Growing Green

student guide

Purple Plow

Uncovering STEM Solutions

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

Identify 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.[i]

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."[ii] 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.

Challenge Question (Call to Action)

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

The solution must address the following needs:

- Production as well as economic, environmentaland 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
- Sharing progress and results on social media by tagging @ThePurplePlow

1. Identify

PURPOSE OF STEP

Define the problem and how it is affecting life globally, nationally, and locally. Research and consider how others have approached solving the problem including how people have addressed this problem historically. Describe why this problem needs a solution. 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

Present a description of the challenge to the facilitator. The description should include how this challenge affects communities globally, nationally and locally. The description should also include ways in which others have addressed finding a solution and constraints to be considered (e.g., time, space, resources, etc.).

At the completion of this step, discuss the reflection questions led by the facilitator.

1. Identify reflection

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.):

2: Imagine

PURPOSE OF STEP

Brainstorm solutions to the challenge. List all of your ideas – don't hold back! Discuss the possible solutions. Select the best possible solution from your brainstormed list.

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

Students will present a list of possible solutions to the identified challenge to the facilitator.

At the completion of this step, discuss the reflection questions led by facilitator.

2: Imagine Reflection

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.):

3: Design

PURPOSE OF STEP

Diagram the prototype and identify the materials needed to build your solution. 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

The students will present a detailed diagram of the prototype as well as a written plan of how it will be built. Look for the following in the plan: a materials list with budget (if building a physical model), detailed directions, and expected outcomes.

At the completion of this step, discuss the reflection questions led by the facilitator.

3: Design Reflection

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.):

4: Create

PURPOSE OF STEP

Follow the design plan and build the model or prototype.

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

Share completed design with the facilitator.

At the completion of this step, discuss the reflection questions led by the facilitator.

4: Create Reflection

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.):

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 (qualitative data)?
- What information can be put into a chart or graph (quantitative data)?
- Create data tables, graphs, photographs showcasing data, etc.
- How will you demonstrate conservation of energy?
- How will you evaluate the tradeoffs of your chosen energy source?

SIGNS OF STEP COMPLETION

Keep records of all test trials and share data with the facilitator. The design should include both qualitative and quantitative data. Share recordings and any improvements made to the design prototype and the effect they had on the outcome.

At the completion of this step, discuss the reflection questions led by the facilitator.

5. Test & Improve Reflection

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.):

6: SHARE

PURPOSE OF STEP

Communicate what was learned throughout the challenge. Share the design, data, and conclusions. Present results.

STUDENT PROMPTS AND GUIDING QUESTIONS

- Take pictures of your model.
- Film your energy prototype in action.
- Develop a presentation including knowledge gained, design plans and materials used to create the model, testing completed during challenge and data analysis.

SIGNS OF STEP COMPLETION

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

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REFERENCES

[i]U.S. Energy Information Adiminstration. (2018, July 13). *Renewable energy explained.* Retrieved from https://www.eia.gov/energyexplained/?page=renewable_home

[ii]United States Department of Agriculture, Economic Research Service. (2017, February 6). *Energy production and consumption in agriculture.* Retrieved from https://www.ers.usda.gov/webdocs/charts/82357/janfeb17_infographic_hitaj.png?v=0