Alignment to the PA STEELS Standards

The mySci *Using Our Resources Wisely* unit was designed for the Next Generation Science Standards (NGSS) and throughout the unit there are indications of NGSS Performance Expectations. The unit is also aligned to the Pennsylvania Science, Technology & Engineering, Environmental Literacy and Sustainability (STEELS) Standards[1]. The targeted performance expectations for this unit from both the NGSS and STEELS standards are shown in the tables below.

STEELS Performance Expectations Addressed	
3.3.4.D Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.	3.3.5.D Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

STEELS Performance Expectations Partially Addressed	
3.3.5.E Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.	3.4.3-5.A Analyze how living organisms, including humans, affect the environment in which they live, and how their environment affects them.**
3.5.3-5.M Demonstrate essential skills of the engineering design process.*	3.3.5.C Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
3.5.3-5.P Evaluate the strengths and weakness of existing design solutions including their own solutions.*	3.2.4.B Make and communicate observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

*The PA Technology and Engineering standard is partially aligned to the claimed NGSS ETS performance expectation for this unit.
** The PA Environmental Literacy and Sustainability standard is partially aligned to the claimed NGSS ESS performance expectation for this unit.

Color Coding for the Three Dimensions

The mySci *Using Our Resources Wisely* unit uses NGSS color coding to indicate specific connections to each of the three dimensions. The PA STEELS standards use different colors for the three dimensions. The colors used in both standards to refer to the three dimensions are below.

Color coding used for the three dimensions of the NGSS standards	**Color coding used for the three dimensions of the STEELS standards**
Orange text highlights connections to DCIs (**Disciplinary Core Ideas**)	**Blue text** highlights connections to DCIs (**Disciplinary Core Ideas**)
Blue text highlights connections to the SEPs (**Science and Engineering Practices**)	**Green text** highlights connections to the SEPs (**Science and Engineering Practices**)
Green text highlights connections to the CCCs (**Cross-Cutting Concepts**)	**Purple text** highlights connections to the CCCs (**Cross-Cutting Concepts**)

[1] Alignment is based on mySci's NGSS claims and not an in-depth evaluation for STEELS standards.

The purpose of this unit is not to be used in a PA classroom, but rather to illustrate the shifts required by STEELS. With strong science, engineering, and environment connections, it represents the integrated nature of the Pennsylvania STEELS standards while showcasing strong curriculum-based system of assessments.

mySci inspiring the next generation of scientists

Earth and Space Systems:
Natural Resources, Earth Systems, Renewable and Non-Renewable Energy, Human Impacts

Teacher Guide

mySci **Unit 22**:

Using Our Resources Wisely

Washington University in St. Louis
Institute for School Partnership

Bayer Fund

HIGH QUALITY NGSS DESIGN
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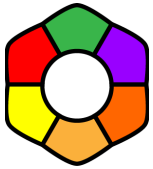
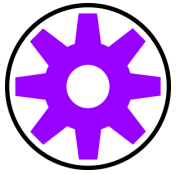
Table of Contents

mySci Symbols Key

 Indicates an opportunity for students to write	 Indicates an opportunity for assessment	 Indicates an opportunity to employ a driving question board
 Indicates an opportunity for the teacher to make a chart	 Indicates an opportunity to attend to equity and inclusion	 Indicates appropriate time to administer the post assessment
 Indicates an opportunity for reading	 Indicates an opportunity to differentiate instruction	 Indicates link to a teacher facing mySci tutorial explaining how to set up the activity for students
 Indicates an opportunity for discourse	 Indicates a key science idea	 Indicates a multimedia resource

Unit 22: Quick View **Using Our Resources Wisely**

ANCHORING PROBLEM:

We need farms to grow food, but the process of producing food for all of us can harm Earth systems.

DRIVING QUESTIONS:

How are farms part of Earth's systems?
How does our use of natural resources on farms affect Earth's systems?
How can farmers use resources wisely to protect Earth's systems?

These questions are provided for you as model driving questions to support categorizing individual student questions and organize the learning progression. Each section is designed to intentionally build toward defining the anchoring problem and designing a solution. You can use these questions to guide your instruction, however, you are encouraged to adapt these questions using the language you develop with your students.

