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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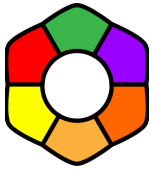
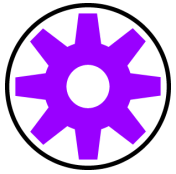
Table of Contents

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 6: Summary

How can we use animal waste as a natural resource?

Time: 2 days

Learning Target

Plan and conduct an investigation to see how we can use animal waste as a natural resource on the farms.

Summary

- In the previous lesson, students analyzed and graphed data of the amount of freshwater and saltwater on Earth. They used this information to explain why it is important to protect water from pollution and depletion.
- In this lesson, students will plan investigations to explore what environmental factors affect the amount of natural gas produced.
- **Students figure out that animal waste can create natural gas. We can use experimental design to consider how to opitimize the amount of gas produced from waste in a biodigester. This idea will be further investigated in Lesson 9, as a solution to energy use on farms.**
- In the next lesson, students use Samso as a case study to examine how people can reduce their own negative impacts on Earth's systems.

Building Towards

3-5-ETS1- 3. (5.ETS1.C.1)

NGSS 3-Dimensions:

ETS1.C: Optimizing the Design Solution

Planning and Carrying Out Investigations

Lesson 6: Five E Quick View	
ENGAGE	Students make observations and ask questions about a model biodigester.
EXPLORE	Students brainstorm ways to investigate how to produce and capture gas from waste to use as an energy source.
EXPLAIN	Students plan and set up an investigation about the environmental factors that affect gas production.
ELABORATE	Students develop a plan for collecting data about the environmental factors that affect gas production.
EVALUATE	Students ask new questions about farm resources, the impact on the environment, and solutions to this problem.

Lesson 6: Prep List

Inside mySci kit you will find:	Items you must supply:	Preparation:
(16) small clear travel size plastic bottles (1) 4 oz. bag of soil 1 Large yellow funnels Small bottle of vinegar 40 balloons 1 set of yellow measuring spoons 2 coffee stirrers Roll of string (from previous lessons) to measure balloon circumferences	If students do not choose the type of scraps used variable: a uniform mixture of pureed fruit and vegetable scraps to evenly divide among biodigester bottles (Note: Choose items that will break down relatively fast. **Lettuce, blueberries, and bananas** work well, for example.) If students do choose the type of scraps used variable: make the mixture based on their experimental design. If students choose temperature as their variable: a refrigerator and a sunny, warm place. Food processor or blender to make a puree of the scraps Water Rulers	Puree the food scraps the morning or evening before this lesson. Lesson 6 Student Journal pages or Printed Student Journals

Literacy Connections	Remote Learning
Key Vocabulary **biodigester:** a container that collects gas created by living things as they break down food **decomposer:** an organism, such as bacteria or fungi, that breaks down dead organisms **constraint:** what the design is limited by or cannot do **criteria:** what the design must have or be like Supplemental Reading Resources What is compost?	Interactive & Mini Lesson Videos Hands-on at Home Suggestions Have students collect kitchen scraps and watch them decompose either outside or in a cup covered with cellophane. What factors make them decompose faster or slower?

L6 – Five E Lesson Plan

ENGAGE

Students make observations and ask questions about a model biodigester.

Note:
The biodigester time lapse video depicts the biodigester during 72 hours of recording.

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 **animal waste**. If no questions directly relate, use prompts to build on student questions, supporting them to think about what they observed on a farm and pointing out examples of animal waste on farms.

Say to students:

Today's activity will support us in answering this question (ex: **How can we use animal waste as a natural resource?***). By answering this question, we will be able to build on our understanding of how using natural resources might affect the farm and Earth's systems*.

Ask students:

- *What did we learn about in the previous lesson? What do you remember about connections we made between farming and fresh water? Did we learn anything in the last lesson that connects to animal waste?* (Freshwater makes up a small portion of the water on Earth and farms use a lot of fresh water. We also know that farms can pollute water when animal poop washes into rivers and streams.)

Say to students:

- *What can farmers do with all the poo? What ideas do you have?*

Students may say you could collect the poop in some sort of storage device. If they do not say this, ask:

- *What if we designed a container for the poop with a lid on it so that way nothing can escape?*
- *What do you think would happen? Why do you think that?*

Allow students to share their ideas with the class.

