**Lesson 5: Design Your Own Farm**

**Problem Statement:**

“Dear Diary,

Mom and Dad said that we have to move to the country because we want more space and they want to be someplace quiet. I don’t know where we are planning to move but I know I’m sad that I’m leaving my friends. Mom says I can still chat with them online, and my computer and XBOX will be powered by poop! LOL!!

I’m really wondering how I can power my XBOX with poop. Do I just plug it into a pile of poop? I think living on a farm I’ll have a lot of chores. I wonder what I’ll have to do.

My parents said there will be lots of ways for us to get power for our house. We can use solar panels, wind turbines (whatever those are!) and even something called a “digester” that can break down poop (and some other materials) and use it for power. Wow! We can even use falling water to make power. Mom and Dad says we will be able to get all the power we need without even needing to get electricity from the city. They even said living like this will be better for the environment and we’ll be polluting less. How in the world will we be able to do this?

I’m really excited to learn about how sun, wind, and poop can make power. I also can’t wait to have so many animals! Plus, my parents said I get to actually help design the self-sustaining farm! I guess I’ll give it a try.”

**Learning objectives:** Students will be able to identify different types of renewable energy available on their farm to support desired electricity.

**Lesson standards (NGSS, CCSS, CTE):**

**NGSS**

* 4-ESS3-1 - Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.
* 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
* K-2- ETS1-1 Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

**CCSS:**

* [CCSS.ELA-LITERACY.RI.4.1](http://www.corestandards.org/ELA-Literacy/RI/4/1/) Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
* [CCSS.ELA-LITERACY.RI.4.4](http://www.corestandards.org/ELA-Literacy/RI/4/4/) Determine the meaning of general academic and domain-specific words or phrases in a text relevant to a *grade 4 topic or subject area*.
* [CCSS.ELA-LITERACY.RI.4.7](http://www.corestandards.org/ELA-Literacy/RI/4/7/) Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
* [CCSS.ELA-LITERACY.RI.4.9](http://www.corestandards.org/ELA-Literacy/RI/4/9/) Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably.
* CCSS.ELA-LITERACY.W.4.8 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources.
* CCSS.MATHCONTENT.4.NBT.B.5 Multiply a whole number of up to four digits by a one-digit whole number, and multiply two two-digit numbers, using strategies based on place value and the properties of operations.

**Soft skills:** Communication, collaboration, critical thinking

**Locally and/or personally relevant for students:**

* Personally Relevant: materials used to build a home, knowledge of the standard Western lifestyle
* Locally Relevant: begin to think about different sources of energy; where their own energy may come from; generating interest and knowledge for future job opportunities

**Connections to career and educational pathways:**

* Idea: Invite a local architect to meet with the class to share design considerations.
* Students are engaging in the engineering and design processes by developing solutions to a problem and testing the theory to refine their designs.
* Students will gain an interest in STEM fields by designing sustainable homes and learning about the benefits of renewable energy versus the way we use energy in our traditional homes.

**Materials:**

* Document camera or way to display documents
* Copy of “What We Need and Want to Power in Our Farmhouse” (1 for each group)
* Copies of map with land layout (1 for each groups, plus extra in case a group needs to start over)
* Copies of “Design Requirements” (2 for each group to share)
* “Consensus Chart” from Lesson 1 (What do we want to power in our home?)

**Lesson preparation:**

**Time required:** 90 minutes (or two 45-minute sessions)

**Grouping of students for instruction:**

Students should be in their groups that they have been working with throughout the unit.

