3RD GRADE CURRICULUM

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Ending project: Testing and Evaluating 3 Solar Ovens

Lesson I: 3rd grade
What is Energy?
- Brainstorming activities to begin discussion
- Discussing 4 forms of energy: mechanical, thermal, electrical, chemical
- Experiments exploring energy conversion (ex. running in place–mechanical energy into thermal energy)

Lesson 2: 3rd Grade
What is Potential Energy?
- Create Energy Matrix Conversion Charts
- Candle burning experiment–discuss potential energy

Lesson 3: 3rd Grade
Embodied Energy & Energy Fuel Sources
- Discuss renewable and non-renewable fuel sources
- Fueling our bodies
- Energy Stories Puzzle Pack exercise: different energy sources (natural gas, electricity, wood, solar)

Lesson 4: 3rd Grade
Radiant Energy
Solar Energy: A Renewable Energy Source
- Discuss the solar system and the sun as an energy source
- Exercises about absorption and reflection
- Introduce solar ovens: a brief history, different styles, where and why are they used

Lesson 5: 3rd Grade
Maria Telkes: Mini-book
- 10 lesson mini history exercise about Maria Telkes and the history of solar cooking

Lesson 6: 3rd Grade
Cooking Internationally with Solar Ovens
3 Solar Oven Projects
- Kenya: building solar ovens with Kenyan communities
- India: a government sponsored program
- Haiti: local volunteers work in Haiti building solar ovens and teaching classes

Lesson 7: 3rd Grade
Solar Ovens
Brainstorming and Evaluating
- Brainstorm criteria for solar ovens
- Introduce 2 or 3 solar ovens (already built) and compare

Lesson 8: 3rd Grade

Solar Oven Experiments

- Measure inside temperature of solar ovens with IR thermometers
- Heat water using solar ovens
- Graph and chart data

Lesson 9: 3rd Grade

Cooking with the Solar Ovens

- Review recipes from India, Kenya, Haiti
- Choose recipes to cook in the solar ovens (beans, rice, bread, stews)

Lesson 10: 3rd Grade

Cooking with the Solar Ovens

- Cook foods in the solar ovens

Lesson I: 3rd grade
What is Energy?

Lesson Overview: All life and action in the world involves some form of energy.
Lesson Concept: Any physical process that takes place in the world involves mechanical energy.

Materials:

- Large white paper for note-taking
- 4 different colors of construction paper or poster board
- Hand bell (to ring)
- Wooden unit blocks or other large blocks to set up as "dominoes"
- Large plastic tub
- Water toys
- Black marker

Standards:

- English:
  - IX.11.EE.1 (Inquiry & Research: Generate questions about important issues that affect them or topics about which they are curious, and use discussion to narrow questions for further exploration).
- Mathematics:
  - III.1.EE.4 (Data Analysis & Statistics: Identify what data are needed to answer a particular question or solve a given problem, and design and implement strategies to obtain, organize and present those data).
- Science:
  - IV.1.EE.4 (Use Scientific Knowledge from the Physical Sciences in Real-World Contexts: Identify forms of energy associated with common phenomena).

Timeline: 1 class period (30 – 50 minutes)

Class Structure: whole class experiments and discussion

Assessment Strategy: EEK! Daily Assessment
Pre-Module Assessment Question #1
General Assessment Strategy #1

Lesson I: 3rd grade
What is Energy?

This lesson is an introduction and exploration of what is energy. This lesson focuses on physical movement–student's moving their bodies and moving objects with their bodies–as one way of beginning to think about energy.

Lesson Overview: All life and action in the world involves some form of energy.
Lesson Concept: Any physical process that takes place in the world involves mechanical energy.

Supplies Needed:

- Large white paper for note-taking
- 4 different colors of construction paper or poster board
- Hand bell (to ring)
- Wooden unit blocks or other large blocks to set up as "dominoes"
- Large plastic tub
- Water toys
- Black marker
- Dynamo flashlight
- Hotplate
- Tea Kettle with functioning whistle

Background Information:

The primary focus is on mechanical energy / our bodies in motion. Often, physical movement is a good starting point for introducing larger–more complex–issues. During this lesson, the focus is for students to realize that 'energy' is an integral part of their life–they cannot live and move without 'energy'.

Mechanical energy can be understood as the moving of any mass through space (air). This basically includes any physical actions that take place in the world. Therefore, using our bodies as examples to demonstrate mechanical energy is a good starting place. But, please do not stress that our bodies are machines. Mechanical does not mean mechanistic. We are much more that machines, even in the world of physics.

