Wind Energy

STEM Road Map for Elementary School

Grade 5

Edited by Carla C. Johnson,
Janet B. Walton, and Erin Peters-Burton

NSTApress
National Science Teachers Association

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WIND ENERGY MODULE OVERVIEW

Janet B. Walton, Sandy Watkins, Carla C. Johnson, and Erin Peters-Burton

THEME: Innovation and Progress

LEAD DISCIPLINES: Social Studies and Science

MODULE SUMMARY

This module focuses on the interactions of Earth's systems, including geography and weather, as well as wind as an energy source. As a culminating activity, students are challenged to develop a proposal for the location of a wind farm. Students investigate U.S. geography, weather patterns, the economics of wind energy, and issues surrounding the use of wind turbines. In science, students learn about how Earth's spheres—the lithosphere, hydrosphere, atmosphere, and biosphere—interact and how these interactions can be observed and measured. Student teams analyze the wind energy potential of their proposed wind farm locations, and each team creates a proposal taking into account factors such as cost, energy production, and environmental impacts of wind farms. Using their findings, student teams deliver presentations on their proposed wind farms with the goal of garnering support from members of the surrounding community and potential investors (adapted from Capobianco et al. 2015).

ESTABLISHED GOALS AND OBJECTIVES

At the conclusion of this module, students will be able to do the following:

- Demonstrate an understanding of the climatic basis of wind
- Identify and describe each of Earth's four spheres: atmosphere, biosphere, hydrosphere, and lithosphere
- Discuss interactions among Earth's spheres and the effects of those interactions
- Identify and discuss the differences between renewable and nonrenewable energy sources

- Demonstrate an understanding of how wind is converted into energy by creating model wind turbines, and identify the major components of a wind turbine
- Identify and describe the steps of the scientific method
- Describe the Engineering Design Process (EDP), which engineers use to design and build products and solve problems
- Apply their understanding of the EDP and the scientific process to plan an investigation, address design challenges, and solve problems
- Apply map skills and their understanding of U.S. geography to identify desirable wind farm sites
- Discuss the economic and environmental implications of wind as an energy source
- Apply their knowledge of the environmental impacts of wind farms to create plans to mitigate those impacts
- Apply their knowledge of economic impacts of wind farms on communities to create a persuasive argument for a wind farm location

CHALLENGE OR PROBLEM FOR STUDENTS TO SOLVE: THE WIND FARM CHALLENGE

As a culminating activity for the module, students participate in the Wind Farm Challenge. In this challenge, students act as energy entrepreneurs who believe that wind energy is the energy of the future. They will choose a location to build a new wind farm and will also try to convince local community members and potential investors that the wind farm is a good idea.

CONTENT STANDARDS ADDRESSED IN THIS STEM ROAD MAP MODULE

A full listing with descriptions of the standards this module addresses can be found in the appendix. Listings of the particular standards addressed within lessons are provided in a table for each lesson in Chapter 4.

STEM RESEARCH NOTEBOOK

Each student should maintain a STEM Research Notebook, which will serve as a place for students to organize their work throughout this module (see p. 12 for more general discussion on setup and use of this notebook). All written work in the module should be included in the notebook, including records of students' thoughts and ideas, fictional accounts based on the concepts in the module, and records of student progress through the EDP. The notebooks may be maintained across subject areas, giving students the opportunity to see that although their classes may be separated during the school day, the knowledge they gain is connected.

Each lesson in this module includes student handouts that should be kept in the STEM Research Notebooks after completion, as well as a prompt to which students should respond in their notebooks. Students will have the opportunity to create covers and tables of contents for their Research Notebooks in Lesson 1. You may also wish to have students include the STEM Research Notebook Guidelines student handout on page 26 in their notebooks.

Emphasize to students the importance of organizing all information in a Research Notebook. Explain to them that scientists and other researchers maintain detailed Research Notebooks in their work. These notebooks, which are crucial to researchers' work because they contain critical information and track the researchers' progress, are often considered legal documents for scientists who are pursuing patents or wish to provide proof of their discovery process.

