted, and distributed. Active solar techniques use photovoltaic panels (solar panels) and solar thermal collectors (solar water heaters) to harness the energy. Passive techniques include orienting a building to the Sun, selecting materials with thermal mass properties, and using materials with light dispersing properties.

-Although solar energy is a clean, renewable source, it has disadvantages. Unlike the non-renewable energy sources we have studied, these disadvantages are concerned with reliability, not environmentalism. For instance, the amount of sunlight that reaches Earth's surface daily is not consistent. It varies depending on geographical location, time of day, time of year, and weather conditions.

The environmental impacts associated with solar power can include land use and habitat loss, water use, and the use of hazardous materials in manufacturing, though the types of impacts vary greatly depending on the scale of the system and the technology used — photovoltaic (PV) solar cells or concentrating solar thermal plants (CSP).

How solar energy works:

Solar energy is generated during the day by the sun's powerful rays.

Source: www.greenmountain.com/resources/enviro-kids/renewable-energy-101

1. Photovoltaic solar panels, built from silicon, absorb the sun's rays and convert them into energy
2. A control device converts the energy from direct current electricity to alternating current electricity, capable of powering electrical items
3. This electricity is added to the electricity grid which powers local homes and businesses, but also can be stored in batteries for future use

1.5. Materials you will need
- Learn and Save interactive DVD

1.6. Activities
1. Ask students to draw a flow chart to show how energy that starts as heat and light from the sun can be harnessed and used to power a refrigerator in a home. Ensure that students annotate the flow chart to describe the energy changes that take place.
2. If possible, take students to a place where solar panels or heaters are installed. Point out the main components of the devices and explain how they work. After this exercise, have students create an annotated diagram of a solar panel or heater.
3. Divide students into groups and have them compete for a prize rewarding a representation of the most creative solar-powered device.
4. Allow students to watch the Learn and Save DVD to find out more about the topic.

LESSON 2.
DEFINITION OF HYDRO POWER

2.1. General objectives
-Develop a working knowledge of the advantages and disadvantages of hydropower plants for the societies in which they exist.
-Develop a working knowledge of the use of hydropower in the Caribbean.
-Demonstrate familiarity with the issue of the viability of hydropower as an alternative energy source in the Caribbean.

2.2. Specific objectives
- Identify the phases of the water cycle.
- Explain how we can extract energy from moving water.
- Explain how hydroelectric plants work.
- Explain why water is classified as a renewable source of energy.

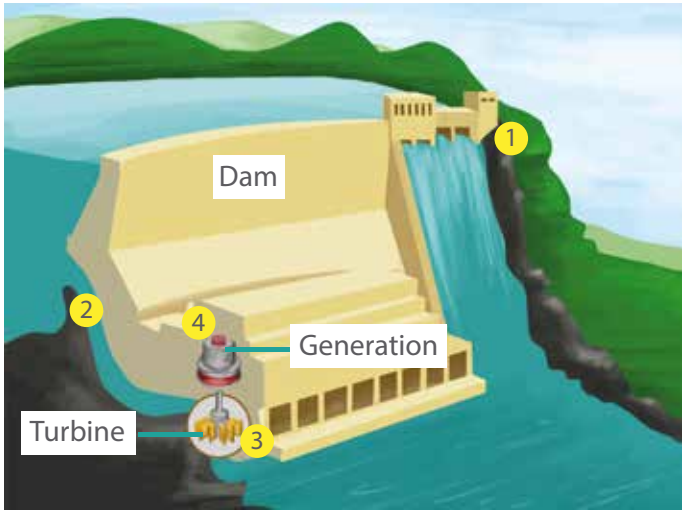
2.3. Process skills
Observation, investigation, and discussion.

