Unit 7.1
"Off the Grid": Creating an Energy Plan
Public Preview

Unit Summary

In this unit, students try to remain on "the grid" by exploring energy and electricity generation. Through a series of hands-on investigations, students are able to apply what they have learned to create an electricity generation plan for an isolated piece of land utilizing wind and/or water.

Students are first introduced to several renewable energy sources, including wind and water, that could be used to generate electricity. To think about the most efficient placement of electrical generators, students engage in investigations to explore gravitational potential energy (MS-PS3-2) and kinetic energy (MS-PS3-1). Realizing that energy needs to be transferred between different objects, students explore and model energy transfers within a system (MS-PS3-5). Students also kinesthetically simulate the transformation of energy to further explore how energy changes within a system. Finally, students revisit electricity generation by first exploring magnetic and electric forces (MS-PS2-3) and then exploring electromagnetic forces within an electromagnet.

Unit Challenge Questions

- How can we capture and transform energy from the world around us to help meet our needs?

Unit Big Ideas

- Energy is transferred within and between systems in different but predictable ways.
- Modeling these energy transfers helps make it possible to harness energy for societal needs.

Connection to 21st Century Issues

As modern society expands and becomes more advanced, the dependence on electronic devices also grows. People today depend on electricity and energy on a hourly basis - from living in their home to traveling through the country and even communicating globally. It is not often someone plugs in a device to charge and considers all the scientific and engineering principles that go into generating electricity in the charging cord. Electrical energy in an electrical socket typically begins in another form; chemical energy from coal or nuclear, or mechanical energy from wind or water. Even when energy starts in it's mechanical form, it could be deconstructed further into potential and kinetic energy. This kinetic energy from steam (created from burning coal), wind, or water can be transferred to a set of turbine blades, before turning magnets in a generator that transforms the kinetic mechanical energy into electrical energy. Scientists and engineers must fully understand this process to design and build larger and larger systems that can generate and transport energy from generation plants or cells to the consumer.

Unit Challenge

Unit Challenge Summary

Students face going "off the grid" because their parents are frustrated with electricity bills. Fearing the loss of their devices and other creature comforts, students work collaboratively to design and explain an electricity generation plan for the "off the grid" property their parents are moving them to. Students must use the concepts of energy, energy transfers, and the transformation of energy to describe how wind and/or water could be utilized to generate electricity. Within their electricity generation plan, students must decide locations of the generators, use reasoning to defend their locations, and provide their parents with explanations of how the generators function and generate electricity. Students must also be able argue from evidence as to why their plan will work and is the best solution for the challenge.

Unit Challenge Scenario

"Your parents are fed up with paying their electric bills. They've decided to go completely off the grid. They are going to build a house on a plot of land they've already purchased. There are no electrical lines nearby and your parents have no intention of hooking up to any external electrical source. You are horrified at the thought of having no phone, no game devices, no TV/DVDs, no light, no refrigeration and no hot water.

Your parents have given you a map of the land, and you're pretty sure you could design an electricity generation plan that uses wind energy and/or water energy to generate electricity for the devices you want to use on the property. Your parents have agreed to let you try to create this electricity generation plan, but they have a limited budget and they have concerns about environmental impacts. They also don't really know how electricity is generated and have never heard of kinetic, potential, or electromagnetic energy.

You will have to teach them about these forms of energy and convince them your plan will work. Your challenge is to design a plan for electricity generation that stays within budget, has limited environmental impacts, and generates enough electricity for your household, AND to convince your parents it will work. Otherwise, you and your family will be left IN THE DARK!"

Unit Challenge Student Products & Teacher Resources

Exemplary Student Products and Other Teacher Resources:

- 7.1_UnitChallenge_ElectricityGeneratorExemplar
- 7.1_UnitChallenge_WindGeneratorExemplar
- 7.1_UnitChallenge_WaterGeneratorExemplar
- 7.1_UnitSummaryTable_TeacherVersion
- 7.1_UnitChallenge_StudentProductChecklist

Unit Challenge Student Resources

- 7.1_UnitChallenge_Map(NoNumbers)
- 7.1_UnitChallenge_Map(ElevationNumbers)
- 7.1_UnitChallenge_DecisionMatrix
- 7.1_UnitChallenge_DecisionMatrixInformationSheets
- 7.1_UnitChallenge_PresentationRubric
- 7.1_UnitChallenge_AudienceEvaluation
- 7.1_UnitSummaryTable_StudentVersion