STUDENT HANDOUT

STEM RESEARCH NOTEBOOK GUIDELINES

STEM professionals record their ideas, inventions, experiments, questions, observations, and other work details in notebooks so that they can use these notebooks to help them think about their projects and the problems they are trying to solve. You will each keep a STEM Research Notebook during this module that is like the notebooks that STEM professionals use. In this notebook, you will include all your work and notes about ideas you have. The notebook will help you connect your daily work with the big problem or challenge you are working to solve.

It is important that you organize your notebook entries under the following headings:

1. **Chapter Topic or Title of Problem or Challenge:** You will start a new chapter in your STEM Research Notebook for each new module. This heading is the topic or title of the big problem or challenge that your team is working to solve in this module.
2. **Date and Topic of Lesson Activity for the Day:** Each day, you will begin your daily entry by writing the date and the day's lesson topic at the top of a new page. Write the page number both on the page and in the table of contents.
3. **Information Gathered From Research:** This is information you find from outside resources such as websites or books.
4. **Information Gained From Class or Discussions With Team Members:** This information includes any notes you take in class and notes about things your team discusses. You can include drawings of your ideas here, too.
5. **New Data Collected From Investigations:** This includes data gathered from experiments, investigations, and activities in class.
6. **Documents:** These are handouts and other resources you may receive in class that will help you solve your big problem or challenge. Paste or staple these documents in your STEM Research Notebook for safekeeping and easy access later.
7. **Personal Reflections:** Here, you record your own thoughts and ideas on what you are learning.
8. **Lesson Prompts:** These are questions or statements that your teacher assigns you within each lesson to help you solve your big problem or challenge. You will respond to the prompts in your notebook.
9. **Other Items:** This section includes any other items your teacher gives you or other ideas or questions you may have.

MODULE LAUNCH

Ask students to share their ideas about where the power for their school and their homes comes from. Create a class list of these ideas. Next, ask students what other sources of energy they can think of, and add these to the list. Ask students if they think that a whole town could be powered by wind. Tell students that there is a town in the United States that gets all its energy from wind. Show a video about the wind energy system of Rock Port, Missouri (visit YouTube and search for "Innovative Cities Rock Port Missouri" or access the video directly at *www.youtube.com/watch?v=mnifNSrZRUQ*). Introduce the module challenge, the Wind Farm Challenge. Tell students that in this challenge they will act as energy entrepreneurs who believe that wind energy is the energy of the future. They will choose a location to build a new wind farm and will also try to convince local community members and potential investors that building it is a good idea. Students will work in teams to design a prototype of a wind turbine, identify an appropriate location for their wind farms, and create plans to mitigate the wind farm's environmental impacts.

PREREQUISITE SKILLS FOR THE MODULE

Students enter this module with a wide range of preexisting skills, information, and knowledge. Table 3.1 (p. 28) provides an overview of prerequisite skills and knowledge that students are expected to apply in this module, along with examples of how they apply this knowledge throughout the module. Differentiation strategies are also provided for students who may need additional support in acquiring or applying this knowledge.

Table 3.1. Prerequisite Key Knowledge and Examples of Applications and Differentiation Strategies