2.4. Content summary
- An understanding of hydropower must be preceded by an understanding of the water cycle.
- Hydropower is one of the oldest sources of energy. It was used thousands of years ago to turn a paddle wheel and power important processes like grain production.
- Moving water offers the opportunity to harness mechanical energy.
- The amount of available energy in moving water is determined by the water's rate of flow or fall. The higher the water head and the stronger the river's flow, the more energy is available.
- When hydroelectric energy is produced, water is accumulated in reservoirs created by dams, and then released (i.e. set into motion) as needed. The potential energy contained in the water that was held back by the dam and then released is converted into kinetic energy as the water falls down a penstock, where it turns turbines (using mechanical energy, a type of kinetic energy) to generate electricity.
-Although hydropower (hydroelectric) generators do not themselves emit air pollutants, hydropower dams, reservoirs, and the operation of generators are associated with some negative environmental effects.
-A reservoir and dam can alter natural water temperatures, chemistry, flow characteristics and silt loads, all of which can lead to significant changes in ecological systems (i.e. systems of living organisms and their relationship with the environment) as well as in rock and land formations both up and downstream of the river.
-Greenhouse gases and methane may form in reservoirs and be emitted into the atmosphere.
-Dominica generates 52,9%[1] of its electricity from hydroelectric sources. Suriname, Jamaica, and St. Vincent and the Grenadines also generate hydroelectric power, but on a smaller scale.

1. Source: CIA World Factbook - Information in this page is accurate as of February 21, 2013

How hydro energy works:

Hydro energy is generated using the power of moving water in our Earth's rivers and oceans.



Source: www.greenmountain.com/resources/enviro-kids/renewable-energy-101

1. A dam blocks water from moving where it wants to naturally
2. Instead, the water flows through a pipe to a turbine, then back out on the other side of the dam
3. Turbines spin by force of water and rotate a generator
4. Generator produces electricity and sends to power lines, bringing electricity to homes and businesses.

2.5. Materials you will need

- Water cycle scheme
- Pictures of waterwheels
- Pictures of dams
- Learn and Save interactive DVD

2.6. Activities

1. Have students study the water cycle scheme.
2. Display pictures of waterwheels being used to generate power. Use the images as stimuli for a related discussion. Make sure that students can explain how waterwheels work and describe the energy changes that take place.
3. Display pictures of a dam and ask students to work in pairs to explain the advantages and disadvantages of hydropower.
5. In groups, have students research the use of hydropower in the Caribbean.
6. Allow students to use the Learn and Save DVD to explore this topic further.

LESSON 3. DEFINITION OF TIDES AND WAVES

3.1. General objectives

- Demonstrate an awareness of the environmental effects of tidal and wave power generation.
- Demonstrate a working knowledge of the viability of tides and waves as energy sources around the world, with attention to the specific concerns of the Caribbean region.
- Outline the advantages and disadvantages associated with this source of energy.

3.2. Specific objectives

- Explain why tides and waves are classified as renewable sources of energy.
- Explain how tides and waves are formed.
- Explain how a tidal power plant works.
- Explain how a wave power plant works.

3.3. Process skills

Observation, investigation, and discussion.

3.4. Content summary

- Throughout the Earth's oceans, tides are caused by a combination of the gravitational pull of the moon and the sun and the rotation of the Earth. Along the coast, tides can cause water levels to vary by up to 40 feet.
-A tidal range of at least 10 feet is required to produce tidal energy economically.
- Due to the general consistency of tidal patterns, tidal power is more reliable than both wind and solar energy.

- Most tidal plants are set up so that a dam (known as a barrage) is built across an inlet. Sluice gates on the barrage allow the tidal basin to fill on the incoming high tide and empty through the turbine system on the outgoing tide. Waves are caused by the movement of wind over the surface of the ocean. There is tremendous energy in the ocean's waves.
-One way to harness wave energy is to bend or focus the waves into a narrow channel, increasing their power and size. The waves can then be channeled into a catch basin or used directly to spin turbines.
-Both tidal and wave power are classified as renewable sources of energy.
-Despite their classification, both tidal and wave power are associated with certain disadvantages. A potential disadvantage of tidal power is the effect a tidal station can have on plants and animals in nearby estuaries. Tidal barrages can change the tidal level in the basin and increase turbidity. They can also affect navigation and recreation. Similar circumstances can provoke the spontaneous generation of electricity from waves.
-Using waves to generate power can disrupt marine life, for example, by effecting changes in the types and distribution patterns of species near the shore. Wave power generation may also interfere with mooring and anchorage lines.
-The Caribbean islands do not, at this time, have any tidal power plants and there are only a few sites at which tidal energy could be produced economically.

