Grade Level: 6-12

Essential Skills: 1, 2, 4, 5, 6, 9

NGSS: MS-ETS1-1, MS-ETS1-2, HS-ETS1-1, HS-ETS1-2

CCSS: 6.SL.1, 6.SL.2, 7.SL.1, 7.SL.2, 8.SL.1, 8.SL.2, 9-10.SL.1, 9-10.SL.2, 11-12.SL.1, 11-12.SL.2

Time: 2-3 class periods

Materials:
- Box or cardboard materials
- Copper tape
- LED lights
- hobby motor
- Propeller
- 3V batteries
- Scissors
- *Greenhouse Engineering* PowerPoint
- *Greenhouse Engineering Challenge* worksheet
- Computer

Per Group of Students
- 1 box
- 6 LED lights
- 1 hobby motor
- 1 propeller
- (3) 3V batteries

***Materials Available from Oregon Agriculture in the Classroom.**

AITC Library Resources:
More Lessons:
Hen House Engineering
Aeroponic Engineering and Vertical Farming

Lesson adapted from National Agriculture in the Classroom's Hen House Engineering.

12/22

Lesson to Grow

Greenhouse Engineering Challenge

Description:
Students will use the *Engineering Design Process* to plan and construct a greenhouse prototype for growing microgreens. Students will apply an understanding of plant needs for growth and determine growing options for communities with climatic challenges.

Directions:
Part 1: Oregon Grown Commodities
1. Display the "Grown in Oregon" map. Ask students to make observations about what they notice on the map. The PowerPoint included in this lesson has a copy of the map pictured and the following questions. **(Slide 1)**

2. Ask students the following questions:
   a. Are the commodities spread evenly across the map?
   b. What factors would limit the ability to grow crops in certain places?
   c. What are some ways communities in non-ideal growing climates can grow crops year-round?

Part 2: Introduction to Greenhouses
1. Explain to students that you'll be exploring different indoor growing systems and they will be challenged to engineer a greenhouse prototype.

2. Introduce students to indoor growing methods. **(Slide 2)** Ask students to help define the different growing systems if they are familiar with any of them.
Traditional: the method of growing plants using pots, trays or growing beds and soil.
Aquaponics: a system of aquaculture in which the waste produced by farmed fish or other aquatic animals supply nutrients for plants grown hydroponically, which in turn purify the water.
Hydroponics: the method of cultivating plants using a mineral nutrient solution in a water solvent without the use of soil.
Aeroponics: a technique for growing plants without soil or sunlight in which the roots of the plant are suspended in the air and misted periodically with nutrient-rich water and light is provided by specialized grow lights.

3. Explain to students that each of these systems are often grown in a building or a climate controlled greenhouse.

4. Introduce students to commonly used commercial greenhouse types. **(Slide 3)** Explain to students that there are two different types of systems that are most commonly used.
Gutter Connected: A series of greenhouses connected by gutters with a large shared interior. It is recommended to use this type of greenhouse with a growing area over 10,000 sq. ft. Typically greenhouses are 40' wide.
Free-standing: A stand-alone greenhouse with a quonset, gothic or gable roof. It is recommended to use this type of greenhouse with a growing area less than 10,000 sq. ft.

Typically, the standard length of a greenhouse is based on 9' or 12' increments. The most common lengths are 96' and 144'

Lesson adapted from National Agriculture in the Classroom's Hen House Engineering.

5. Explain to students that farmers have to make decisions on which type of structure to implement and determine the best combination of options to suit their needs. One option they have to consider is roof pitch, introduce students to a few of the most common roof pitches. **(Slide 3)** Ask students why they think roof pitch might be important. Explain that roof pitch affects light transmissions and is really important in climates with snow. The pitch of the roof affects how easily snow or rain falls off of it.

Quonset: widths up to 34' **Gable:** widths up to 60' **Gothic:** widths up to 30'

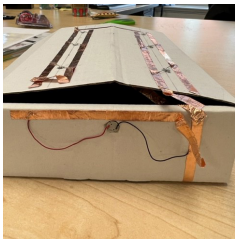
6. Introduce the greenhouse engineering challenge to students. **(Slide 4)** Explain to students that a community member has approached their class to engineer and plan an external greenhouse structure to support the growing of microgreens. Read the specific scenario provided below and on the PowerPoint slide.

Scenario: A community member has asked you to develop a plan and prototype of an external structure to support indoor farming of microgreens with climatic controls to create the optimum growing environment for a region that receives on average 33.8 inches of snowfall in year. The structure will be placed on a piece of land that is flat and has a total area of 5,000 sq. ft. (50'x100').