Throughout mySci Units color coding is used to call out specific connections to each of the 3 dimensions of the NGSS standards:

Orange text highlights connections to DCIs (Disciplinary Core Ideas)

Blue text highlights connections to the SEPs (Science and Engineering Practices)

Green text highlights connections to the CCCs (Cross-Cutting Concepts)

STORYLINE

In this unit, students will **make sense of Earth's systems and natural resources, ways that humans use natural resources, human impacts on Earth systems, and how humans can change behaviors to reduce impacts on the environment.**

This unit **intentionally develops the Crosscutting Concept of System and System Models and also uses Scale, Proportion, and Quantity and Energy and Matter for sensemaking**.

This unit **intentionally develops the Science and Engineering Practices of Developing and Using Models and Obtaining, Evaluating, and Communicating Information.**

The unit also **incorporates Using Mathematical and Computational Thinking, Constructing Explanations and Designing Solutions, and Planning and Carrying Out Investigations for sensemaking.**

1. First, students will explore the four Earth systems (hydrosphere, biosphere, atmosphere, and geosphere) and learn how these systems interact.

2. Next, students will learn about natural resources and how humans use them for things like energy, food, and shelter. They will investigate some of the impacts of using natural resources, including the effects of fossil fuel consumption. Students will also examine the hydrosphere in detail, including the distribution of water on Earth. They will learn that water is a limited resource, and the amount and quality of available water can be affected by human activities.

3. Finally, they will learn about strategies humans can use to decrease our impact on the environment. They will examine a case study of an island in Denmark that changed from using non-renewable to renewable energies and then engage in a design challenge to design, build, test, and refine a wind turbine to perform a specific task. Students will also consider how farms can repurpose animal waste to generate energy using biodigesters.

Unit 22: Sections Quick View

Section 1 **How are farms part of Earth's systems?**	Section 2 **How does our use of natural resources on farms affect Earth's systems?**	Section 3 **How can farmers use resources wisely to protect Earth's systems?**
Total time: 6 days LESSON 1 **How can we describe the different parts of the Earth?** *(3 days)* LESSON 2 **How do Earth's systems interact?** *(3 days)*	*Total time: 11 days* LESSON 3 **What are natural resources and how do humans use them?** *(3 days)* LESSON 4 **How does our use of fossil fuels affect Earth's systems?** *(3 days)* LESSON 5 **How does our use of water affect Earth's systems?** *(3 days)* LESSON 6 **How does animal waste affect the environment, and what can we do about it?** *(2 days)*	*Total time: 9 days* LESSON 7 **How can people use resources in a way that is less harmful to the Earth?** *(3 days)* LESSON 8 **How can we use farms to harness wind energy?** *(3 days)* LESSON 9 **How can farms make better use of animal waste?** *(3 days)*

Links to Resources for this Unit

SECTION 1 SLIDE DECK **SECTION 2 SLIDE DECK**

SECTION 3 SLIDE DECK

PARENT/GUARDIAN LETTER

English Version Spanish Version

STUDENT JOURNAL:

Digital Student Journal Answer Key

Print Student Journal Answer Key

ASSESSMENT DOCS:

Post Assessment Answer Key

LITERACY LINKS:

Epic Booklist Unit 22

Quizlet Unit 22

Printable Glossary

Google Slide Vocabulary Cards English

Google Slide Vocabulary Cards English/Spanish

APPENDICES:

Teacher Background Information: Appendix A

Read-Aloud Guides: Appendix B

Handouts/Teacher Pages: Appendix C

NGSS/MLS: Appendix D

Safety Guidelines: Appendix E

Performance Expectations Addressed

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- 3. (5.ETS1.C.1) Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.
5-ESS2-2. (5.ESS2.C.1) Describe and graph the amounts of saltwater and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.

Performance Expectations Partially Addressed

5-ESS3-1. (5.ESS3.C.1) Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.
3-5-ETS1- 2. (5.ETS1.B.1) Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
5-ESS2-1. (5.ESS2.A.1) Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
4-PS3-2.(4.PS3.B.1) Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

Unit 22: **Fast Track** Pacing Guide

Unit 22 Fast Track Pacing Guide

These suggestions can be used if you do not have the full amount of time required to dedicate to the whole unit.