3.5. Materials you will need

- Scheme of tidal and wave power plants
- Learn and Save interactive DVD

3.6. Activities

1. Have students create annotated diagrams representing tidal and wave power plants.
2. Ask students to explain how each type of power plant works, making sure to describe the energy changes that take place.
3. Dividing students into groups of two, display pictures of a dam and ask each group to explain the advantages and disadvantages of hydropower.
4. In groups, students should research the uses of tidal and wave power around the world.
5. Allow students to use the Learn and Save DVD to find out more about this topic.

LESSON 4. DEFINITION OF WIND

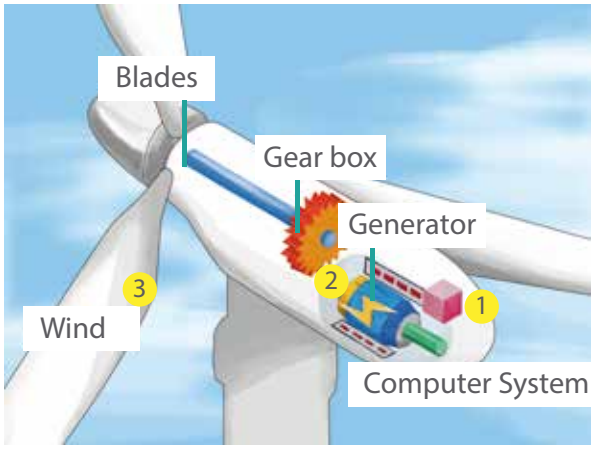
4.1. General objectives

-Demonstrate a working knowledge of the advantages and disadvantages of using wind power.
-Demonstrate an awareness and appreciation for the current use and further potential of wind as a source of energy in the Caribbean region.

4.2. Specific objectives

-Explain how winds are created.
-Explain how we can harness the energy contained in wind.
-Explain how windmills work, making sure to describe the energy changes that take place.
-Explain why wind is classified as a renewable source of energy.
-Explain how wind can be used to generate electricity. Be sure to include the practical aspects associated with building a windmill.

How wind energy works:



Source: www.greenmountain.com /resources/enviro-kids/renewable-energy-101

Wind is a renewable source for energy which can be caught using large wind mills (called turbines) that spin to generate electricity.

1. Computer systems control the direction of turbine blades to match the direction of the wind
2. Wind pushes turbine blades into rotation.
3. Blades turn a generator to convert mechanical energy into electricity
4. Generator sends electricity through transmission lines to the power grid, bringing electricity to homes and businesses

4.3. Process skills

Observation, investigation, and discussion.

4.4. Content summary

- Wind is air that has been set in motion by the uneven heating of the Earth's surface by the sun.
- During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises and heavier, cooler air rushes in to take its place, creating wind. At night, the winds are reversed because the air cools more rapidly over land than over water. Today, wind energy is used mainly to generate electricity.
- For many years now, farmers have been using wind energy to pump water from wells using windmills.
- Wind is a clean source of energy that, when compared with other energy sources, is associated with fewer negative environmental impacts.
- Wind turbines (often called windmills) generally do not (albeit with rare exceptions) emit air or water pollutants or greenhouse gases. In fact, as an alternative means of generating electricity, windmills have the potential to reduce the burning of fossil fuels and therefore reduce the amount of air pollution, carbon dioxide emissions, and water consumption involved in the operation of fossil fuel power plants. That is why windmills are said to have a small ecological footprint relative to the amount of electricity they are capable of producing.
- The islands of the Lesser Antilles are divided into three groups. The two main groups are the Windward Islands in the south and the Leeward Islands in the north. The Windward Islands got their name because, during the exploration of the New World, sailors on arriving ships found them to be more windward than the Leeward Islands, given that the region's prevailing winds, the trade winds blow from east to west. Saint Vincent, for instance, has average winds of 16.77 miles per hour, and Saint Lucia has average winds of about 18 miles per hour. Historically, windmills have been used in the Caribbean since the 1900s. They were fixtures of the sugar industry, for example.

Where the Dutch windmill was the industry standard for over 200 years. Because of the Caribbean's trade winds, windmills were fast, powerful, and sufficiently reliable. At the height of St. Kitts' colonial sugar industry there were over 300 windmills operating on the island.

Late in the 18th Century steam driven mills replaced windmills on most estates in St. Kitts. Therefore, if you were to survey the Kittitian landscape, the typical view will show a stone smokestack as a taller twin to the older windmills.