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Knowledge
Measurement skills: • Distance • Time	Measurement skills: • Measure distances, time, and time intervals using standard units.	Measurement skills: • Provide students with opportunities to practice measuring distances using various units and measuring time to the nearest minute. • Provide students with additional content, including textbook support, teacher instruction, and online videos for telling time to the nearest minute.
Map-reading skills	Map-reading skills: • Use U.S. maps to identify regions, landforms, and other geographic features. • Use wind maps to select wind farm sites.	Map-reading skills: • Review basic map-reading skills and knowledge of geography, including continents, oceans, mountains, rivers, canyons, and deserts. • Provide students with map-reading practice.
Inquiry skills: • Ask questions, make logical predictions, plan investigations, and represent data. • Use senses and simple tools to make observations. • Communicate interest in phenomena and plan for simple investigations. • Communicate understanding of simple data using age-appropriate vocabulary.	Inquiry skills: • Select and use appropriate tools and simple equipment to conduct an investigation. • Identify tools needed to investigate specific questions. • Analyze and communicate findings from multiple investigations of similar phenomena to reach a conclusion.	Inquiry skills: • Select model and use appropriate tools and simple equipment to conduct an investigation. • Scaffold student efforts to organize data into appropriate tables, graphs, drawings, or diagrams by providing step-by-step instructions. • Use classroom discussions to identify specific investigations that could be used to answer a particular question and identify reasons for this choice.
Numbers and Operations: • Add and subtract numbers within 1,000. • Multiply and divide whole numbers.	Numbers and Operations: • Engage in activities that involve finding sums of numbers within 1,000. • Understand percentages with a focus on division. • Use division to calculate speed.	Numbers and Operations: • Review and provide models of adding and subtracting within 1,000 using the standard algorithm. • Review multiplication and division and provide examples of calculating percentages.

Table 3.1. (*continued*)

Prerequisite Key Knowledge	Application of Knowledge by Students	Differentiation for Students Needing Additional Knowledge
Reading: • Use information gained from the illustrations and words in a print or digital text to demonstrate understanding of the connection between a series of events, scientific ideas or concepts, or steps in technical procedures in a text.	Reading: • Read informational texts to understand various facets of wind energy, including financial costs, economic benefits, and environmental impacts.	Reading: • Provide reading strategies to support comprehension of nonfiction texts, including activating prior knowledge, previewing text by skimming content and scanning images, and rereading.
Writing: • Write informative/explanatory and persuasive texts in which students introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.	Writing: • Write informative/explanatory and persuasive texts to examine a topic and convey ideas and information clearly. • Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequences.	Writing: • Provide a template for writing informative/explanatory texts to scaffold student writing exercises. • Provide writing organizer handouts to scaffold student work in describing details and clarifying event sequence.

POTENTIAL STEM MISCONCEPTIONS

Students enter the classroom with a wide variety of prior knowledge and ideas, so it is important to be alert to misconceptions, or inappropriate understandings of foundational knowledge. These misconceptions can be classified as one of several types: "preconceived notions," opinions based on popular beliefs or understandings; "nonscientific beliefs," knowledge students have gained about science from sources outside the scientific community; "conceptual misunderstandings," incorrect conceptual models based on incomplete understanding of concepts; "vernacular misconceptions," misunderstandings of words based on their common use versus their scientific use; and "factual misconceptions," incorrect or imprecise knowledge learned in early life that remains unchallenged (NRC 1997, p. 28). Misconceptions must be addressed and dismantled in order for students to reconstruct their knowledge, and therefore teachers should be prepared to take the following steps:

- *Identify students' misconceptions.*
- *Provide a forum for students to confront their misconceptions.*

- *Help students reconstruct and internalize their knowledge, based on scientific models. (NRC 1997, p. 29)*

Keeley and Harrington (2010) recommend using diagnostic tools such as probes and formative assessment to identify and confront student misconceptions and begin the process of reconstructing student knowledge. Keeley and Harrington's *Uncovering Student Ideas in Science* series contains probes targeted toward uncovering student misconceptions in a variety of areas. In particular, the portions of volume 2 (Keeley and Eberle 2008) and volume 3 (Keeley and Harrington 2014) that address electricity and the nature of science may be useful resources for addressing student misconceptions in this module.

Some commonly held misconceptions specific to lesson content are provided with each lesson so that you can be alert for student misunderstanding of the science concepts presented and used during this module. The American Association for the Advancement of Science has also identified misconceptions that students frequently hold regarding various science concepts (see the links at *http://assessment.aaas.org/topics*).