CLASS EXERCISES:

I. Brainstorming 'What is Energy?' with the class

Begin the class by asking the question: what do you think energy is?
Write down all the responses on a large piece of paper (we suggest 18 x 24 heavy duty construction paper or poster board) that you can keep posted in the classroom or hang up during the subsequent lessons for reference.

Prompts:

- Does your body use energy? When?
- Where does your energy come from?
- How do plants grow? What do they need in order to grow and be healthy?
- How do animals (other than humans) grow? What do they need in order to grow and be healthy?
- How does your body grow? What do you need in order to grow and be healthy?

II. Forms of Energy

Write the following 4 different forms of energy on 18x24 pieces of construction paper or poster board (use different colors for each form of energy) and place on the board or wall where the class can see them.

4 Forms of Energy:
Mechanical energy
Thermal energy
Chemical energy
Electrical energy

Have the students brainstorm different examples of each form of energy. Write all their answers on white paper and place on the boards.

III. Hands-on experiments

Conduct the following experiments. At this point, we are not introducing energy conversion but just the final form of energy (the end result) in each experiment. Explain that the energy of motion is mechanical energy.

Ask the students what could be happening to make the following experiments occur, encourage short *and* elaborate responses:

After each experiment, have the students brainstorm (and then write down their ideas) which form of energy is represented in each experiment.

4 Forms of Energy:
Mechanical energy
Thermal energy
Chemical energy
Electrical energy

A. Have the students discuss what form of energy is represented in the following experiments:

1. Listening to sounds: sound energy is mechanical energy. The following explanation is a simplification of the process of hearing sound: Sound waves (vibrations) move through the air, reach the ear, then vibrate the inner ear (this is where sound amplification takes place), and we hear sound.
    a. Hands clapping
    b. Feet stomping on the floor
    c. Ringing a bell
2. Turning on the light switch: electrical energy
3. Moving their bodies: mechanical energy
    a. Jumping in place
    b. Waving hands in the air
    c. Dancing
4. Domino effect: mechanical energy

a. Set up a row of large unit blocks and demonstrate chain reaction by pushing them over

5. Move objects with falling water: mechanical energy
    a. Set up a large tub filled with water and toys, pour the water from a variety of directions to move the toys

*Teacher's Note: It is very important to use the scientifically accepted language from the very beginning of introducing a concept. Hence, not saying "sound energy", but instead "sound energy is actually mechanical energy because we are moving air with vibrations–we hear these vibrations as sounds."

IV. Energy Conversions

Now, we take the lesson further by discussing **energy conversions**.

CLASS EXERCISE:

A. Have the students create the following experiments:

1. Rubbing Hands Together–mechanical into thermal
   Rubbing your hands together creates friction. Whenever two 'things' create friction, heat is created.
2. Running in Place–mechanical into thermal
   You run (mechanical) and your body begins to increase in temperature (thermal) and create body heat
3. Dynamo Flashlight–mechanical into electrical
   Pumping your hand on the handle (mechanical) moves gears inside the flashlight (mechanical to mechanical) the gears spark an electrical current (mechanical into electric) and the light turns on as long as you continue to pump the handle.
4. Heating Water on a Hot Plate–electrical into thermal
   The hot plate uses electricity (electrical energy). As the water molecules are excited (mechanical energy) the water becomes hot (thermal energy).
5. Boiling Water in a Kettle–thermal into mechanical
   The boiling water (thermal energy) forces steam (chemical energy) through the whistle on the kettle and produces a sound (mechanical energy).

V. Stating results:

After completing the experiments use large sheets of paper to create a class Energy Conversion Matrix Chart. Below is an example of what one could look like to explain the energy conversions in the above experiments.

Energy Conversion Chart

From → To ↓	**Mechanical energy**	**Thermal energy**	**Chemical energy**	**Electrical energy**
Mechanical energy		Tea kettle whistling		
Thermal energy	Friction: rubbing hands together Running in place			Heating water
Chemical energy		Boil water		
Electrical energy	Dynamo flashlight			

*Teacher's Note: You may want to create symbols with the class that represent each form of energy to use with the words: mechanical, thermal, chemical, and electrical energy.