4.5. Materials you will need

- Pictures of windmills in use
- Umbrellas
- Pictures of a wind farm
- Learn and Save interactive DVD

4.6. Activities

1. Have students explain how winds are formed on the Earth. Ask them to draw a diagram/chart representing the process.
2. Display pictures of windmills in use. Use the

images as stimuli for a discussion. As a component of open discussion, have students explain how windmills work and describe the energy changes that take place.
3. Display pictures of a wind farm and, in groups of two, have students discuss and present on the advantages and disadvantages of this energy source.
4. Have students compare/contrast steam generated by a fossil fuel boiler and wind as energy source
6. In groups, students should research the use of wind energy in the Caribbean.
7. Allow students to use the Learn and Save interactive DVD to find out more about this topic.

LESSON 5. DEFINITION OF GEOTHERMAL

5.1. General objectives

-Demonstrate a working knowledge of the advantages and disadvantages associated with geothermal energy.
-Demonstrate an awareness and appreciation for the use and further potential of geothermal energy as an alternative energy source in the Caribbean.

5.2. Specific objectives

-Explain where geothermal energy comes from and how it can reach earth's surface.
-Explain how geothermal energy can be produced in a power plant
-Explain why geothermal energy is a renewable source of energy.

4.3. Process skills

Observation, investigation, and discussion.

5.4. Content summary

- Geothermal power refers to power from the heat (thermal) of the Earth (geo-). The inside of the Earth consists of the outer core, the mantle, and the crust. The topmost layer of the mantle, just below the Earth's crust, contains molten rocks called magma. Magma is a high temperature (estimated to be in the order of 1000 - 1400 ˚C) and highly viscous fluid. Volcanic eruptions occur when magma breaks through the Earth's crust ("river" of magma) onto the Earth's surface, where it is called lava. Any surface water that trickles into the cracks in the Earth's crust and comes into contact with magma gets heated up and eventually escapes back to the Earth's surface as a hot spring. The temperature of rocks increases as you go deeper into the Earth's core.

- Geothermal energy used to heat homes and generate electricity is produced by digging deep wells, which pump hot water or steam from underground to the Earth's surface.

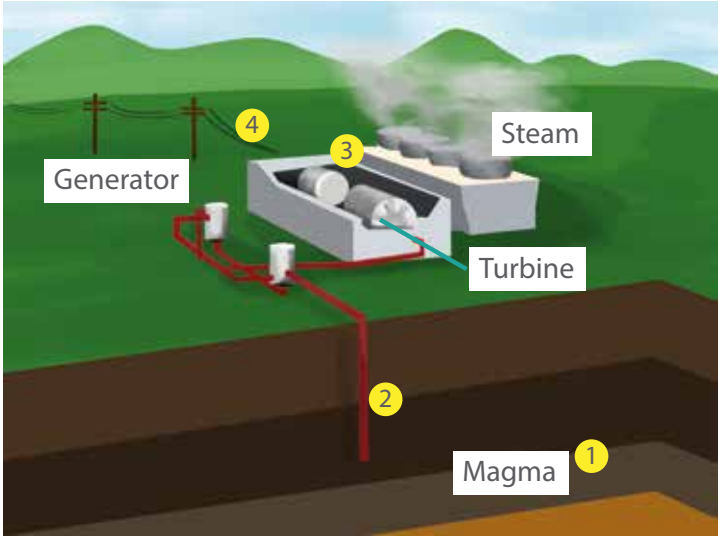
- Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect, because no fuel is needed. Once a geothermal power station has been built, the energy is almost free. A minimal amount of energy may be used to power a pump, but this is so negligible that it can be taken from the energy being generated.

- The Eastern Caribbean Islands that have a solid potential for successfully harnessing a reliable supply of geothermal power are Dominica, Grenada, Saint Lucia, Saint Kitts and Nevis, and Saint Vincent.

- Geothermal energy is one of the most viable alternative energy sources for the Caribbean region and one in which the movement toward more sustainable energy has invested much conviction. Guadeloupe already has a geothermal plant and there are similar projects underway in both Nevis and Dominica.

How does Geothermal Works:

Geothermal energy is created using heat from the Earth's core.