SRL PROCESS COMPONENTS

Table 3.2 illustrates some of the activities in the Wind Energy module and how they align to the SRL learning processes before, during, and after learning.

Table 3.2. SRL Process Components

Learning Process Components	Example From Wind Energy Module	Lesson Number
BEFORE LEARNING		
Motivates students	Students create a class list of sources of power and energy for their school and homes. Then they learn about one town that is entirely powered by wind.	Lesson 1
Evokes prior learning	Students use their own environment to consider the type of energy that is produced for their own consumption.	Lesson 1
DURING LEARNING		
Focuses on important features	Students explore factors that optimize wind resources and technologies for a particular type of geographic location.	Lesson 2
Helps students monitor their progress	Students share results of Don't Bother the Neighbors activity in presentations. Students observe what other students focus on in their presentations.	Lesson 3
AFTER LEARNING		
Evaluates learning	Students get feedback on their final challenge products from detailed rubrics.	Lesson 4
Takes account of what worked and what did not work	Students respond to questions from the audience after their Wind Farm Challenge presentation.	Lesson 4

STRATEGIES FOR DIFFERENTIATING INSTRUCTION WITHIN THIS MODULE

For the purposes of this curriculum module, differentiated instruction is conceptualized as a way to tailor instruction—including process, content, and product—to various student needs in your class. A number of differentiation strategies are integrated into lessons across the module. The problem- and project-based learning approach used in the lessons is designed to address students' multiple intelligences by providing a variety of entry points and methods to investigate the key concepts in the module. Differentiation strategies for students needing support in prerequisite knowledge can be found in Table 3.1 (p. 28). You are encouraged to use information gained about student prior knowledge during introductory activities and discussions to inform your instructional differentiation. Strategies incorporated into this lesson include flexible grouping, varied environmental learning contexts, assessments, compacting, and tiered assignments and scaffolding.

Flexible Grouping: Students work collaboratively in a variety of activities throughout this module. Grouping strategies you might employ include student-led grouping, grouping students according to ability level, grouping students randomly, or grouping them so that students in each group have complementary strengths (for instance, one student might be strong in mathematics, another in art, and another in writing). You may also choose to group students based on their prior knowledge. For Lesson 2, you may choose to maintain the same student groupings as in Lesson 1 or regroup students according to another of the strategies described here. You may therefore wish to consider grouping students in Lesson 2 into design teams on which they will remain throughout the module.

Varied Environmental Learning Contexts: Students have the opportunity to learn in various contexts throughout the module, including alone, in groups, in quiet reading and research-oriented activities, and in active learning through inquiry and design activities. In addition, students learn in a variety of ways, including through doing inquiry activities, reading fiction and nonfiction texts, watching videos, participating in class discussion, and conducting web-based research.

Assessments: Students are assessed in a variety of ways throughout the module, including individual and collaborative formative and summative assessments. Students have the opportunity to produce work via written text, oral and media presentations, and modeling. You may choose to provide students with additional choices of media for their products (for example, PowerPoint presentations, posters, or student-created websites or blogs).

Compacting: Based on student prior knowledge, you may wish to adjust instructional activities for students who exhibit prior mastery of a learning objective. For instance, if some students exhibit mastery of calculating wind speeds in Lesson 1, you may wish to limit the amount of time they spend practicing these skills and instead introduce various units of measurement and unit conversions to these students.

Tiered Assignments and Scaffolding: Based on your awareness of student ability, understanding of concepts, and mastery of skills, you may wish to provide students with variations on activities by adding complexity to assignments or providing more or fewer learning supports for activities throughout the module. For instance, some students may need additional support in identifying key search words and phrases for web-based research or may benefit from cloze sentence handouts to enhance vocabulary understanding. Other students may benefit from expanded reading selections and additional reflective writing or from working with manipulatives and other visual representations of mathematical concepts. You may also work with your school librarian to compile a set of topical resources at a variety of reading levels.

