EQuIP Rubric for Science

How do we power clocks and other devices?

Curriculum Developer: OpenSciEd

GRADE 4 | FEBRUARY 2025

nsta
National Science Teaching Association

Category I Rating

A	B	C	D	E	F
Explaining Phenomena/ Designing Solutions	Three Dimensions	Integrating the Three Dimensions	Unit Coherence	Multiple Science Domains	Math and ELA
EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE

Score Category I: 3

Category II Rating

A	B	C	D	E	F	G
Relevance and Authenticity	Student Ideas	Building Progressions	Scientific Accuracy	Differentiated Instruction	Teacher Support for Unit Coherence	Scaffolded Differentiation Over Time
EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE	ADEQUATE

Score Category II: 3

Category III Rating

A	B	C	D	E	F
Monitoring 3D Student Performance	Formative	Scoring Guidance	Unbiased Tasks/Items	Coherent Assessment System	Opportunity to Learn
EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE	EXTENSIVE	ADEQUATE

Score Category III: 3

UNIT 2	
Sum Categories	**9**
Rating	**E**

Overall Summary Comments

This unit is designed for the *Next Generation Science Standards* (*NGSS*), including clear and compelling evidence of the following criteria:

Category I

- I.B Three Dimensions. The focal elements of the DCI, SEP, and CCC are used and developed in the unit and provide students with opportunities to build proficiency.
- I.C Integrating the Three Dimensions. The unit is designed so that students use elements from all three dimensions to explain a phenomenon.
- I.D Unit Coherence. Student questions are used to connect lessons, leading to an understanding of the science ideas that explain the phenomenon.

Category II

- II.A Relevance and Authenticity. Students experience the phenomenon directly, and the unit includes many ways that students can connect their learning with their own community and experiences.
- II.B Student Ideas. Students have opportunities throughout the unit to express their ideas in a variety of ways, to get feedback from peers and the teacher, then clarify or change their thinking.
- II.E Differentiated Instruction. The unit materials give guidance to teachers on adapting the lessons to meet the needs of a variety of learners.
- II.F Teacher Support of Unit Coherence. Teachers are supported in helping students grasp the connections between lessons by the unit's navigation routine, which includes tasks at the beginning of each lesson to establish a link to the prior lesson.

Category III

- III.B Formative Assessment. These assessments are embedded into the instructional sequence and evaluate student thinking on all three dimensions.
- III.E Coherent Assessment System. The unit includes various forms of assessment that target all learning goals.

The unit was reviewed to "provide constructive criterion-based feedback and suggestions for improvement to developers" (EQuIP Rubric for Lessons and Units: Science (Version 3.1). Reviewers recommend focusing on the following criteria during revisions:

- II.E Scaffolded Differentiation Over Time: Although students have multiple opportunities to engage in some of the focal SEP elements, some of those SEP elements were used in single lessons, so there are no opportunities to first provide scaffolds, then remove those scaffolds.
- III.F Opportunity to Learn: The unit has few places in which teachers provide feedback to the thinking of individual students.

Why are there two colors of text in this report?

Black text is used in this report to identify direct quotations or paraphrases of a lesson/unit (the evidence) and why/how this evidence indicates the criterion is being met (the reasoning). (EQuIP Rubric for Lessons & Units: Science (Version 3.1))

Black text is also used for evidence and reasoning that does not affect the rating of the criterion.

Purple text is used in this report to identify direct quotations or paraphrases of a lesson/unit (the evidence) and why/how this evidence indicates that the criterion is NOT being met (the reasoning). (EQuIP Rubric for Lessons & Units: Science (Version 3.1)) The exception to this is when a criterion is rated as "extensive." In those cases, purple is used as a visual cue to *"provide constructive criterion-based feedback and suggestions for improvement to developers"* (EQuIP Rubric for Lessons & Units: Science (Version 3.1)).

CATEGORY I
NGSS 3D Design

I.A. Explaining Phenomena / Designing Solutions

EXTENSIVE

Making sense of phenomena and/or designing solutions to a problem drive student learning.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem solving.

ii. The focus of the lesson is to support students in making sense of phenomena and/or designing solutions to problems.

iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical, life, and/or earth and space sciences.