Source: www.greenmountain.com/resources/enviro-kids/renewable-energy-101

1. The Earth's hot core creates magma and heats the Earth's crust which is made up of rocks and water.
2. A well drilled two miles deep into the Earth's surface captures the rising hot water and steam.
3. The hot steam rises to the surface and pushes a turbine, which rotates a generator.
4. Generator produces electricity and sends it to power lines, which bring electricity to homes and businesses.

5.5. Materials you will need

- Scheme of a geothermal plant
- Pictures of a geothermal plant
- Map of the Caribbean
- Learn and Save interactive DVD

5.6. Activities

1. Have students explain how geothermal energy is formed within the Earth.
2. Display a diagram of a geothermal plant and ask students to explain how a plant works and describe the energy changes that take place.
3. Display pictures of a geothermal plant and have pairs of students work together to explain the advantages and disadvantages of geothermal energy.
4. Display a map of the Caribbean and have students identify the volcanic islands.
5. In groups, students should research the role of geothermal energy in the Caribbean's energy scheme.
6. Have students continue their research using the Learn and Save DVD.

LESSON 6. DEFINITION OF BIOMASS

6.1. General objectives

- Explain the advantages and disadvantages of the use of different types of biomass.
- Develop an awareness of the use of biomass in the Caribbean.
- Demonstrate an appreciation for the interaction between the environment and biomass as an energy source in the Caribbean region.

6.2. Specific objectives

- Explain why biomass is classified as a renewable source of energy.
- Explain how plants convert energy from the sun into chemical energy during photosynthesis.

- Give examples of biomass and state their use(s).
- Explain how we get energy from different types of biomass.

6.3. Process skills

Observation, investigation, and discussion.

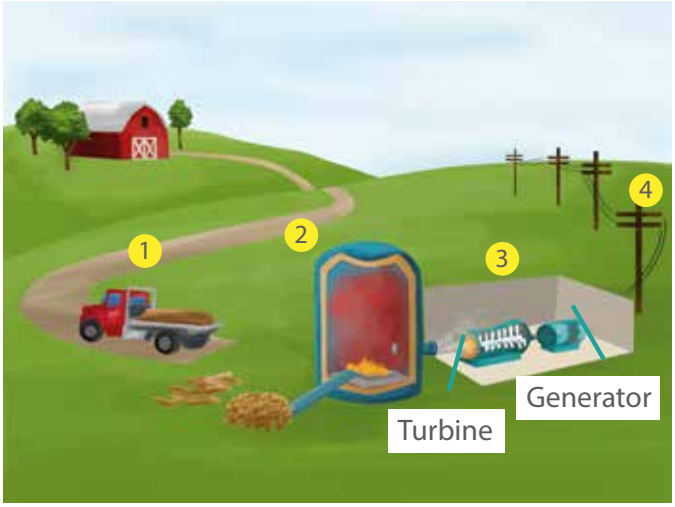
6.4. Content summary

-Biomass refers to all organic substances formed during plant photosynthesis, which decompose to carbon dioxide and water within a certain number of years. These substances may be in the form of straw, wood, manure, or other biodegradable waste.
- Some examples of biomass fuels are wood, crops, manure, and some common garbage items.

- When burned, the chemical energy in biomass is released as heat. Wood waste or garbage can be burned to produce steam for making electricity, or to provide heat to industrial buildings and homes. Biomass can be converted to other usable forms of energy, such as methane gas or biogas – from rotting garbage, and agricultural and human waste – or transportation fuels, such as ethanol and biodiesel. Biogas, just like natural gas consists mainly of methane, which is the gas that gives both gases their burning strength. Raw biogas, however, has much lower strength than natural gas because its methane content is lower than that of natural gas. Natural gas has between 90 to 99 % methane content where most raw biogas will have about 60 to 80% methane. Therefore, after undergoing some purification, biogas can be used just the same way we use natural gas to produce heating and cooking at homes and offices.
- Biomass is classified as a renewable energy source because trees and crops can be regrown, and waste will continue to be produced.
- Relying on biomass as an energy source has both a positive and a negative impact on the environment. For example, burning biomass may result in more or less air pollution depending on the type of biomass and the types of fuels or energy sources that it replaces.
- Growing plants specifically for use as biofuels is controversial because the land, fertilizers, and energy used to grow biofuel crops must be redirected – away from resources necessary to grow food crops. Also, in some parts of the world, large areas of natural vegetation and forest have been uprooted to make space for the biofuel crops like sugar cane (used to make ethanol) and soybeans and palm-oil trees (used to make biodiesel).
- In most developing countries wood and charcoal are the predominant source of energy for cooking food and for keeping warm, thus to maintain the quality of life that encompasses the majority of citizens.
- Biomass energy is used in some parts of the Caribbean to produce cooking gas; however, the smaller Caribbean islands do not produce enough waste to make biomass energy generation an economical national endeavor.