STRATEGIES FOR ENGLISH LANGUAGE LEARNERS

Students who are developing proficiency in English language skills require additional supports to simultaneously learn academic content and the specialized language associated with specific content areas. WIDA has created a framework for providing support to these students and makes available rubrics and guidance on differentiating instructional materials for English language learners (ELLs) (see *www.wida.us/get.aspx?id=7*). In particular, ELL students may benefit from additional sensory supports such as images, physical modeling, and graphic representations of module content, as well as interactive support through collaborative work. This module incorporates a variety of sensory supports and offers ongoing opportunities for ELL students to work with collaboratively. The focus in this module on wind energy affords opportunities to access the culturally diverse experiences of ELL students in the classroom because students may have varied geographical backgrounds and diverse experiences with the ways that natural resource availability influences electricity generation (e.g., capturing wind energy and solar power).

Teachers differentiating instruction for ELL students should carefully consider the needs of these students as they introduce and use academic language in various language domains (listening, speaking, reading, and writing) throughout this module. To adequately differentiate instruction for ELL students, teachers should have an understanding of the proficiency level of each student. The following five overarching preK–5 WIDA learning standards are relevant to this module:

- Standard 1: Social and Instructional language. Focus on social behavior in group work and class discussions.
- Standard 2: The language of Language Arts. Focus on forms of print, elements of text, picture books, comprehension strategies, main ideas and details, persuasive language, creation of informational text, and editing and revision.
- Standard 3: The language of Mathematics. Focus on numbers and operations, patterns, number sense, measurement, and strategies for problem solving.
- Standard 4: The language of Science. Focus on safety practices, energy sources, scientific process, and scientific inquiry.
- Standard 5: The language of Social Studies. Focus on change from past to present, historical events, resources, map reading, and location of objects and places.

SAFETY CONSIDERATIONS FOR THE ACTIVITIES IN THIS MODULE

Science activities in this module focus on wind energy. Students create wind turbines from a variety of materials and should use caution when handling materials with sharp edges, particularly as they spin. For more general safety guidelines, see the Safety in STEM section in Chapter 2 (p. 18).

DESIRED OUTCOMES AND MONITORING SUCCESS

The desired outcomes for this module are outlined in Table 3.3, along with suggested ways to gather evidence to monitor student success. For more specific details on desired outcomes, see the Established Goals and Objectives sections for the module and individual lessons.

Table 3.3. Desired Outcomes and Evidence of Success in Achieving Identified Outcomes

Desired Outcomes	Evidence of Success	
	Performance Tasks	Other Measures
Students can apply an understanding of geography, mapping, and various science and mathematics concepts to complete small group projects and individual tasks related to the projects within the module.	• Students maintain STEM Research Notebooks that contain designs, research notes, evidence of collaboration, and ELA-related work. • Student teams design prototypes of wind turbines and create plans to mitigate the environmental impacts of a wind farm. • Student teams research and present information on a wind turbine location. • Students are able to discuss how they applied their understanding of concepts introduced in the unit to their designs (individual and team) and presentations. • Students are assessed using project rubrics that focus on content and application of skills related to the academic content.	Student collaboration is assessed using a collaboration rubric.

ASSESSMENT PLAN OVERVIEW AND MAP

Table 3.4 provides an overview of the major group and individual *products and deliverables,* or things that student teams will produce in this module, that constitute the assessment for this module. See Table 3.5 (p. 36) for a full assessment map of formative and summative assessments in this module.