The reviewers found **extensive** evidence that making sense of phenomena and designing solutions to a problem drive student learning. Materials are organized so that students are figuring out the central phenomenon of winding clocks and plug-in clocks both needing something to make them turn on and stay on. Student questions and prior experiences related to the phenomenon or problem motivate sensemaking and/or problem solving. An engineering problem is a learning focus for the latter part of the unit, and it is integrated with the disciplinary core ideas from physical and Earth sciences.

i. Student questions and prior experiences related to the phenomenon or problem motivate sense-making and/or problem-solving.

- In this unit, students make sense of an anchoring and related phenomenon.
- Lesson 1, Explore Section, Step 2: "Observe and manipulate a winding clock. Display slide B and tell students that the first clock they will observe is a winding clock. Before you give students time to observe and manipulate its parts, ask students if they have seen or heard about a clock that "winds up." Give students 1-2 minutes to respond, and then show them the winding clock that you have already started. Ask them to think about what had to happen to make it turn on and stay on. After 1-2 minutes of response time, give each student an opportunity to manipulate the pieces on the winding clock. (Try not to spend more than 3-5 minutes here as students will have more opportunities to talk about this throughout the lesson.) Alternatively, show students Winding a clock." (Lesson 1, Teacher Guide)
- Lesson 2, Explore Section, Step 4, "Have students turn and talk with a partner about the evidence they could look for that would help them understand how the plug-in clock is turning on and staying on." (Lesson 2, Teacher Guide)
- Lesson 3, Synthesize Section, Step 4: "Explain to students that our goal in the Consensus Discussion is to consider what our investigation helped us figure out about why a plug-in clock turns on and stays on. Tell students that it will be important for them to not only share what they observed in the investigation but also to listen to and connect with what other groups/students share so we can understand what we think we figured out and where we still have questions." (Lesson 3, Teacher Guide)
- Lesson 4, Synthesize Section, Step 3, "Display slide J. Use the prompt on the slide to have students turn and tell a partner about how an observation on the class list helps tell the story of how energy gets to the plug-in clock. Have students share their ideas with the class." (Lesson 4, Teacher Guide, p18)
- Lesson 5, Navigate Section, Step 1: "Have a student summarize that we figured out that electricity comes into our school from power lines outside and then is carried in wires/conduits to our classroom to turn on devices like clocks. Ask students what we are planning to investigate today." (Lesson 5, Teacher Guide)