LESSON WRAP-UP

- Ask students to try and explain energy conversion in their own words. One way to explore this is to ask the students to explain what happened in Class Exercise #1–rubbing your hands together. (We begin with our hands at rest, then put them in motion, and then create heat.)
- One way to explain energy conversion is: "We begin with an action. But, during that action a change takes place and our end result is that we now have something different–something that we didn't begin with."
- Another way to think of the overall concept for yourself is: There is a **potential to create energy and a result of creating energy** (potential energy is discussed later in the module for the students).

Lesson 2: 3rd grade
Potential Energy

Lesson Overview: All 'things' in the world have potential energy.
Lesson Concept: Everything has potential energy but there are many possibilities for how the potential energy is converted into useable energy.

Materials:
- Dynamo flashlight
- 1 Pillar Candle
- Matches
- 1 large glass jar (mayonnaise size)

Standards:
- English:
  - IX.11.EE.1 (Inquiry & Research: Generate questions about important issues that affect them or topics about which they are curious, and use discussion to narrow questions for further exploration).
- Science:
  - I.1.EE.1 (Construct New Scientific and Personal Knowledge: Generate reasonable questions about the world based on observation).

Timeline: 1 class period (45 – 50 minutes)

Class Structure: whole class discussion with teacher led experiment

Assessment Strategy: EEK! Daily Assessment
Pre-Module Assessment Question #2

Lesson 2: 3rd grade
Potential Energy

This lesson introduces the concept of 'potential energy'. This concept builds on the previous understanding of energy and energy conversion. This day will involve more hands-on demonstrations: revisiting experiments from Lessons 1 or 2 and introducing new ones.

Lesson Overview: All 'things' in the world have potential energy.
Lesson Concept: Everything has potential energy but there are many possibilities for how the potential energy is converted into useable energy.

Supplies Needed:
- Dynamo flashlight
- 1 Pillar Candle
- Matches
- 1 large glass jar (mayonnaise size)

Background Information:

Everything in the world has potential energy that can be converted into useable forms of energy. Your body, for example, has potential energy. It can move objects, squeeze flashlight handles, jump in the air. Here is another way to think about potential energy: food has potential energy stored inside of it. We eat the food and are able to run, jump, and think. The sun has potential energy and it can heat objects that absorb its energy.

REVIEW:

I. Dynamo Flashlights

Remember the Dynamo Flashlights? (Demonstrate the Dynamo and pass around the class).

- Discuss how the Dynamo flashlight works and the energy conversions involved in order to create the light. Ask the following questions:
    - What action causes the light to turn on? (Squeezing the handle with your hand causes the light to come on).
    - Do you remember the energy conversion that takes place? (At this point, you could hang up the colored pieces of paper from Lesson 2 that illustrated the sequence of the energy conversion.)
    - Energy conversion sequence: the motion of your hand squeezing the handle back and forth (mechanical energy to mechanical energy) turned gears inside the flashlight (mechanical energy to mechanical energy) that sparked wires (mechanical energy to electrical energy) and caused the light to come on (electrical energy to electrical energy). The mechanical energy was ultimately transformed into electrical energy.
    - Question: In the Dynamo flashlight experiment, what 2 things have potential energy? (your body and the Dynamo flashlight)

CLASS EXERCISE:

After discussing the above ideas about potential energy lead the Candle Burning Experiment. Refer to the Energy Conversion Matrix the class created during Lesson 2.

I. Candle Burning Experiment: this is a teacher-only led experiment

Have the students gather around a table and place the candle on the table.

(Supplies: 1 large pillar candle
Matches
Large glass jar (mayonnaise size))

The Main Concept of this experiment is to demonstrate a potential energy source

- Place the candle on the table
- Play a version of "Simon Says" with the students. Ask the students to take turns around the circle and direct you through the process of lighting the candle. If they miss a step, you will stop, make some sort of funny sound, and the next person has a turn.

Candle Lighting Steps: students take turns directing you (example of possible answer scenario below):

- Pick up the box of matches
- Open the box of matches
- Take a match out of the box
- Strike the match on the box
- Move the match over next to the wick
- Light the wick
- Blow out the match
- Put the extinguished match down in a safe place
- Close the box of matches

Now, the candle is lit. Have the students go through the same process out loud to figure out how the candle is staying lit.

Possible prompt questions for the students below: questions in green and responses in blue

- What happens to the candle as it burns?

The wax melts and forms a puddle at the base of the wick.

- What is the wick doing?

The wick is fueling the flame. The wick wicks up the wax from the melted puddle. The wick, through wicking up the wax, keeps the combustion reaction happening.

- How does the wick stay lit?