Plant Waste:

Leftover wood and crop waste from factories and farms can be burned to produce electricity.

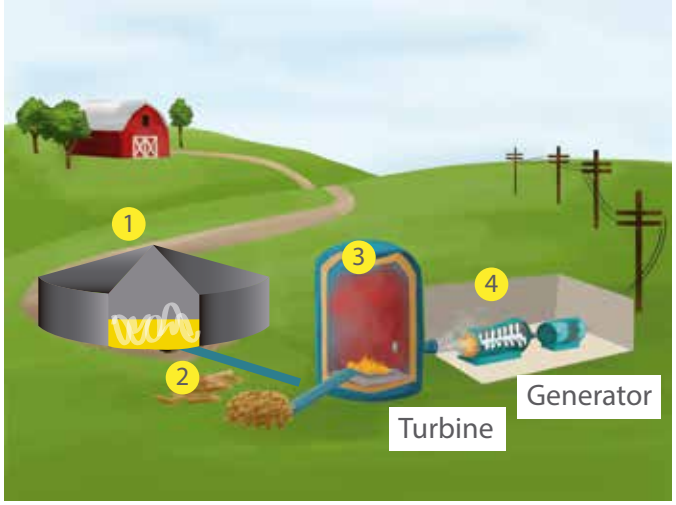


Source: www.greenmountain.com/resources/enviro-kids/renewable-energy-101

1. Wood scraps, sawdust and crop waste are collected from farms or manufacturing plants
2. The waste is burned to heat water and create steam
3. Steam is sent to a turbine, which spins to power a generator.
4. Generator creates electricity and sends to transmission lines.

Biogas:

Waste produced by cows or other farm animals creates a gas called methane, which can be captured to produce electricity.



Source: www.greenmountain.com/resources/enviro-kids/renewable-energy-101

1. Animal waste is collected in a large tank or pond with bacteria
2. As bacteria decomposes the waste, methane is released
3. Methane is then burned to heat water and generate steam.
4. Steam turns a generator turbine to create electricity, which is sent to transmission lines

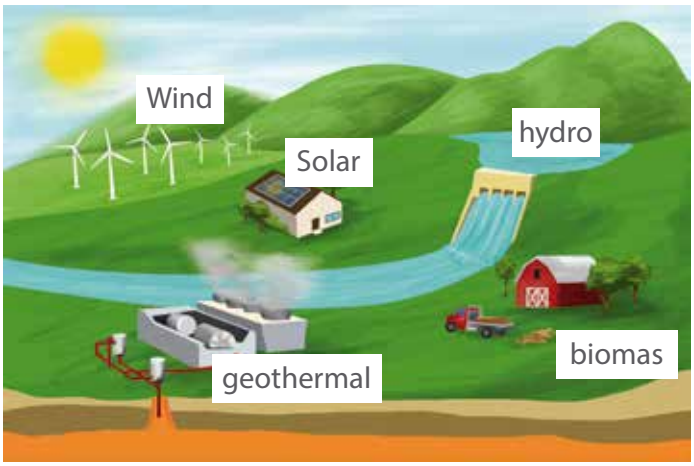
6.5. Materials you will need

- Scheme of plant photosynthesis
- Pictures of different types of biomass being used to produce energy
- Learn and Save interactive DVD

6.6. Activities

1. Have students complete the plant photosynthesis schemes.
2. Have students complete a table exploring the different types of biomass. Ensure that names of the different types of biomass as well as a representational drawing are included.
3. Display pictures of different types of biomass being used in different contexts and lead pairs of students in a discussion about how each type and its use interacts with the environment.
4. In groups, students should research the use of biomass energy in the Caribbean.
5. Allow students to use the Learn and Save DVD to research the topic further.