- Lesson 6, Navigate Section, Step 1, "Review what we figured out and wondered about the last lesson. Display slide A. Give students 1-2 minutes to review the Class Consensus Model and have a few students summarize for the class what we figured out and what we wondered." (Lesson 6, Teacher Guide)
- Lesson 7, Navigate Section, Step 6, "Ask students if they think they have enough information to explain why the plug-in clock turns on and stays on. Students should be able to answer many of the questions related to energy transfer and powering a device and should notice that they have gathered a lot of evidence. (Lesson 7, Teacher Guide)
- Lesson 8, Synthesize Section, Step 2: "Display slide B and point out the sentence starters and prompts for students to use during this discussion. You might say something like, 'We are trying to decide what we know about how the plug-in clock turns on and stays on and where we still have questions, so let's work together to discuss and combine our ideas.' Remind students that consensus means agreeing, but that does not mean we know all the answers to our questions. We are trying to find if we do agree on some ideas, and find places where we're still not sure (because that will help us plan what we still need to figure out)." (Lesson 8, Teacher Guide)
- Lesson 9, Navigate Section, Step 1: "Point to the Related Phenomena/things that turn on charts and focus students on the devices they used to tell time. Have students choose a few of those devices, then turn and talk with a partner about the questions on the slide, then facilitate a brief discussion. Jot down students' responses on chart paper, whiteboard, or in a virtual space. 'How are clocks that need to be set similar or different from clocks that always have the right time? How do you think some clocks know the time without being set?' Summarize student responses by saying that it sounds like we aren't sure how a clock can get information like the time, without having to be set with our hands. Suggest to students that maybe we look closer at how we could send information to one another to see if that will help us figure out why we don't have to set some clocks." (Lesson 9, Teacher Guide)
- Lesson 10, Navigate Section, Step 8, "Remind students that one big part of why we did this task was to start to make sense of how some clocks know the time without being set manually. Have students turn and tell a partner how they think clocks such as the ones on our phones, computers, or other electronics receive information about the time, based on what we have figured out in our own designs. After students talk for about a minute, ask a few students to share. Accept all answers." Lesson 10, Teacher Guide)
- Lesson 11, Explore Section, Step 2: "Build connections between our designs and clocks. Display slide C and review with students that we have been trying to make sense of how some clocks might get time information without being set with our hands. Point out some of the clocks on their Related Phenomena/Things that turn on charts that they listed. Give them a moment to turn and tell a partner similarities and differences they see between their designs and the clocks they use to tell time. Have students briefly share out. Look and listen for ideas such as: The clocks we use have to plug-in. The clocks we use have to be charged. The clocks we use don't have to be set. In our designs, we had to always write down the time. In our designs we had to move something each time we tested. We can't continuously tell time with our designs. Our designs always show the same time. Ask 1-2 students to summarize what they heard and emphasize that it sounds like we can name several differences between the clocks we can design within our constraints and the clocks we use to tell time. Suggest that it seems important that we gather more information to learn more about how some clocks do not have to be set." (Lesson 11, Teacher Guide)
- Lesson 12, Navigate Section, Step 1, "Remind students that we left the last session with some questions about the effects of usable energy sources after thinking about the effects of plugging in clocks or other devices that we use. Suggest that we might need more evidence about usable energy sources and their effects." (Lesson 12, Teacher Guide)
- Lesson 13, Synthesize Section, Step 3, "Revisit our criteria and constraints. Point out to students that we started our investigation by wondering what are the effects of using usable energy sources to power our devices, like clocks. We took some time to think about criteria and constraints for what we would want for usable energy sources in our own community. Suggest to students that they revisit their criteria and constraints now that they have more information about effects and how to reduce electricity usage." (Lesson 13, Teacher Guide)

During the unit, learning is driven by students' questions that lead to a greater understanding of the phenomenon.

- Lesson 1, Navigate Section, Step 6: "Brainstorm ideas for investigation. Display slide O. Point out to students that they have generated many interesting ideas and questions about why a plug-in clock turns on and stays on. Distribute the Investigation Ideas handout. Point students back to the class's initial consensus model/DQB. Invite students to choose one group of questions, or you can assign groups of questions to specific student partnerships/trios. Have students work for 3-5 minutes to brainstorm ideas for what we can do to help answer some of those questions." (Lesson 1, Teacher Guide)
- Lesson 1, Synthesize Section, Step 5, "Build our Driving Question Board. Display slide N. Explain that we want to gather and organize our questions in a way that will help guide the investigations we do and help us track the ideas we figure out along the way. Explain that it is important that we hear everybody's questions, and we might find that we have questions similar to some of our classmates' questions. As we share, we'll organize our questions into groups so we can more easily plan investigations and track what we have figured out" (Lesson 1, Teacher Guide)
- Lesson 2, Connect Section, Step 2, "Take a school tour. Start in your own classroom, then continue along a route so students can notice examples of the following ways we know something is on: light: exit signs, projectors, devices with screens, even printers with an "on" light or display. sound: school bells, communication devices, speakers/radios, walkie-talkies. heat: toaster, oven, microwave in the cafeteria or staff kitchen. motion: fans, electric pencil sharpener, powered wheelchair, dishwasher. (Lesson 2, Teacher Guide)
- Lesson 2, Navigate Section, Step 7, "Invite students to share their new questions with the class. Display slide R. Ask students to write one question that they have now, or one question that they still have after our exploration, on a sticky note. Have students read their questions aloud and bring them up to add to the Driving Question Board or to the Related Phenomena lists. (Assist students in placing them wherever they are most relevant.)" (Lesson 2, Teacher Guide)
- Lesson 3, Navigate Section, Step 1: "Have students look over the class lists of related phenomena we created after the school tour in Lesson 2 and our Driving Question Board. Remind them that they had asked questions about batteries in Lesson 2. Ask them to identify the devices that we think are powered by a battery. Have students turn and talk with a partner about the slide questions, then share aloud with the class." (Lesson 3, Teacher Guide
- Lesson 3, Navigate Section, Step 5, "Introduce My Growing Ideas charts. Display slide K. Say something like, We have just figured out a lot of things and we still have some things we are wondering about, so let's take some time to capture our ideas and questions. If this is the first unit of the year, explain that because students are older and more independent now, they can keep track of their own thinking as we make progress on figuring out our questions. Since this is the first time we are recording our thinking like this, suggest that we practice together today. Then in future lessons, students can work entirely on their own." (Lesson 3, Teacher Guide)
- Lesson 5, Navigate Section, Step 1, "To motivate today's investigations, as a class, have students think about different ways they have heard that we can generate electricity." (Lesson 5, Teacher Guide)
- Lesson 6, Navigate Section, Step 5: "Discuss the questions on the slide, then point out that it sounds like we have questions about how electricity could be generated without moving parts, like a turbine. Post these new questions to the DQB...Tell students we can start to investigate some of these questions in the next lesson." (Lesson 6, Teacher Guide)
- Lesson 8, Synthesize Section, Step 2: "Then, emphasize that it sounds like students have gathered a lot of evidence about the different ways that energy is transferred. Suggest that they take the time to create an evidence bank so that we can keep track of all the evidence we have gathered." (Lesson 8, Teacher Guide)
- Lesson 8, Navigate Section, Step 4, "Revisit our Driving Questions Board. Display slide E. Remove several questions from the DQB, enough to give each group at least one question to discuss, possibly more if you want. Distribute