The wick stays lit because it is coated in wax.

- What happens if we cover the candle with glass jar?

The flame will die out. It needs the oxygen from the air to keep lit (keep burning, continue the combustion process).

- Why doesn't the entire candle melt instantaneously?

When something burns a combustion reaction occurs. The candle burning is a combustion reaction. Combustion reaction occurs depending on the amount of the fuel source and the amount of available oxygen in the air. The fuel source is the melted wax puddle created at the base of the wick. When we place the glass jar over the flame, we limit how much oxygen is available to "feed the flame". ****TEACHER NOTE: Rate limiting effect of combustion is how much oxygen is available to continue the combustion effect. ****

- What is the potential energy?

The candle is the potential energy.

- What is the fuel source?

The melted wax is the fuel source. And, the wick keeps the fuel source available for use.

- Have the students describe the change in energy (the energy conversion) that takes place during the Candle Burning Experiment. If they seem stumped, refer to the Energy Matrix Chart that has been created during Lessons 1 & Lesson 2.

Energy Conversion for Candle Burning Experiment

Chemical Energy to Thermal Energy:

The motion of your hand striking the match: mechanical energy

The match lighting: chemical energy

The candle burning: chemical energy

The candle creates heat: thermal energy

LESSON WRAP-UP

After finishing the Candle Burning Experiment, have the students re-cap 'what is potential energy' through the following actions. Also, have them map the energy conversions first and then ask what is the energy potential source.

- Jump in the air

Mechanical energy to mechanical energy: legs bend (mechanical energy) and jump into the air, your body pushes through the air around itself (mechanical energy) and then lands on the floor and makes a sound (mechanical energy). Potential energy: your body

- Run in place for 1 minute

Mechanical energy to thermal energy: legs move back and forth (mechanical energy), as your body is moving it begins to heat (thermal energy). Potential energy: your body

Lesson 3: 3rd grade
Embodied Energy and Energy Fuel Sources

Lesson Overview: We use energy resources everyday.
Lesson Concept: There are many different energy sources used to create heat.

Supplies Needed:
- Energy Stories Student Packets
  - Illustrator: Jessica Western & Matt Issacson
- Large white construction paper
- Markers / pencils
- Student hand-outs (or use as teacher overheads)
  - Potential Energy & Energy Conversion Table

Standards:
- Science:
  - II.1.EE.4 (Reflect on the Nature, Adequacy, and Connections Across Scientific Knowledge: Develop an awareness of and sensitivity to the natural world).
  - IV.1.EE.4 (Use Scientific Knowledge from the Physical Sciences in Real-World Contexts: Identify forms of energy associated with common phenomena).
  - V.1.EE.5 (Use Scientific Knowledge from the Earth and Space Sciences in Real-World Contexts: Describe uses of materials taken from the earth).
- Social Studies:
  - II.2.EE.1 (Geographic Perspective: Describe how people use the environment to meet human needs and wants).
  - II.2.EE.2 Geographic Perspective: Describe the ways in which their environment has been changed by people, and the ways their lives are affected by the environment).

Timeline: 1 class period (45 – 50 minutes)

Class Structure: small group project

Assessment Strategy: EEK! Daily Assessment
Pre-Module Assessment Question #3
General Assessment Strategy #1

Lesson 3: 3rd Grade
Embodied Energy and Energy Fuel Sources

In this lesson, students will learn about four main fuel sources.

Lesson Overview: We use energy resources everyday.
Lesson Concept: There are many different energy sources used to create heat.

Supplies Needed:
- Energy Stories Student Packets
  - Illustrator: Jessica Western & Matt Issacson
- Large white construction paper
- Markers / pencils
- Student hand-outs (or use as teacher overheads)
  - Potential Energy & Energy Conversion Table

Background Information:
Potential energy, embodied energy, and different fuel sources will be the primary foci of this lesson. Through using cooking food as our linking example, different cooking methods will be explored as well as the embodied energy (potential energy) in energy sources. This background material on food will be the basis for Lessons 6-10 when we discuss different eating habits/customs around the world and how people throughout the world use different methods to cook food.

The main concepts of this lesson are:
- Introduce the idea that there are many different energy sources used to create heat
- Discuss different energy sources that are used throughout the world–not everyone in the world has a stove fueled by electricity or natural gas (as in the United States)–for cooking
  - Some of these energy sources are renewable and some are non-renewable

    - Renewable energy sources: Infinite supply
    - Non-renewable energy sources: Finite supply

CLASS EXERCISES:
Recall the Candle Burning Experiment and the experiments we did afterward. Now, we have a basic idea of what is embodied energy and how we could identify potential energy. Also, we have compiled a chart of energy conversions over the last (few days, few lessons, etc.). (Have the Energy Conversion Matrix up in a visible place for this lesson). Let's now focus on our bodies.

