GROWING GREEN

Student Guide

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Challenge Rationale

Agriculture consumes large amounts of energy in the production of our food. Farms consume energy both directly through the use of diesel, electricity, propane, natural gas and renewable fuels as well as indirectly through the use of fuel in the production of fertilizers, pesticides and feedstock. In this challenge, students will learn about energy in various forms and design as well as build and share a solution that diversifies energy consumption.

Establishing The Challenge

The Challenge

A well-established, diversified energy system can provide benefits to society. Investment in diversifying our energy portfolio can reduce emissions and insulate against price shocks from overreliance on one form of energy. About 90% of American energy consumption is from nonrenewable sources— primarily distillate fuels and coal. Renewable energy comprises a fraction of the American energy portfolio — approximately 10% of total energy consumption.[1]

Energy is needed to produce the food we eat and transport it to consumers here at home and around the world. The most recent data from the USDA shows that the agricultural sector consumed "1,714 trillion British Thermal Units (BTU) of energy in 2014."[2] Renewable energy can help farmers become more self-sufficient, diversify income and promote practices that can benefit the environment. While agriculture consumes energy in a multitude of ways, there is also an opportunity to utilize renewable energy to meet the needs of the industry.

[1] U.S. Energy Information Administration. (2018, July 13). Renewable energy explained. Retrieved from https://www.eia.gov/energyexplained/renewable-sources/

[2] United States Department of Agriculture, Economic Research Service. (2017, February 6). Energy production and consumption in agriculture. Retrieved from https://www.ers.usda.gov/amber-waves/2017/january-february/energy-consumption-and-production-in-agriculture

Establishing The Challenge

Challenge Question

How can we improve or diversify the way agriculture generates or consumes energy?

THIS SOLUTION MUST ADDRESS THE FOLLOWING NEEDS:

- Production as well as economic, environmental and societal needs
- Trade-offs of using the different energy sources

SUCCESS WILL BE DETERMINED BY:

- Production of a model solution that uses a renewable energy source in an agricultural application to diversify energy consumption and demonstrates innovation
- Producing and sharing a presentation that communicates knowledge gained

STEP ONE

1 | IDENTIFY

Purpose of Step

Define the need and how it affects life globally, nationally, and locally. Research and consider how others have approached solving the need including how people have addressed this need historically. Describe why this challenge needs a solution and determine constraints (e.g., time, space, resources, etc.).

Student Prompts and Guiding Questions:

- What is energy?
- What are the different sources of energy?
- What are the trade-offs of using each type of energy?
- How do renewable and nonrenewable sources of energy affect the environment and climate?
- Why should we care about where we get our energy?
- How do we use energy in our daily lives? In food production?
- Compare and contrast energy generated from nonrenewable sources to energy generated from renewable sources.
- How does the agriculture industry consume energy?
- How does the agriculture industry produce energy?
- In what areas of production do farms use the most energy?
- What forms of renewable energy could be used on farms?

Signs of Step Completion

Students will present a description to the facilitator. The description should include how this challenge affects communities globally, nationally, and locally as well as past efforts to solve it and relevant constraints (e.g., time, space, resources, etc.).

Important discoveries during this step:

- Define the problem as it relates to you locally
- Plans for the next step
  (e.g., knowledge to gain, questions to answer, preparations to make, etc.)

STEP ONE: REFLECTION

1 | IDENTIFY

Important Discoveries During this Step:

Define the Problem as it Relates to You Locally:

Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):

STEP TWO

2 | IMAGINE

Purpose of Step

Brainstorm solutions to the challenge. List all of your ideas – don't hold back! Discuss and select the best possible solutions.

Student Prompts and Guiding Questions:

- How do farms consume energy?
- In what areas of production do farms use the most energy?
- What forms of renewable energy could be used on farms?
- How is renewable energy used in agriculture?
- What current solutions are being used to conserve energy? To reduce greenhouse gases?
- What are engineers doing to improve our energy sources?

Signs of Step Completion

Present a list of possible solutions to the identified challenge to the facilitator.

STEP TWO: REFLECTION

2 | IMAGINE

Important Discoveries During this Step:

List Your Possible Solutions:

Identify the Solution that You Think will be Achievable:

Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):

STEP THREE

3 | DESIGN

Purpose of Step

Develop a possible solution and identify the materials needed to provide evidence for why the solution is creative, unique, and sustainable. Write out the steps to take and describe the expected outcomes.

Student Prompts and Guiding Questions:

- What form of energy will be used and why?
- How will you demonstrate energy conservation?
- What materials are needed?
- What environmental factors should be considered?
- How do material costs and other creative constraints factor in?
- Justify your particular design choice.

Signs of Step Completion

Present a detailed description of the solution as well as a written plan of how it could be carried out. Include the following in the plan: a materials list with budget (if building a physical model or conducting lab research), detailed directions, and expected outcomes.

STEP THREE: REFLECTION

3 | DESIGN

Important Discoveries During this Step:

Justify Your Model Design and the Materials You will Need:

Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):

STEP FOUR

4 | CREATE

Purpose of Step

Follow the design plan and construct the solution.

Student Prompts and Guiding Questions:

- Use all research, knowledge gained, and the design plan to create the solution.
- Repeat any of the previous steps should issues arise during the building process.
- Consider the parameters of the challenge and what needs to be accomplished for a successful challenge.

Signs of Step Completion

You will construct the solution and share with the facilitator.

STEP FOUR: REFLECTION

4 | CREATE

Important Discoveries During this Step:

Describe any Barriers You Overcame in Creating Your Model:

Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):

STEP FIVE

5 | TEST & IMPROVE

Purpose of Step

Test the design and collect qualitative and quantitative data. Discuss results and compare with the expected outcome. Seek areas of improvement and make changes where needed.

Student Prompts and Guiding Questions:

- What will need to be observed (i.e., qualitative data)?
- What information can be put into a chart or graph (i.e., quantitative data)?
- Create data tables, graphs, or photographs showcasing data, etc.
- How will you demonstrate the benefits of your possible solution?
- How will you evaluate the trade-offs of your chosen energy source?

Signs of Step Completion

The students will keep records of all test trials and share data with the facilitator. Entries should include both qualitative and quantitative data. The students will also share recordings of any improvements made to the solution and the effect they had on the outcome.

STEP FIVE: REFLECTION

5 | TEST & IMPROVE

Important Discoveries During this Step:

Impacts to the Global, National, and Local Community:

Plans for the Next Step (E.G. Knowledge to Gain, Questions to Answer, Preparations to Make, Etc.):

STEP SIX
6 | SHARE

Purpose of Step

Communicate what was learned throughout the challenge. Share the design process, data, and conclusions on how the solution answers the challenge question.

Student Prompts and Guiding Questions:

- Develop a presentation including knowledge gained, design plans, and materials used to develop a potential solution that is creative and sustainable.
- How is your solution an appropriate, innovative solution that realistically responds to the precise design competition problem?
- How does your solution address budgetary constraints, timeline issues, and other potential challenges?
- How successful was your solution in addressing the elements of the challenge?
- Describe and/or demonstrate what you learned from this challenge.

Signs of Step Completion

Present what was learned through the design process, including sharing how the solution addresses the problem, key aspects of design, data from test trials, and end results.

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