questions from the DQB to each group. Each group should discuss their question(s) and be ready to sort them into one of three categories; answered, partially answered, or still need to be answered." (Lesson 8, Teacher Guide)

- Lesson 11, Navigate Section, Step 4, "Briefly review the work we did in this lesson set. Display slide H. Point out questions on the DQB related to wireless communication and how some clocks do not need to be set and ask students to turn and talk about how they would answer them. If time allows, invite a few students to share with the whole class, and to jot down their answers on the sticky note, or on another one that will be placed nearby it...Ask students to share a related question that is already on their DQB or any new ones they may have. Then, emphasize their questions related to the effects of usable energy sources. Suggest that this line of questions sounds like the next thing we should investigate." (Lesson 11, Teacher Guide)
- Lesson 12, Navigate Section, Step 1: "Remind students that we left the last session with some questions about the effects of usable energy sources after thinking about the effects of plugging in clocks or other devices that we use. Suggest that we might need more evidence about usable energy sources and their effects." (Lesson 12, Teacher Guide)
- Lesson 13, Navigate Section, Step 5, "Take stock of what we have figured out and what questions we still have. Display slide J. As a class, go through the remaining questions on the Driving Question Board. Quickly review with students the answers to the questions. Determine if any questions have been left unanswered or if there are any that we can partially answer." (Lesson 13, Teacher Guide)

The unit has multiple lesson-level phenomena that are connected to the anchor phenomenon. Understanding of the anchor phenomenon is then used to solve an engineering design problem.

- Lesson 3, Synthesize Section, Step 4: "Explain that we have now developed a model for how a simple circuit works, and we have already developed an initial model of how the clocks worked, but today, we are trying to explain where the energy comes from and goes to make a device like a clock turn on and stay on. Add the battery to our Class Consensus Model (Why does the plug-in clock turn on and stay on? chart), if it is not already there, using students to guide where they think it should be placed." (Lesson 3, Teacher Guide)
- Lesson 5, Navigate Section, Step 1: "Say something like, "We have some materials we can use to investigate how wind turbines work. If we observe a small wind turbine here in our classroom, how could we tell if energy is being transferred by electrical currents from it? What would our evidence be?" If needed, point to the Related Phenomena/ Things that turn on lists to help students remember what is our evidence of energy transfer." (Lesson 5, Teacher Guide)
- Lesson 7, Synthesize Section, Step 5: "Remind students that we started our investigation wondering how solar panels are able to generate electricity and we carried out a fair test investigation to test solar panels in the sun. Give students 1-2 minutes in pairs to summarize what they learned from the discussion before sharing out." (Lesson 7, Teacher Guide)
- Lesson 8, Synthesize Section, Step 3: "Tell students they will be using their understanding of usable energy sources and how a plug-in clock turns on to identify evidence that could be used to explain energy transfer in a game console." (Lesson 8, Teacher Edition)
- Lesson 9, Navigate Section, Step 1, "Summarize student responses by saying that it sounds like we aren't sure how a clock can get information like the time, without having to be set with our hands. Suggest to students that maybe we look closer at how we could send information to one another to see if that will help us figure out why we don't have to set some clocks." (Lesson 9, Teacher Guide)
- Lesson 9, Synthesize Section, Step 6: "Once students have completed their designs, point them to the prompt at the bottom of the handout. Give students a few more minutes to write about how they think their design solutions may