I. Food and Energy
Lead Questions:
- How does your body get its energy?

- Do you get the same amount of energy from all foods, no matter what food you eat? For example, do you get the same amount of energy–amount and time–from eating a bag of chips and a cheese sandwich?
- Which would you get more energy from? (More = longer and stronger) for example, if you were going to run around the track 10 times, what might you eat if you wanted a long and sustained amount of energy?
- What might you eat if you wanted a short "burst" of energy?
    - A candy bar or a sandwich?

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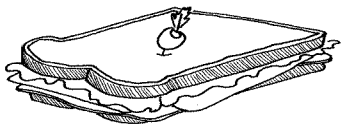

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illustrators: Jessica Western and Matt Isaacson

- A piece of pizza or a bag of chips?

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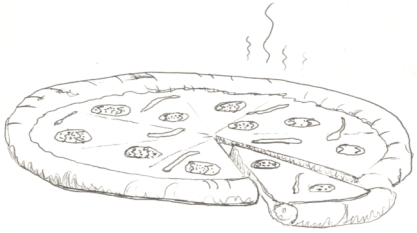

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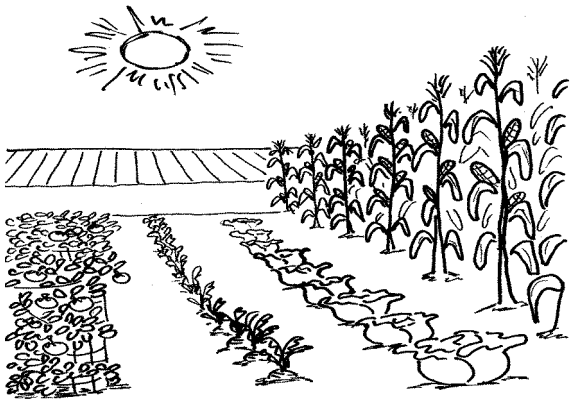
illustrators: Jessica Western and Matt Isaacson

Your body needs fuel to keep it alive and moving and different foods have different amounts of embodied energy in them that your body converts into useable energy through the chemical process of digestion There is a finite amount of stored potential energy within food.

Teacher's Note: In the above examples, we are not discussing strict calorie content. The idea to stress with the students is which food would provide you with a longer sustained amount of energy (i.e. which food should you eat to accomplish the most amount of work over the longest period of time).



II. Cooking Food

Lead Questions:

- How do you cook food at your home? (gas stove, electric stove, microwave oven, toaster oven)
- How might people in other countries cook their food or heat water if they don't have access to electricity? (propane, wood, dung)

III. Energy Stories: diagramming energy sources: a Discovery Lesson

The following exercise is a group lesson (3 – 5 students per group). The students will create picture stories using the following pictures to describe the process of using different energy sources for fuel.

- Hand out the Energy Stories Picture Packs (1 to each group)
- Have the student groups arrange the pictures to create an Energy Story
- Let the students arrange the stories how they think describes the process
- Not all the pieces of the puzzle are given in the picture packs. The students will need to "fill in the gaps" of the story to have it make sense. Make sure they know this when you hand out the picture packs.
- After the students arrange the picture pieces and draw in the missing pieces, have them write a description on the top of each picture to tell the story in words also.

- The class will be working on all 4 examples simultaneously. Use the following 4 examples of fuel methods for the remaining lesson: natural gas, electricity, wood, solar
- Gas Stove cooking: natural gas is the potential energy source
- Electric Stove cooking: there are many options for the potential energy source– water (hydroelectric), coal, natural gas, windmill, oil fired burner, wood burner. Usually, from the electric company, there is a combination of sources being used to supply the electric company grid with power.
- Wood for Fuel cooking: wood is the potential energy source
- Solar cooking: the sun is the potential energy source (they might not suggest this idea, if they don't introduce the idea AFTER going through the diagrams and info for gas, electric, and wood cooking.