**What is the instruction? Consider the PBL Procedure that is being addressed here:**

**Explore and Solve the Problem**

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| **Teacher** | **Student** |
| 1. Remind students that in their last session, they shared with their team the type of energy that they had become an “expert” on. Tell them that in our first lesson, they drew their own sketch of a farmhouse and what inside would need electricity. Today, they will be coming up with one design as a group and decide which type of energy sources they will use to power their new home. | 1. Students should be seated with their group they have been working with during this project. |
| 2. Tell students they will make a wish list of desired energy consuming items. (Table included at the end of lesson.) Explain how to fill in the table and that the items already there are required.  It would be a good idea at this point to facilitate a discussion around cooperation, respect, and compromise since different students will have different ideas. Have students discuss in small groups potential problems and solutions. Then have each group share out to the whole class. You can also let them know that this is a rough draft and they will be able to go back and make changes in the future.  The teacher should walk around and listen in on conversations and offer ideas and suggestions as needed.  After enough time for discussion has been given, have groups share their ideas.  Give each team a paper with the table and have them get started. Give teams about 10-15 minutes to complete this part. Walk around look for teams who may need assistance. Hang the “Consensus List” from Lesson 1 for the students to reference.  \*Possible Breakpoint if you want to divide the lesson over 2 shorter time periods.\* | 2. Students can ask clarifying questions about how to fill out the table if needed.  Students will talk with their teams about potential issues or disagreements that may arise and possible solutions or compromises. Students will talk about how to respectfully disagree with one another.  Students will work together in their groups to determine what they will power in their home, the frequency for each item, and if that item is a need or a want on the table provided.  Each group will offer ideas and suggestions on how to work together successfully.  Students will work cooperatively to create their table. |
| 3. Show students the map/drawing of farm land area (provided at the end of lesson). Explain the physical features of the land, the scale, and the key. | 3. Allow students to ask questions for clarification as needed. |
| 4. Ask to students to get their Energy Notes grid from Lesson 3 to refer to during this part. Tell students that they will decide which types of energy they are going to use to provide electricity to their farmhouse. Encourage students to discuss and question each other about the type of renewable energy or energies they are choosing and the physical location they will put them on their map. Remind students that they also will need to draw a “bird’s eye (from the top) view” of the footprint of their farmhouse. Tell students that energy sources will have requirements/limitations. Pass out and explain “Design Requirements” handout (included at the end of this lesson).  Teacher should walk around and monitor groups’ progress. Remind students to keep in mind their list of everything they wish to power in their home. You may want to ask questions such as:   * Do you think that will provide enough energy? * Which types of renewable energy are including? What made your team choose that? | 4. Students will get out their Energy Notes grid from Lesson 3.  Students will work in their teams to create their farm design. |
| 5. Ask the students “How much energy do you think your farm house is consuming in one day?” Give them this frame for reference: The average refrigerator uses about 200 watts per hour. Ask, “How many watts is that per day?”  Teacher should walk around and monitor groups’ progress. If needed, ask questions that will help students with their estimates like:   * How many hours per day did you decide you were going to run this item? * Do you think this would take more or less electricity to run than a refrigerator? | 5. Students will come up with an estimate of how many watts they think it will take to power their house.  Students should work together to solve the watts a refrigerator will use in 1 day. Then, estimate how much the other household items will take and add to get a total estimate. |
| 6. Have students store their work in their team folder. Tell them that next time, they will talk about how they can find out if they will have enough energy to power their new home! | 6. Students should collect their things and place them in the team folder. |

**Accommodations:** For students that may find the calculations difficult, have them work with a partner.

**Assessment:**

Formative Assessments: each group’s farm design, informal observations

**References/Resources:**

Average solar panel wattage per day: <https://solarpowerrocks.com/solar-basics/how-much-electricity-does-a-solar-panel-produce/>

Average refrigerator wattage:

Square footage needed for a cow:

<https://www.bookstore.ksre.ksu.edu/pubs/MF2316.pdf>

Info on anaerobic digesters:

<https://www.epa.gov/sites/production/files/2014-12/documents/recovering_value_from_waste.pdf>

Land space needed for a geothermal heat pump:

<http://www.accutempcomfort.com/blog/geothermal-service/how-much-space-do-i-need-for-geothermal-installation/>

Creek powered hydro set up:

<http://www.backwoodshome.com/a-small-creek-provides-plenty-of-power-for-this-off-grid-home/>

Wind Turbines:

<http://www.fiddlersgreen.net/models/Miscellanous/Wind-Turbine.html>

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