be similar or different from how some clocks know the time. When students have completed their handouts, collect them to be used in Lesson 10." (Lesson 9, Teacher Guide)

- Lesson 11, Explore Section, Step 2: The class discusses what they noticed across multiple information stations and what the big ideas are from these stations. At the end of the discussion, "Tell students that it sounds like they obtained a lot of information about how devices communicate that can help us figure out how some clocks don't have to be set. Suggest that they take some time to come to a consensus on what they figured out." (Lesson 11, Teacher Guide)
- Lesson 12, Navigate Section, Step 1, " Remind students that we left the last session with some questions about the effects of usable energy sources after thinking about the effects of plugging in clocks or other devices that we use. Suggest that we might need more evidence about usable energy sources and their effects." (Lesson 12, Teacher Guide)
- Energy Transfer Electricity Front Matter, "The anchoring phenomenon for this unit is that winding clocks and plug-in clocks need something to make them turn on and stay on." (Energy Transfer Electricity Front Matter, p12) The front matter indicates only one phenomenon that is explored in the unit; however, students can explain this phenomenon in Lesson 8. Lessons 9-14 include two small phenomena that are connected in a logical way through the navigate sections of Lessons 9 and 12.

ii. The focus of the unit is to support students in making sense of phenomena and/or designing solutions to problems.

The anchoring phenomenon indirectly connects to all learning objectives. However, the learning objectives that do not mention the anchoring phenomenon still serve the students in designing solutions to the lesson-level phenomena they are investigating. For example, in Lesson Set Two (Lessons 9-11), the learning objectives do not mention clocks. However, the lessons allow students to understand why some clocks always have the right time.

Lesson 1, **Develop a model to describe the causes of why a clock turns on and stays on** (**effects**).

- Lesson 1, Synthesize Section, Step 3, "Individually create initial models. Display slide H. Distribute the Initial Model handout and give students 8-10 minutes to draw their models. Encourage students to use arrows to show why the plug-in clock turns on and stays on, and to label what their arrows represent. Students will have time to refine their models after talking with a partner in the next step." (Lesson 1, Teacher Guide)

Lesson 2, **Make observations to gather evidence that energy transfer causes changes in motion, sound, and heat** (**effect**).

- Lesson 2, Explore Section, Step 4: "Summarize the key takeaways from the discussion. Display slide H. Using the prompts on the slide, trace the path of causes and effects through the plug-in clock to see how everything could work together. Start with the plug and ask students what it is connected to and what they think it does, then continue to follow the path of wires to the clock display. As students trace the path, raise questions, such as what could be inside the wires or what could be causing the changes that we see (e.g., sounds coming from the clock or the display lighting up when it's on)." (Lesson 2, Teacher Guide)

Lesson 3, **Make observations of a simple circuit to gather evidence** that the **light bulb turns on** (**effect**) because **batteries transfer energy through electrical currents** (**cause**).

- Lesson 3, Synthesize section, Step 4: "Use the battery and alligator clip wires to make the light shine. Draw and label the system you created in the space below." (Lesson 3 Handout, Make a Light Shine)

Lesson 4, **Make observations of paths for electrical current and energy transfer to build ideas about how energy transfers from somewhere to our plug-in clock by electrical currents.**

- Lesson 4, Synthesize section, Step 3: "We were trying to "tell the story" of how energy transfers to our classroom outlets and allows us to turn on the plug-in clock. On your handout: Using a combination of words, drawings, or symbols, list the observations you made on the school tour that can help tell the story. (Lesson 4 Slides, Slide F)

Lesson 5, **Make observations to gather evidence for how energy from moving objects can be transferred to electrical current**.