Lesson	How to Adapt
Lesson 1	- Explore: Omit going outside.. - Elaborate: Only show one video, or shorten the length of each video. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 2	- Explore: Use the virtual adaptation of the activity to reduce setup time. - Explain: Omit the Crash Course Kids videos. - Elaborate: Only show one video, or shorten the length of each video. Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 3	- Explore: Omit comparing and sorting the self-documentation data, and only do the class chart about it. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 4	- Explore: Omit the student choice research and only do the asthma research. Alternatively, skip the asthma research and allow for student choice. - Explain: Based on what you omitted in the Explore section, only do one cause and effect sphere interaction activity. - Elaborate: Provide students with the Gotta Have It checklist instead of co-constructing it.
Lesson 5	- Omit all portions except for the Explore graduated cylinder, graphing activity, and development of a claim.
Lesson 6	- Keep as is.
Lesson 7	- Elaborate: Omit returning to the model. Students will revise the model again in Lesson 9.
Lesson 8	- Explain: Only have students draw their model and how energy is transferred. Omit drawing an actual wind turbine for comparision. - Elaborate: Read The Boy Who Harnessed the Wind or watch the video.
Lesson 9	- Keep as is.

Lesson 7: Summary

How can people use resources in a way that is less harmful to the Earth?

Time: 3 days

Learning Targets

Obtain and combine information about how humans use science ideas to protect Earth systems.

Revise a model of a farm system to explain how farms could create energy in a way that protect's Earth's resources.

Summary

- In the previous lesson, students designed biodigesters in order to determine the optimal setup for generating the most gas from waste.
- In this lesson, students will use Samsø as a case study to examine how humans can change their impacts on the environment.
- **Students figure out that humans can make changes to how we use natural resources for energy that have less harmful impacts on Earth systems. One way to do this is by using renewable resources such as wind, solar, water, and biofuel.**
- In the next lesson, students will engage in the engineering design cycle to develop a wind turbine that can be used to produce energy.

Building Towards

5-ESS3-1. (5.ESS3.C.1) | 4-ESS3-1

NGSS 3-Dimensions:

ESS3.C: Human Impacts on Earth Systems

ESS3.A: Natural Resources

Developing and Using Models

Obtaining, Evaluating, and Communicating Information

System and System Models

Energy and Matter

Lesson 7: Five E Quick View	
ENGAGE	Students engage in a discussion about what they have learned about human activities and how they can harm Earth systems.
EXPLORE	Students obtain and combine information about how Samso used science and engineering ideas to positively affect Earth systems.
EXPLAIN	Students communicate information about how Samso used science and engineering ideas to positively affect Earth systems.
ELABORATE	Students develop a model of a farm that shows how we can use science ideas to reduce harmful effects on Earth's systems.
EVALUATE	Students evaluate each other's farm models and give feedback.

Lesson 7: Prep List

Inside mySci kit you will find:	Items you must supply:	Preparation:
8 copies of *Energy Island*, by Allan Drummond *The Tree Lady*, by Joseph Hopkins		Lesson 7 Student Journal pages or Printed Student Journals

Literacy Connections	Remote Learning
Key Vocabulary **renewable resource**: a resource that is replaced by nature faster than it is used Supplemental Reading Resources Hot for Hybrids Solar Power Houston Reduces Human Impacts Hydroelectricity Nuclear Power Reducing Plastic Waste Earthshot Prize	Interactive & Mini Lesson Videos Prince EA Video Why Do Some People Use Renewable Resources for Energy? Mini-Lesson Big Changes in the Big Apple Hands-on at Home Suggestions Have students watch the video Island in Denmark Produces More Energy Than it Consumes and share what they learned with their family to think about ways they could use renewable energy.

L7 – Five E Lesson Plan

ENGAGE

Students engage in a discussion about what they have learned about human activities and how they can harm Earth systems.

Begin the lesson by revisiting the Driving Question Board. Highlight questions connected to the learning goals of this lesson by calling attention to questions about **how people can help the environment**. If no questions directly relate, use prompts to build on student questions, supporting them to think about their everyday experiences using resources and questions they might have about reducing their impact.

Say to students:

Today's activity will support us in answering this question (ex: **How can people use resources in a way that is less harmful to the Earth?***). By answering this question, we will be able to think about possible solutions that farmers can use to protect Earth's systems.*

Say to students:

- *We have explored a lot of the harmful effects human activities can have on our planet. What are some of the effects we have when we use fossil fuels and water resources, for example?*

Give students time to Turn and Talk.

Listen for ideas such as: fossil fuels give off pollution, which affect Earth systems, like the air and water; fossil fuels are non-renewable resources, and get depleted over time; water use depletes groundwater; farming can cause animal waste to pollute water.