- After the class completes their Energy Story Diagrams, have the students share their stories with the rest of the class.
- Then, 'read' the Energy Story Placard Books (this is a book or sheet of paper you have created by gluing the Story Packs in consecutive order) for each energy fuel source and discuss the students' ideas with how energy is actually mined, moved, and converted into useable fuel sources.
- At the end of discussing each energy source, ask the students what is the potential energy source and if they can guess the energy conversion.

Teacher's Note: Detailed support materials are provided for electricity generation (sources and techniques) in the Background Information for this section. But, for this lesson, we chose to illustrate generating electricity through coal-fired plants. Coal is responsible for providing 25% of the world's energy.

LEAD QUESTIONS: Use the following lead questions to help the students along: but it is important for the students to arrange the pictures in the way they think is true with no further outside info---this is a discovery lesson.

Lead Questions: Natural Gas

- Does anyone have a stove that uses a flame?——That flame is natural gas.
- Natural gas is found deep inside the earth and then ends up as the flame in our stoves.
- How do you think natural gas gets out of the earth?
- Can you imagine a way the natural gas is moved from deep inside the earth to out of the earth?
- How might it be moved from one place to another?
- How does the natural gas get to your stove? (hint: you don't buy it with your stove)
- What kinds of equipment do you think might be used to get natural gas out of the earth?
- What kinds of equipment do you think might be used to move natural gas from one place to another?
- Do you think people help?
- If yes, how might people help?

Lead Questions: Electricity

- Does anyone have a stove that has electric coils that heat up? Or a toaster oven? ——–Electricity is making the stove and toaster oven work.
- Coal is a very common way to make electricity in the United States.
- Coal is found deep within the earth.
- What color do you think coal is?
- Do you think coal is heavy, light, hard, soft?

- How might coal be taken from out of the earth?
- How do you think coal is carried from deep inside the earth to out of the earth?
- How is coal moved from one place to another?
- How could coal make electricity? (hint: coal can be burned)
- Where is the electricity stored?
- How does electricity move from one place to another?
- How might electricity reach your stove or toaster oven inside your house?

Lead Questions: Wood

- Has anyone ever made a fire out of wood?
- Has anyone ever cooked food over a fire–on a grill, or over a campfire, or in a fireplace?
- People in many parts of the world use wood to cook their food.
- How might wood be moved from one place to another?
- How long do you think it takes for a tree to grow before it could be considered as "good firewood"?
- If your family depended on wood to cook your food, what would you do if all the trees were cut down near your home?
- What happens when you burn wood? (hint: smoke can get in your eyes)
- How does it feel when smoke gets in your eyes or throat? (Many people become very sick with eye, and lung diseases where wood is used to cook food).

Lead Questions: Solar

- If you lie outside on a sunny day, how does your skin feel?
- What is making your skin hot?
- Have you ever tried to walk barefoot on the sidewalk on a sunny day? What happened?
- Do you think you could cook food with the sun?
- If you were making an oven to cook food with the sun, what would it look like?
- What would you make your oven out of?
- How would the sun heat your oven?
- What kinds of food might you cook in your oven heated by the sun?
- Where would you want to live if you cooked food with a sun oven? (hint: be specific–think of a few countries / states / bioregions or specific times of the year in your home bioregion).

III. Renewable or Non-renewable Sources of Energy

From the above 4 examples, have the class decide which energy sources are renewable (sun) and which are non-renewable (natural gas, electricity from coal, wood). Make large charts to place next to the Energy Matrix Chart:

Renewable	**Non-Renewable**
Solar (the sun)	Natural gas (all fossil fuels)
Wood	Coal fired electric plants*

We are focusing for this lesson on electricity created from coal-fired plants. But, there are multiple ways that electricity is generated. Please see Teacher's Notes if you want to elaborate on this topic.

IV. Introduce International Cooking Study

Ask the following questions to students after completing the Energy Story from section III.

a. Where might people live who use natural gas as their primary source of energy? (United States)
b. Where might people live who use electricity as their primary source of energy? (United States)
c. Where might people live who use wood as their primary source of energy? (Kenya, Haiti)
d. Where might people live who could use the sun as their primary source of energy? (Kenya, Haiti, India)

IV. Embodied Energy and Energy Conversions

Brainstorm the potential energy for each fuel source. I.e. What has the embodied energy that is then turned into useful energy?

LESSON WRAP-UP:

- As a class discussion or small group discussion, ask the students to map (create a chart) the energy conversions of each fuel source from the Energy Story Diagrams.
- Hand out the Potential Energy and Energy Conversion Table for Student for further information. We encourage this information to be given to students after they have created their Energy Story Diagrams.