Lesson Sequencing Table

Lesson #	Lesson Questions	What students do...	# days
1	• How can we capture and transform energy from the world around us to help meet our needs?	Students uncover their prior knowledge regarding electricity and energy by reflecting on their morning routines. They also consider how life in their home, town/city, and country are affected by electricity before being introduced to the Unit Challenge. Students also create a Unit Bubble Map to guide them through the unit.	1
2	• What scientific knowledge and evidence do we need to explain where and how electricity can be generated?	Students are introduced to renewable energy and utilize a jigsaw learning method to explore six energy sources. Students compare the sources and critically think about how each source would or would not be a viable option for large scale electricity generation in Michigan.	2
3	• How can electrical energy be generated? • What are the necessary parts of an electrical generation system?	Students explore a simple electric generator that lights a small light bulb. After the physical investigation, students create initial models of the generator system before creating a consensus model with the class.	2
4	• What causes the potential energy within a system to change? • How does the location of an electric generator affect its ability to capture energy from its surroundings?	Students experience a food “splat-o-meter” before exploring the concepts of potential energy and height by conducting an investigation utilizing a pendulum system. Students model the system and use the results to think about the most efficient placement of a hydroelectric generator.	3
5	• How are mass and speed related to kinetic energy?	Students witness how height and mass can affect the distance traveled of an object launched from a catapult. Students use this experience to expand their pendulum investigation to explore how mass can affect energy. Students gain valuable graphing experience to determine which has the larger effect on kinetic energy - speed or mass.	3
6	• How does energy change as it is transferred between objects in a system?	Students see several examples of energy being transferred between objects, before planning and carrying out their own investigation to see how energy is transferred within a windmill system. Students model the system and use a claim-evidence-reasoning to describe how the system functions.	3

7	● What happens to energy when it appears to “disappear” in a system?	Students experience several situations in which it appears energy “disappears”. Through a simulation investigation, students identify different types of energies and witness energy transforming from one type to another. By acting out the simulated energies, students learn about the total energy and the conservation of energy in a system.	2.5
8	● What factors affect the strength of (static) electric and magnetic forces?	Students ask questions about magnetism and static electricity and decide on the ones that are testable in the classroom. Students investigate their testable questions and explore what factors affect magnetic and electric forces. Students use this information to further their understanding of the electric generators, and to prepare them for the next lesson.	2.5
9	● How can electromagnetism transform mechanical energy (energy of object motion) into electrical energy? ● What factors affect the strength of electromagnetic forces?	Students witness a large scale magnet that can be turned on and off. The electromagnet is scaled down to a desktop version that students work with to investigate the factors that affect the strength of the electromagnet. Students then apply what they know about the electromagnets	2
UC	● How can we capture and transform energy from the world around us to help meet our needs?	Students apply what they have learned throughout the unit to address the Unit Challenge. Students work in groups to prepare and present their challenge solution to their parents.	4

Select Assessment Tools

The tools below are just **some** of the assessment opportunities that are available in this unit. The tools in this section have undergone more formal review.

Pre-Post Assessment:

- Unit 7.1 Pre-Post Assessment- Student Version
- Unit 7.1 Pre-Post Assessment- Teacher Version

Embedded Assessment:

- Lesson 05 Check Your Progress
    - 7.1_L05_Check_Student_EA_StudentCopy
    - 7.1_L05_Check_Teacher_EA_StudentExemplar
- Lesson 08 Check Your Progress
    - 7.1_L08_Check_Teacher_EA_InstructionsRubric
    - 7.1_L08_Check_Student_EA_StudentCopy
    - 7.1_L08_Check_Teacher_EA_StudentExemplar

Unit Challenge Student Product Proficiency Rubrics:

- 7.1_LUC_Check_ChallengePresentation_Teacher_InstructionsRubric

Unit Content Resources:

- NGSS Connections
- Prior and Future Knowledge
- Unit Materials List
- Compiled Gotta Have Checklist*
- Unit External Web Links*
- Unit Overview Video*
- Teacher Background Content Resources*

*Available to teachers who have completed the Unit Primer as part of the Mi-STAR Professional Learning Program

Unit Advance Preparation:

- Consult the Unit Materials Shopping List
- Complete the Unit 7.1 Planning Tool