Renewable Energy sources:



Source: www.greenmountain.com/resources/enviro-kids/renewable-energy-101

Module 5.

Uses of Energy and Energy Efficiency and Conservation

LESSON 1. USES OF ENERGY

1.1. General objectives

- Identify the different uses of energy specific to the industrial, commercial, domestic, and transportation sectors.
- Demonstrate a working knowledge of the effects of specific energy sources in each sector.

1.2. Specific objectives

- State ways in which energy-powered devices have improved the quality of our lives.
- Suggest some difficulties we may encounter if we did not have the use of some of these devices.
- Compare new technological developments with those of the past.
-Infer that people keep inventing new things in order to improve upon past inventions and ultimately, to improve the quality our lives.

1.3. Process skills

Observation, communication, discussion, inference, and comparison.

1.4. Content summary

- Our homes, businesses, industries, and travel and transportation needs consume a high volume of energy. For example, we are comfortable at home because we use energy to provide lighting, to keep our food fresh, and to take a relaxing (perhaps warm) shower.
-Commercial buildings (i.e. offices, hospitals, schools, police stations, places of worship, warehouses, hotels, and shopping malls) use more than half of the total energy they consume to cooling and lighting systems. Electricity and natural gas are the most common energy sources on which they rely.
- In the industrial sector, a variety of energy sources are used to satisfy different needs. One main use is as boiler fuel, which means producing heat that is transferred to the boiler vessel to generate steam or hot water. Another use is as process heating, which is when energy is used directly applied to raise the temperature of products in the manufacturing process, for example, when separating components of crude oil during petroleum refinement, when drying paint during automobile manufacture, and when cooking packaged foods.
- Gasoline is used mainly by cars, motorcycles, and light trucks; diesel fuel is used mainly by heavier trucks, buses, and trains. Today, there are some vehicles that run on electricity, natural gas, propane, and/or ethanol. Hybrid-electric vehicles combine the benefits of gasoline engines and electric motors by reducing the amount of fuel required to move a vehicle.
-Overall, energy-consuming equipment has improved the quality of our lives, and people will continue to invent more items to improve the human experience.

1.5. Materials You Will Need

- Worksheets
-Pictures of industrial sites and commercial centers in your country
- Learn and Save interactive DVD

1.6. Activities

1. Use pictures to stimulate a class discussion about equipment/devices in the home and at school that use electricity. As the first part of the exercise, have students identify the devices. Follow that with having them suggest ways in which each device is useful.
2. Present pictures of equipment/devices that technological developments. Have the students identify a modern device that more efficiently performs the function once performed by the

device in the image. Use the images and the students' responses as stimuli for a discussion about the difficulties we are likely to encounter without the use of modern technological devices.
3. Allow children to compare old and new technological devices (e.g. rotary and touch phones; digital and analog clocks; sail and motor boats). Have students record their findings in a table.
4. Encourage students to talk to an elder (a grandparent, for example) about how some common tasks now performed with the aid of modern technology were done before the advent of the relevant technological device. Have each student write a short paragraph detailing his/her findings. Encourage students to include pictures.
5. Display pictures of industrial sites and commercial centers and ask students to identify the way in which energy is being used in each image.
6. In groups, students should research the source(s) and amount of energy used by different sectors in your home country.
7. Assign students to small groups and have them propose sector-specific energy saving measures.
8. Allow students to learn more about this topic using the Learn and Save Interactive DVD.

LESSON 2. ENERGY EFFICIENCY AND CONSERVATION BASICS

2.1. General objectives

- Emphasize that there is a difference between energy efficiency and energy conservation.
- Demonstrate an appreciation for energy efficiency and conservation.

2.2. Specific objectives

-List some energy efficiency measures.
-Differentiate between energy efficiency and conservation.
-Identify energy efficiency programs implemented by governments.

2.3. Process skills

Observation, communication, and discussion.

2.4. Content summary

-The terms "energy conservation" and "energy efficiency" have distinct definitions. There are many practices we can adopt to use less (conservation) and to use energy more wisely (efficiency).
-An energy efficient measure involves the use of a technological device that requires less energy to perform the same function as another device. A compact fluorescent light bulb is an energy efficient alternative to an incandescent light bulb because it uses less energy, but produces the same amount of light. However, the decision to replace an incandescent light bulb with a compact fluorescent one is an act of energy conservation.
-Energy conservation, then, is any behavior that results in the use of less energy, for example turning the lights off when you leave a room and recycling aluminum cans.