7. Explain to students that they will need to learn about greenhouse structures and the needs of plants to complete this challenge. Ask students to collaborate with a student next to them to create a list of everything plants need to grow. **(Slide 5)** Provide time for students to share their answers.
https://aggie-horticulture.tamu.edu/ornamental/greenhouse-management/greenhouse-structures/
8. Explain to students the five required needs of plants: air, water, light, nutrients and heat. **(Slide 6)**

Part 3: Greenhouse Engineering Challenge

Stage 1: The Plan



1. Distribute a copy of the *Greenhouse Engineering Challenge* worksheet to students. Review the scenario and key considerations students must address as they plan. **(Slide 7)**

2. Divide students into six groups of students to develop a plan and prototype for the local community member. Instruct students to use the worksheet to help guide their project plans.

3. Instruct students to complete steps 1, 2 and 3 on their worksheet with their group members. Students will need to do additional research to create their plans.

Stage 2: Introduction to Circuits

To engineer the greenhouse, students will need to learn about electrical circuits to add lights and a fan for ventilation. Use the Paper Circuits Activity to introduce circuits to students.

Stage 3: Build a Model

1. Instruct students to review their lighting plans in Step 2 to include the type of circuit they will be using.

2. Then, students should continue to Step 4 to develop their build plan and sketch their prototype. After they have completed Step 4, students should bring their plan to be reviewed by the teacher. Upon approval, provide students with the materials allotted to their group. Each group of students should receive a box, hobby motor, propeller, six LED lights and three 3V batteries.

3. Students should continue to Step 5 and build a prototype of their greenhouse. Then, students should test their greenhouse as described in Step 6. Once all groups have built their model, have each group share their prototype and plan with the rest of the class.

References:

Bartock, Jr., John W. "Selecting and Building a Commercial Greenhouse." UMass Extension Greenhouse Crops and Floriculture Program, 2013, ag.umass.edu/greenhouse-floriculture/fact-sheets/selecting-building-commercial-greenhouse.

Wilkerson, Dr. Don. "Greenhouse Structures." Texas Greenhouse Management Handbook, Texas AgriLife Extension Service, aggie-horticulture.tamu.edu/ornamental/greenhouse-management/.

Smith, Tina, and Paul Lopes. "Types of Greenhosue." Greenhouse BMPS. UMass Extension Greenhouse Crops and Floriculture Program, 2010, ag.umass.edu/sites/ag.umass.edu/files/book/pdf/greenhousebmpfb.pdf.

Activity Page

Greenhouse Design Challenge

Name: _____

Objective:
A community member has asked you to develop a plan and prototype of an external structure to support indoor farming of microgreens with climatic controls to create the optimum growing environment for a region that receives on average 33.8 inches of snowfall in year. The structure will be placed on a piece of land that is flat and has a total area of 5,000 sq. ft. (50'x100').

Step 1

Identify the Problem and Constraints

A technological problem may be solved through the development or improvement of technology.

1. What is the problem?

2. What will solving this problem accomplish?

Criteria	Constraints
Criteria = a set of standards that determines whether a solution is successful or not.	Constraint = limitations on the solution
• Your solution must be able to withstand snowfall • Your solution must include lights and a fan for ventilation. • You solution must fit in an area of 5,000 sq. ft.	You will be provided: • 1 box • 6 LED lights • 1 hobby motor • 1 propeller • (3) 3V batteries

Step 2

Research

Research to determine the best solution for the community member.
Research topics below to help develop your prototype plan.

Type of Greenhouse *Freestanding or Gutter-connected, roof pitch, size, etc.*	**Method of Growing Microgreens** *i.e. aeroponics, aquaponics, hydroponics or traditional soil based*
Lighting *Placement/spacing of lights, how many hours plants need of lights, type of circuit to use, etc.*	**Microgreen Plant Care** *Describe growth, care and harvesting of plants.*

Step 3

Imagine: Brainstorm Possible Solutions

List and describe 3-5 greenhouse prototype ideas. Include information about structure type, the number of structures and growing method.

Step 4

Plan: Select the Best Solution

Evaluate the positive and negative points of each idea from your brainstorm list, consider the criteria and constraints and choose what you think is the best solution. Describe it in detail below and sketch the design.

Step 5

Create: Build a Prototype

Review the plan with your teachers and gather the materials provided for the build. Build the structure and check the box for when it's complete to move onto the next step!

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Step 6

Test and Evaluate

Test your system to ensure it works! Check the lights and fan to ensure your electrical circuit is correct. Check the box after you have tested your prototype!

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Step 7

Improve: Change your design if needed!

After you have tested your greenhouse prototype, evaluate the structure using the questions below.

1. What did not work?

2. What would you change about your greenhouse prototype design?

3. Are there any materials that would help make your design more successful?