- *Let's look at one example of a way that farmers can store animal waste.*

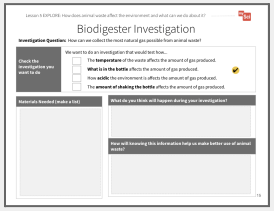
	Show the time lapse video of the biodigester. ▸ *What do you notice happens over time?* (The balloon was not inflated, but got inflated over time). ▸ *What do you think is happening?* (Some students may point out that there is gas in the balloon.) If students have completed mySci Unit 24 the concept of gas particles taking up space is a review (DCI PS1.A). If they have not completed mySci Unit 24, it is okay just to get students thinking that gas is filling up the balloon, but it is not expected that they understand the particle level of the states of matter at this point. If students do not make the connection that there is gas inside the balloon ask: ▸ *What do you think is filling the balloon up?* ▸ *What do you know about balloons?* ▸ *What is typically inside a balloon?* Then ask: ▸ *What do you wonder?* (Potential student questions may include, but are not limited to: Why did the balloon inflate? What happened inside the jar? Did air get inside the balloon from outside?) Say to students: ▸ *This is a basic model of a **biodigester** (bio = life, digest = break down) set-up to collect natural gas from waste. The natural gas from the food waste formed in the plastic bottle and collected in a balloon.*

EXPLORE

Students brainstorm ways to investigate how to produce and capture gas from waste to use as an energy source.

Attending to Equity:

In this exploration, students are given an opportunity to design their own investigation procedure to figure out what conditions will make the most natural gas from food scraps. This allows students to feel like "active and valued sensemakers" in their classroom science community. See more in this STEM Teaching Tool.


Biodigester Investigation

Biodigester Investigation Student Journal pages

Say to students:

- *We just discussed that gas is filling the balloon of our biodigester. Does anyone know of any gas that is used for energy? Recall what we learned about fossil fuels from lesson 4.* (Students may discuss the gas (gasoline) that runs cars or the natural gas they may use to cook with at home).

Say to students:

- *The gas captured by the biodigester can be used as a natural gas energy source. We want to figure out how to create a biodigester that creates the most gas from animal waste. This is the* ***criteria*** *for the designs. We know we can't actually use animal waste in the classroom- that would not be safe.*
- *What else could we use as a model of animal waste?* (We will use food scraps. Animals eat fruits and vegetables, and this is a part of their waste, so it is a good substitute.)

Say to students:

- *If we want to make the best use of animal waste, we need the best environment possible to make gas. Different groups can test different types of bottle environments to see which conditions make the most gas to use. Let's brainstorm the different things we could change about the environment of the bottle.*

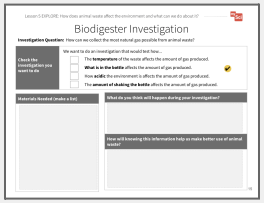
To support this, show students the materials they have available to them. This will help narrow their suggestions. Discuss these as the constraints of their design. Record the different suggestions students come up with on chart paper.

There are opportunities to bring in life science connections – for example, if you have completed mySci unit 21 you can review the concepts from DCIs LS2.A and LS2.B. However, if you have not completed mySci unit 21 you should skip this section as students have not yet made sense of these concepts. The

	idea to review is **decomposition** or **decomposers** (there are bacteria, both on food and in soil, that help break down the food waste). The living bacteria release gas as a by-product of their own digestion, or breakdown, of the food (this is above grade level, so it is not crucial that you students understand this process). You may need to scaffold with students to discuss that bacteria are living, so just like you and me, they have a certain type of environment where they survive best. We have a range of temperatures where we survive best, and so do bacteria. We have a particular amount of acidity where we survive best, and so do bacteria. Bacteria make the most gas when they are "happiest". Provide students with the first Biodigester Investigation Student Journal page. There are four different types of investigations listed, but students may come up with other ideas as part of the class discussion that you can approve based on classroom constraints. It is ok if two groups do the same variable – tell students this will just help us get more data. In groups, let them explore the materials and think about what they could investigate, and what that would tell them about using waste as an energy source. Discuss with students that the materials are **constraints,** or what their designs are limited by.

EXPLAIN

Students plan and set up an investigation about the environmental factors that affect gas production.

 Biodigester Investigation Student Journal pages	Give students time to fill out the second and third Biodigester Investigation Student Journal pages to solidify their plans. You may want to "sign-off" on their procedures before they can have access to the materials. Discuss with students the importance of including each of the 4 different scenarios so that the class can come together at the end of the investigation and create the best biodigesters possible for the design challenge. If students are struggling to come up with a procedure, walk a group or the whole class through using one of the experiment options as an example. If other groups finish early, you can use their procedure

Biodigester Set Up Tutorial

as an example.

Say to students:

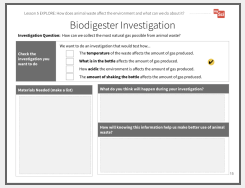
- *Now that we have planned our investigations, let's set up our biodigesters.*

Give students time to set up their experiments.