Have students share their ideas and record them on the board or on chart paper. Ask students:

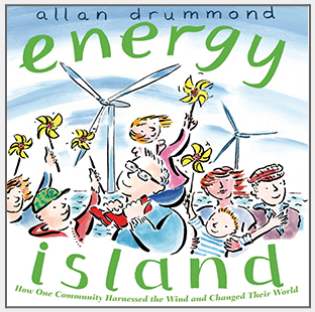
- *What similarities do you notice across the effects you shared?*
- *Are there any that we could combine into one category?*
- *What would we call the new category?*

After you have guided the students through creating categories ask them:

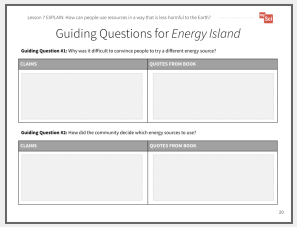
	▸ *What do you think are some solutions to these problems?* (The purpose of this is to get the students thinking. You are not looking for correct answers. They will explore solutions as they move through the lesson. Some categories that might arise from this discussion include: air pollution, water pollution, resource overuse/depletion.)

EXPLORE

Students obtain and combine information about how Samso used science and engineering ideas to positively affect Earth systems.



Read-Aloud Guide



Guiding Questions for *Energy Island* Student Journal pages

Students will continue to build on the SEP Obtaining, Evaluating, and Communicating information. In lesson 3, students developed the practice of obtaining information, using only one resource. In lesson 4, they used multiple resources, and combine information. In this lesson students will again use multiple resources and combine information. They will use this information to create presentations to communicate this information.

Divide the students into eight groups. Provide each group with the following resources:

1. *Energy Island*
2. Island in Denmark Produces More Energy Than it Consumes
3. Website: Waste Becomes Important Part of Island Circuit

Students will work in groups to use the resources listed in order to develop a slide or poster about *Samsø.* Students will use the Guiding Questions for *Energy Island* Student Journal pages to help them gather information for their presentation.

Discuss that a "claim" is what you think is true, and "evidence" is an observation or data that supports your claim. Students will make claims based on the book, video, and article and provide specific evidence for each claim. Make it clear that they can have more than one claim and that they can have more than one piece of evidence to support each claim.

Career Connections: EGFI - Environmental Engineers PBS Learning Media: Renewable Energy Scientist (2.35)	Once students have obtained information from their resources, they can use a combination of pictures, drawings, and text to create their slide or poster presentations. For example, students may want to draw a model of the island that includes descriptions based on their research. Presentations should include information about the resources the island uses, why they use these resources, and the benefits of using these resources.

EXPLAIN

Students communicate information about how Samso used science and engineering ideas to positively affect Earth systems.

Attending to Equity:
Historically women have been leaders in social and environmental movements, however their contributions often go unrecognized. You could read the children's book *The Tree Lady* to examine the story of Kate Sessions, a woman who worked to make a positive impact on her community.

Read-Aloud Guide

When all groups are finished, have them share out with the class what they found. There are two different options for having students share.

Option 1: Students hang their posters around the room and then rotate around the room to look at the posters. While they walk around to each poster, students record the natural resources each group discussed as well as the benefits of using those resources. Once everyone has visited each poster, have students circle repeating natural resources in order to find patterns across the presentations.

Option 2: Each group presents their poster to the class. While one group is presenting, the other groups record the natural resources each group discussed as well as the benefits of using those resources. Once every group has presented, have students circle repeating natural resources in order to find patterns across the presentations.

Bring the class back together and review the problems that were discussed at the beginning of the lesson. Ask students:

- *Do you think the people of Samsø provided a solution to any of these problems?*
- *If so, what was their solution?*
- *What did you notice about the resources they used on Samsø?*
- *How are they different than the energy resources we learned about in previous lessons?*

Formative Assessment

ESS3.C: Human Impacts on Earth Systems ~~Human activities in agriculture, industry, and everyday life have had major effects on the land, vegetation, streams, ocean, air, and even outer space.~~ But individuals and communities are doing things to help protect Earth's resources and environments.

Obtaining, Evaluating, and Communicating Information

Obtain and combine information from books and other reliable media to explain solutions to a problem.

Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.

Energy and Matter

Energy can be transferred in various ways ~~and between objects~~.

(Students may notice they moved away from using fossil fuels, replacing them with things like the wind, the sun, and plants. They may discuss that these resources get depleted over time. Students may also notice that they use multiple different resources to address their energy needs.)