Table 3.4. Major Products and Deliverables in Lead Disciplines for Groups and Individuals

Lesson	Major Group Products and Deliverables	Major Individual Products and Deliverables
1	• Blown Away Design Challenge boat • Resource Your Day research and handout • Earth's Spheres model/presentation	• Enough for Everyone? handout • Scarcity Scramble handouts • Blown Away Engineer It! handouts • Connect the Spheres handout • Earth's Spheres graphic organizer • STEM Research Notebook prompt
2	• U.S. Map Scavenger Hunt handout • How Windy Is the Wind? anemometer	• Map Me! handouts and maps • Where's the Wind? handouts • How Windy Is the Wind? Engineer It! handouts • Earth's Spheres Assessment • STEM Research Notebook prompt • Evidence of collaboration
3	• Dollars and Wind budget • Don't Bother the Neighbors presentation • Catch the Wind pinwheel • Energy Explorers data and calculations	• Catch the Wind data sheets • Don't Bother the Neighbors Engineer It! handouts • Scientific Method Assessment • STEM Research Notebook prompt • Evidence of collaboration
4	• Wind Farm Challenge presentation and model	• Wind Farm Challenge Economic Benefits handouts • Wind Farm Challenge Careers handouts • Wind Farm Challenge presentation graphic organizers • STEM Research Notebook prompt • Evidence of collaboration

Table 3.5. Assessment Map for Wind Energy Module

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	Blown Away Design Challenge *boat*	Group	Formative	• Understand that engineers use a process, the EDP, to solve problems and create products. • Apply understanding of wind energy and the EDP to a design challenge.
1	Resource Your Day *research*	Group	Formative	• Identify renewable and nonrenewable resources and discuss how these are used in their daily lives. • Describe the power source for their homes and schools.
1	Earth's Spheres *model/ presentation*	Group	Formative	• Understand that wind is the movement of air due to pressure differentials and Earth's rotation. • Understand and discuss the role of Earth's systems in the creation of wind.
1	Enough for Everyone? *handout*	Individual	Formative	• Understand and discuss the concept of resource scarcity.
1	Resource Your Day *handout*	Individual	Formative	• Identify renewable and nonrenewable resources and discuss how these are used in their daily lives
1	Scarcity Scramble *handout*	Individual	Formative	• Identify renewable and nonrenewable resources and discuss how these are used in their daily lives • Define and discuss the concept of resource scarcity

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
1	Blown Away Engineer It! *handouts*	Individual	Formative	• Understand that engineers use a process, the EDP, to solve problems and create products. • Apply understanding of wind energy and the EDP to a design challenge.
1	Connect the Spheres *handout*	Individual	Formative	• Identify Earth's four spheres: atmosphere, biosphere, hydrosphere, and lithosphere • Describe and illustrate interactions among Earth's spheres
1	Earth's Spheres *graphic organizer*	Individual	Formative	• Understand and discuss the role of Earth's systems in the creation of wind.
1	STEM Research Notebook *prompts*	Individual	Formative	• Discuss the role of Earth's spheres in the creation of wind • Understand and discuss the concept of resource scarcity.
2	How Windy Is the Wind? *anemometer*	Group	Formative	• Apply understanding of anemometer design and function and of the EDP to design and build a functioning anemometer.
2	How Windy Is the Wind? Engineer It! *handout*	Individual	Formative	• Apply understanding of anemometer design and function and of the EDP to design and build a functioning anemometer.
2	Map Me! *handouts and map*	Individual	Formative	• Identify geographic features of a U.S. region and create a map of these features. • Apply understanding of map symbols and conventions to locate landforms and geographic locations on maps.

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
2	Where's the Wind? *handouts*	Individual	Formative	• Apply map-reading skills to locate and identify existing wind farms in a region of the United States. • Apply understanding of map symbols and conventions to locate landforms and geographic locations on maps. • Apply map-reading skills to identify average wind speeds in a region of the United States. • Apply understanding of the differences in geography across the United States to make predictions about wind resource availability.
2	Earth's Spheres Assessment	Individual	Summative	• Identify Earth's four spheres: atmosphere, biosphere, hydrosphere, and lithosphere. • Describe and illustrate interactions among Earth's spheres. • Discuss the role of Earth's spheres in the creation of wind. • Create a model that illustrates interactions among Earth's spheres.
2	STEM Research Notebook *prompt*	Individual	Formative	• Identify differences and similarities between sedimentary, igneous, and metamorphic rocks..
2	Evidence of collaboration	Individual	Formative	• Collaborate with peers to create a solution to a problem.