- Lesson 5, Synthesize Section, Step 5: "Give students 5-7 minutes to develop their model (question #2) explaining how a wind turbine generates electricity before sharing it with a partner. Remind them to use arrows to show how and where energy is being transferred. Then, have students write an explanation (question #3) using evidence from their observations to describe how the wind turbine generates electricity." (Lesson 5, Teacher Guide)

Lesson 6: **Combine information** and **describe patterns** about **how different sources of energy can be used to generate electricity.**

- Lesson 6, Synthesize Section, Step 3: "Choose one usable energy source. Explain how electricity can be generated from that source." (Lesson 6 Handout, Generating Electricity Data Sheet).

Lesson 7, **Plan and carry out a fair test investigation to gather evidence** about how **energy can transfer from place to place through light**.

- Lesson 7, Explore Section, Step 2, "Using their developing understanding of variables, help students come up with an investigation question to guide their fair test, something like "How does changing the amount of sunlight affect the movement of the motor?" Display slide D. Give students 2-3 minutes to discuss in groups the prompts on the slide, then facilitate a brief conversation to come to consensus on how to carry out the fair test investigation." (Lesson 7, Teacher Guide) Lesson 8, **Make observations to provide evidence** that **energy can be transferred from place to place by sound, light, heat, and electric currents.**
- Lesson 8, Synthesize Section, Step 2, "When prompting students for evidence, allow students 2-3 minutes to look through a science notebook for examples and discuss with table partners before sharing the whole group. If students need more guidance to know where to look for evidence you can provide a lesson number or recall investigations that we completed. Prompting for evidence will be important to support them in creating their evidence bank, which they will do after updating their Class Consensus Model." (Lesson 8, Teacher Guide)

Lesson 9, **Define a simple design problem** and **identify criteria and constraints for transferring information across a distance**.

- Lesson 9, Explore Section, Step 4: "Use prompts on the slide to guide the class to consensus for the criteria for this design, and record their ideas on the chart." "Define constraints for our design problem. Display slide F. Point students back to the ideas they had about narrowing the design problem with limitations or conditions. Use this to explain that we can't jump into planning or testing until we think about our constraints to better define our design problem. Co-construct a definition for constraints with students and add it to the Word Wall, something like limitations on our design or solution. Use prompts such as these to establish the constraints on our design." (Lesson 9, Teacher Guide) In planning this, students connect back to their understanding of clocks. " We started this design project to help us understand how some clocks know the time without being set. How do you think your communication design solution might be similar or different from how some clocks receive time information?" (Lesson 9 Handout, Develop a Design Solution). Lesson 10, **Plan and carry out a fair investigation to test**

design solutions based on criteria and constraints for transferring information (**energy**) across a distance and to **suggest improvements**.

Lesson 10, Plan and carry out a fair investigation to test design solutions based on criteria and constraints for transferring information (energy) across a distance and to suggest improvements.

- In Lesson 10, Explore Section, Step 3, the class discusses the results of their investigation. "What do you have to do to send the information? How do you think this is similar or different from how a clock can receive information?" (Lesson 10, Teacher Guide)

Lesson 11, **Obtain information to explain how devices use digitized patterns to communicate information (energy) across long distances.**

- Lesson 11, Explore Section, Step 2: "Distribute the *Stations Activity Sheet* to each student. Before moving to the stations, refer students to our Class Agreements and ask students to pick one that they will focus on during the activity. Divide students into groups and assign each group a starting station. Give students about 10-12 minutes to complete each station before rotating to the next one." (Lesson 11, Teacher Guide) "Record the evidence of energy transfer for each method of information transfer you obtained information about." (Lesson 11 Handout, Stations Activity Sheet)

Lesson 12, **Obtain and combine information about the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.**

- Lesson 12, Explore Section, Step 3, "Investigate usable energy sources. Display slide D. Organize students into groups of 3-4 and distribute Energy Sources Research." (Lesson 12, Teacher Guide) Students read about how energy transfer occurs with different energy sources.