You may use the Biodigester Set Up Tutorial as a reference when helping your students set up their biodigesters. Note that the example includes using water for the biodigesters. If students choose to make their environment more acidic, they would use vinegar or a mixture of vinegar and water.

ELABORATE

Students develop a plan for collecting data about the environmental factors that affect gas production.



Biodigester Investigation Student Journal pages

Give students time to look at other group set ups and what they are testing. You could have one student share out, or have them do a gallery walk to view the other investigations. Say to students:

- *Now we need to decide how we will collect our data. We need to collect data in a similar way so that we can compare group results and see which factors allowed for the best production of natural gas.*

Have students use the fourth Biodigester Investigation Student Journal page to create their data table. You may need to scaffold so that students can make the connection that they could take numerical measurements by wrapping string around their balloons as they fill up with gas, and then laying the string on a ruler. You may notice that the balloons inflate and deflate over time, but any production of gas should be counted (the balloons may not be airtight).

Students can also use qualitative data, like seeing bubbles forming when they tap on or gently shake the biodigester. Help students develop a plan to check their biodigesters every day for the rest of the unit.

EVALUATE

Students ask new questions about farm resources, the impact on the environment, and solutions to this problem.

Formative Assessment

ETS1.C: Optimizing the Design Solution Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.

Planning and Carrying Out Investigations
Plan and conduct an investigation collaboratively to produce data to serve as the basis for evidence, using fair tests in which variables are controlled and the number of trials considered.

The Biodigester Investigation Student Journal pages are a chance to formatively assess students' understanding of the SEP Planning and Carrying Out Investigations and the DCI ETS1.C. If students are struggling to plan and carry out their investigation, pick one investigation that is different from what the student groups choose and develop the procedure as a class to model the process.

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

- *What did we observe during today's activity?*

Record the activity and their observations. Next, ask students:

- *What did we learn today? (We observed that waste can produce gas. We observed this as a balloon inflating)* Record their responses. If students need a reminder, they can reference their student journals.

Ask students:

- *How might this help us figure out how our use of natural resources on farms affects Earth's systems? (Students may say that farms use energy from fossil fuels, like natural gas. Waste can produce gas that could be used as an energy resource on a farm.)*

Next, ask students:

- *What new questions do you have?*

Write student responses on the driving question board. (They may have new questions, such as: What other ways can we protect the environment on farms? How can we reduce the amount of fossil fuels we use even more? Are biodigesters the only solution? Do biodigesters have any impacts on Earth systems?)

Do not provide these questions for students, instead help them start thinking about these ideas by

	focusing their attention to the problem that biodigesters are helping to solve to help orient them to thinking about other solutions 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.

Section 3: Quick View **How can farmers use resources wisely to protect Earth's systems?**

LESSON / LEARNING TARGET	VIDEO & TEXT RESOURCES	REMOTE LEARNING		KEY TAKEAWAY	VOCABULARY Quizlet Link Glossary Link
		INTERACTIVES & MINI LESSON VIDEOS	HANDS ON AT HOME SUGGESTIONS		
Lesson 7: **How can people use resources in a way that is less harmful to the Earth?** 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. *(3 days)*	Island in Denmark Produces More Energy Than it Consumes Waste Becomes Important Part of Island Circuit CK-12 text	Big Changes in the Big Apple Prince EA Video Why Do Some People Use Renewable Resources for Energy? Mini-Lesson	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.	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.	renewable resource
Lesson 8: **How can we use farms to harness wind energy?** Design, test, and share a wind turbine that can harness energy from the wind. *(3 days)*	Wind Turbines Energy 101 How do wind turbines work? William Kamkwamba on Building a Windmill Advantages and Challenges of Wind Energy Wind Power Another Crop to Harvest		Have students look at a ceiling or box fan at their house. Draw what the blades look like. How do they think the fan works? Alternatively, have students make a pinwheel. Draw a model to show how the pinwheel is able to move.	Specific technology is used to harness wind as an energy source. Farms have a lot of space that can be used for wind turbines. Even renewable energy sources have some disadvantages, so it is best to have a wide variety of renewable energy sources.	constraint criteria engineer prototype

Lesson 9: **How can we use farm animal waste?** Compare multiple solutions to explain the optimal conditions for converting animal waste into energy. Develop a final model to explain how using our resources wisely helps protect Earth systems. *(3 days)*	Much A-Doo About Poo Digesting the Facts about Renewable Natural Gas			Biodigester technology is used in a specific way so that the most natural gas is produced from animal and food waste. This technology does not add to greenhouse gas emission, and so it harms the Earth less than fossil fuel use.	No new vocabulary