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
3	Dollars and Wind *budget*	Group	Formative	• Research costs and income streams associated with wind farms and apply this information to create a budget.
3	Don't Bother the Neighbors *presentation*	Group	Formative	• Understand that there are environmental impacts associated with wind farms, but that these impacts are substantially different from those associated with burning fossil fuels. • Apply understanding of the environmental impacts of wind farms to create a plan to mitigate one type of environmental disadvantage.
3	Energy Explorers *data and calculations*	Group	Formative	• Apply basic mathematical skills to understand average household energy usage and how various energy sources can meet consumer energy needs.
3	Catch the Wind *data sheets*	Individual	Formative	• Identify the basic parts of a wind turbine. • Apply understanding of wind turbine technology to build a simple wind turbine and measure the amount of electricity it can produce. • Apply understanding of wind turbine technology to create a variety of turbine blades. • Create a plan for a scientific investigation using the scientific method.

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
3	Don't Bother the Neighbors Engineer It! *handouts*	Individual	Formative	• Apply understanding of the environmental impacts of wind farms to create a plan to mitigate one type of environmental disadvantage. • Use the EDP to design an innovation to mitigate an environmental impact of wind farms.
3	Scientific Method Assessment	Individual	Summative	• Identify tools scientists use to measure natural phenomena in each of Earth's spheres. • Identify and describe the steps of the scientific method. • Develop a testable question and a hypothesis for a scientific investigation.
3	STEM Research Notebook *prompt*	Individual	Formative	• Understand that there are environmental impacts associated with wind farms, but that these impacts are substantially different from those associated with burning fossil fuels.
3	Evidence of collaboration	Individual	Formative	• Collaborate with peers to create a solution to a problem.

Table 3.5. (*continued*)

Lesson	Assessment	Group/ Individual	Formative/ Summative	Lesson Objective Assessed
4	Wind Farm Challenge *presentation and model*	Group	Summative	• Apply understanding of economic, environmental, and technological features of wind turbines and wind farms to create a proposal for a wind farm location. • Identify careers related to the wind energy industry. • Create a persuasive argument for a wind farm location. • Demonstrate an understanding of the basic components and function of a wind turbine. • Collaborate with peers to create a solution to a problem.
4	Wind Farm Challenge individual student *handouts*	Individual	Summative	• Apply understanding of economic, environmental, and technological features of wind turbines and wind farms to create a proposal for a wind farm location. • Identify careers related to the wind energy industry. • Create a persuasive argument for a wind farm location.
4	Evidence of collaboration	Individual	Formative	• Collaborate with peers to create a solution to a problem.
4	STEM Research Notebook *prompt*	Individual	Formative	• Demonstrate an understanding of the basic components and function of a wind turbine.

MODULE TIMELINE

Tables 3.6–3.10 (pp. 42–43) provide lesson timelines for each week of the module. These timelines are provided for general guidance only and are based on class times of approximately 45 minutes.

Table 3.6. STEM Road Map Module Schedule for Week One

Day 1	Day 2	Day 3	Day 4	Day 5
Lesson 1: The Wonderful Wind • Launch the module by introducing nonrenewable and renewable energy sources, wind energy, and the concept of scarcity. • Introduce STEM Research Notebook. • Introduce the Wind Farm Challenge.	*Lesson 1: The Wonderful Wind* • Investigate scarcity with Enough for Everyone? activity. • Begin Earth's Spheres activity.	*Lesson 1: The Wonderful Wind* • Investigate natural resources and renewable versus nonrenewable resources in Resource Your Day activity. • Complete Earth's Spheres activity. • Introduce the EDP.	*Lesson 1: The Wonderful Wind* • Continue Resource Your Day activity. • Apply the EDP in Blown Away Design Challenge.	*Lesson 1: The Wonderful Wind* • Investigate the distribution of resources in Scarcity Scramble activity.