2.5. Materials you will need

-Pictures of incandescent and CFL bulbs
-Learn and Save interactive DVD

2.6. Activities

1. Display a picture of an incandescent bulb and one of a compact fluorescent bulb (CFL). Ask students to explain why installing CFLs is an energy efficient measure.
2. Ask students to come up with ways to use other common devices in an energy efficient manner.
3. Have small groups of students research local governmental energy efficiency programs.
4. Allow students to use the Learn and Save DVD to explore this topic further.

LESSON 3.
SAVING ENERGY IN SCHOOLS AND HOUSEHOLDS

3.1. General objectives

- Demonstrate an appreciation for energy saving strategies.

3.2. Specific objectives

- Identify some energy-saving measures that can be applied at school and at home.
- Outline the energy audit process.
-Explain Energy Management Action Plans (EMAPs).
- Design an EMAP.

3.3. Process skills

- Observation, communication, and discussion.

3.4. Content summary

- Energy Audit can encompass a variety of surveying techniques but most commonly consist of an analysis of energy usage within a building or facility and its contained equipment.

The goal of energy audits is to determine how and where can reduce energy consumption without negatively impacting a building or facility's everyday practices. Audits include comprehensive lists of energy efficiency measures derived from building and facility performance. Energy audits also include financial analysis for each identified measure.

- There are many energy-saving attitudes and behaviors that we can adopt to save energy as we go about our daily lives.

3.5. Materials you will need

- Picture or drawing of a house clearly demarcated into different spaces, each space being shown to contain space-appropriate electrical appliances
- Energy Management Action Plan (EMAP) template.
- Learn and Save interactive DVD

3.6. Activities

1. Have students conduct an energy audit in the school, during which they will identify the measures the school could put in place to save energy.
2. Divide the class into two groups and ask each to write an Energy Management Action Plan for the school. Discuss both proposals in class.
3. Present students with a scheme of a house and have them suggest energy-saving tips that would help conserve electricity.
4. Divide the class into two groups and ask each group to prepare a poster showing energy saving practices for school and home.
5. Encourage students to explore this topic further using the Learn and Save DVD.

Energy Saving Tips:

Energy conservation - Turn off lights every time you leave the room

Energy efficiency - In comparison to incandescent bulbs CFL's use only one-fourth the energy and last up to 10 times longer.

Appendix 1

CARILEC TARIFF SURVEY AMONG MEMBER ELECTRIC UTILITIES - DOMESTIC CONSUMERS

YEARS	Dec-05		Dec-06		Dec-07		Dec-08		Dec-09		Dec-10		Jun-11	
Billing Categories (kWh per month)	100	400	100	400	100	400	100	400	100	400	100	400	100	400
UTILITIES (US$)														
Antigua (APUA)							32,59	129,62	35,70	142,07	38,01	151,29	37,91	150,91
Bahamas (GB Power)			20,98	85,15			26,33	106,57	30,02	121,33	15,41	62,88		
Bahamas (BEC)							32,88	131,52						
Barbados (BL&P)	22,12	86,93			24,19	95,23	17,58	68,76	26,27	103,52	30,96	119,86	38,90	151,63
Dominica (DOMLEC)			37,03	153,22	38,53	177,30	39,59	182,00	34,40	158,92	33,75	156,02		
Grenada (GRENLEC)	27,24	108,95	29,46	117,84	30,87	123,49	23,37	74,86	35,08	136,61	38,91	155,64		
Montserrat (MUL)			18,29	78,95			49,60	204,18	38,18	158,54				
Nevis (NEVLEC)			23,37	80,34					30,62	109,87	33,94	123,12		
St. Kitts Electricity Department							14,98	59,63						
St. Lucia (LUCELEC)	23,38	97,54			30,84	127,42	23,23	106,08	25,62	106,52	24,26	115,79	26,87	129,78
ST. Vincent (VINLEC)			29,00	116,00	31,45	131,34	37,95	157,31	28,68	120,25	30,80	128,72		

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