Say to students:

- *What makes Samsø Island so special is that they are using **renewable resources**. This means that the resources can be replaced by nature faster than they are used. Sun, wind, biofuels, and water are energy sources that can be replaced quickly by nature. Let's compare non-renewable and renewable energy sources.*

Use this opportunity to develop connections across the science domains using the CCC of energy and matter. Ask students:

- *What forms of energy are involved in these systems?*
- *What energy transformations are taking place as the community uses renewable resources?*
- *How is the energy from the sun transferred in different ways?*

Give students time to read the hyperlinked CK-12 text and watch the embedded video on renewable resources.

This activity is a chance to formatively assess students' understanding of the SEP Obtaining, Evaluating, and Communicating Information and DCI ESS3.C. See the student journal answer key for an example. If students are struggling to figure out how to organize their information for the presentation,

ELABORATE

Students develop a model of a farm that shows how we can use science ideas to reduce harmful effects on Earth's systems.

Farm Model
Student Journal page

A Farm That Helps Protect the Earth Student Journal page

Say to students:

- *During this unit, we have developed a farm model. In the model we identified:*
  - *The different Earth systems and natural resources represented*
  - *Interactions between the Earth systems*
  - *Effects of resource use on the Earth systems*
- *Now, we are going to create a new farm model that includes our vision for what a farm that creates less impacts on Earth systems could look like.*

Give students the A Farm That Helps Protect the Earth Student Journal page.

- *Just like in our original farm model, we need to use a "Gotta Have It Checklist" to show the components and relationships we need to include in the models.*
- *What would you add to the checklist today to make our models show how a farm can use natural resources in a way that doesn't harm Earth systems as much?*

Examples of things the model's "gotta have" might include:

- Renewable fuel sources for tractors and other farm equipment
- Renewable energy sources for electric power

EVALUATE

Students evaluate each other's farm models and give feedback.

Formative Assessment

ESS3.C: Human Impacts on Earth Systems ~~Human~~ activities ~~in agriculture, industry,~~ and ~~everyday life have had major effects on the land, vegetation~~, ~~streams, ocean, air, and even outer space. But indivi~~duals and communities are doing things to help protect Earth's resources and environments.

ESS3.A: Natural Resources
Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

Developing and Using Models
Develop a model using an example to describe a scientific principle.

Have students share their models with a partner or another group and give each other feedback using the "Gotta Have It Checklist".

- How do their models compare with each other's?
- What new resources did they identify?

Students will continue to refine this model over time. Bring the class back together, and ask students to share out the differences and similarities in their models. This supports students to see the different ways you can represent and label things in models. Based on their discussion, students should change their models to reflect feedback.

Return to the class consensus model that was created in the Engage portion of lesson 1. Revise the class model to include ways to create energy using renewable resources the students described from their individual models. Ask students what labels you should put on your drawing. Continuing to revisit and revise the class model provides continuity throughout this unit.

This activity is a chance to formatively assess students' understanding of the SEP Developing and Using Models, DCI ESS3.C, and CCC System and System Models. See the student journal answer key for an example. If students are struggling to apply what they have learned in developing a model, use the class consensus model you created to support students to further develop their models.

To support student sensemaking across the unit, orient students back to the DQB. Ask students:

- *What did we observe during today's activity?* (We observed a community in Denmark.) Record the activity and their observations.

Next, ask students:

- *What did we learn today?* (We learned that there are communities that are making changes in the natural resources they use for energy, in order to protect the environment.)

System and System Models A system can be described in terms of its components and their interactions.	Record their responses. If students need a reminder, they can reference their student journals. Ask students: ▸ *How might this help us figure out how farmers can use resources wisely to protect Earth's systems?* (Students may say that farms could use renewable resources such as the wind, the sun, or animal waste.) Next, ask students: ▸ *What new questions do you have?* Write student responses on the driving question board. They may have new questions, such as: ● *Are there other places that have made changes like Samsø? Are there other types of renewable resources?* ● *Can renewable resources harm the environment?* ● *Could I power my home with renewable resources?* ● *How do you build a wind turbine?* ● *How does a wind turbine make energy from the wind?* ● *How do you build solar panels?* ● *How does a solar panel make energy from the sun?* Do not provide these questions for students, instead help them start thinking about these ideas by focusing their attention to the solutions that the people of *Samsø* came up with and how that could relate to the anchoring problem: Farms use a large amount of resources. This can have a negative impact on the environment. Have students place their questions into existing categories, or create new categories.