Table 3.7. STEM Road Map Module Schedule for Week Two

Day 6	Day 7	Day 8	Day 9	Day 10
Lesson 2: Where's the Wind? • Introduce wind turbine technology. • Discuss wind resources as they relate to geography. • Investigate hurricane force winds.	*Lesson 2: Where's the Wind?* • Introduce maps and the various types available in Marvelous Maps activity. • Begin How Windy Is the Wind? activity.	*Lesson 2: Where's the Wind?* • Students investigate a region of the United States in Map Me! activity. • Continue How Windy Is the Wind? activity.	*Lesson 2: Where's the Wind?* • Continue Map Me! activity	*Lesson 2: Where's the Wind?* • Begin Where's the Wind? activity.

Table 3.8. STEM Road Map Module Schedule for Week Three

Day 11	Day 12	Day 13	Day 14	Day 15
Lesson 2: *Where's the Wind?* • Continue Where's the Wind? activity	*Lesson 2:* *Where's the Wind?* • Complete Where's the Wind? activity. • Explore meteorology/ weather websites.	*Lesson 3:* *Wind Impact* • Introduce environmental and financial costs of wind farms.	*Lesson 3:* *Wind Impact* • Introduce Dollars and Wind activity. • Students investigate wind turbine electricity generation and blade design in Catch the Wind investigation.	*Lesson 3:* *Wind Impact* • Complete Dollars and Wind activity. • Introduce Don't Bother the Neighbors activity. • Continue Catch the Wind investigation.

Table 3.9. STEM Road Map Module Schedule for Week Four

Day 16	Day 17	Day 18	Day 19	Day 20
Lesson 3: *Wind Impact* • Continue Don't Bother the Neighbors activity.	*Lesson 3:* *Wind Impact* • Complete Don't Bother the Neighbors activity. • Student give presentations.	*Lesson 4:* *The Wind Farm Challenge* • Introduce Wind Farm Challenge. • Review challenge materials. • Students investigate local economic benefits of wind farms and careers in energy.	*Lesson 4:* *The Wind Farm Challenge* • Complete careers research. • Create model of plan or device to mitigate environmental impact.	*Lesson 4:* *The Wind Farm Challenge* • Organize information for presentation and create the summary.

Table 3.10. STEM Road Map Module Schedule for Week Five

Day 21	Day 22	Day 23	Day 24	Day 25
Lesson 4: *The Wind Farm Challenge* • Complete information organization and begin work on creating presentation.	*Lesson 4:* *The Wind Farm Challenge* • Continue work on creating presentations.	*Lesson 4:* *The Wind Farm Challenge* • Continue work on creating presentations.	*Lesson 4:* *The Wind Farm Challenge* • Share presentations.	*Lesson 4:* *The Wind Farm Challenge* • Continue to share presentations.

RESOURCES

Teachers have the option to co-teach portions of this unit and may want to combine classes for activities such as researching the environmental impacts of wind farms. The media specialist can help teachers locate resources for students to view and read about wind energy and provide technical help. Special educators and reading specialists can help find supplemental sources for students needing extra support in reading and writing. Additional resources may be found online. Community resources for this module may include urban planners, engineers, school administrators, and parents.

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Grade 5

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Wind Energy

What if you could challenge your fifth graders to develop an economical, eco-friendly wind farm? With this volume in the *STEM Road Map Curriculum Series*, you can!

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- Study U.S. geography, weather patterns, the economics of wind energy, and issues about the use of wind turbines as an energy source.
- Learn how Earth's spheres—including the lithosphere, hydrosphere, atmosphere, and biosphere—interact and how to observe and measure them.
- Be challenged to develop a wind farm. Working in teams, students will analyze the wind energy potential of a possible location. Then, they will create a proposal that considers the wind farm's cost, energy production, and environmental impact.
- Deliver their presentations to garner support from the wind farm's surrounding community and potential investors.

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