Lesson 13, **Combine information to evaluate the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.**

- Lesson 13, Explore Section, Step 2: "Part 1: Fill in the table below as you listen to the class presentations. Write at least one way that the usable energy source helps plants, animals, land, water, or people and one way it could hurt them." (Lesson 13 Handout, Effects of Usable Energy Sources) The class engages in a discussion where one of the questions is "What could we do to help reduce the effects of energy transfer from usable energy sources?" (Lesson 13, Teacher Guide)

Lesson 14A learning objective: Define criteria and constraints for a device that can be powered and communicate with objects on Earth using energy transfer from a usable energy source.

- Lesson 14 Student Assessment: Step 2. Identify criteria and constraints. The scientists and engineers have to consider what they need their new rover to do and how it might be limited. Criteria: Use the table below to list two things you think the scientists and engineers want their new Mars rover designs to do. Constraints: List one thing that could limit the design as scientists and engineers plan for their new rover." (Lesson 14 Student Assessment)

Lesson 14B learning objective: Apply scientific ideas to refine a device that converts energy from one form to another.

- Lesson 14 Student Assessment: "Step 4. Write on the lines below or add to your drawing above to explain how your design works. If you draw your ideas, be sure to label your drawing. Explain where the energy comes from and where the energy goes to power your new Mars rover. Explain how your rover communicates with scientists and engineers on Earth. Explain where the energy comes from and where the energy goes to communicate with your rover." (Lesson 14 Student Assessment)

iii. When engineering is a learning focus, it is integrated with developing disciplinary core ideas from physical science, life, and/or earth and space sciences.

Lesson 9, **Define a simple design problem** and **identify criteria and constraints for transferring information across a distance**.

- Lesson 9, Synthesize Section, Step 6, “Plan a design with a group. Organize students into groups and distribute the Develop a Design Solution. Have the allowed materials available for students to access while forming their design solutions. Direct them to sketch their chosen design solution and be sure that the parts of the design are labeled, they include how the information will be sent, how it will be received, and how their design meets the criteria and constraints. Give students about 20 minutes to work in their groups and plan their designs. Circulate to assist as needed.” (Lesson 9, Teacher Guide) In planning this, students connect back to their understanding of clocks. “ We started this design project to help us understand how some clocks know the time without being set. How do you think your communication design solution might be similar or different from how some clocks receive time information?” (Lesson 9 Handout, Develop a Design Solution)

Lesson 10, **Plan and carry out a fair investigation to test design solutions based on criteria and constraints for transferring** information (**energy**) across a distance and to **suggest improvements**.

- Lesson 10, Explore Section, Step 2, “Plan for how to carry out our tests. Display slide B. Review the criteria with students on the Criteria and Constraints chart. Then, have students turn and talk with a partner about the prompts on the slide before facilitating a class discussion for planning the tests.” (Lesson 10, Teacher Guide) The CCC of energy transfer is not included in the student tasks in this lesson.
- Lesson 10, Round 1 Design Testing, students are designing a test to answer the question: “How can we design a way to communicate the time to someone who is far away.” (Lesson 10, Student Handout)
- Lesson 10, Explore Section, Step 2: “What data should we collect to make sure that our designs meet the criteria?” “How far it works over. If the message got sent correctly. If the person we send it to can see it.” (Lesson 10, Teacher Guide)

Lesson 10, **Use data to compare solutions to evaluate which design solution best meets the criteria and constraints for transferring** information (and **therefore energy**) across a distance.

- Lesson 10, Synthesize Section, Step 5 Sidebar: “Students may not be making connections between energy and energy transfer and information transfer, and that’s ok. We are building toward this idea in the next lesson, where they will gather additional evidence for how clocks receive information to always have the right time. If students do bring up ideas about energy transfer, such as realizing their designs required a change in motion, affirm these ideas and point students toward the Evidence Bank for Identifying Energy Transfer from Lesson 8 to strengthen these connections.” (Lesson 10, Teacher Guide)

Lesson 11, Obtain information to explain how devices use digitized patterns to communicate information (energy) across long distances.

- In Lesson 11, Explore Section, Step 2, students complete a station activity. They consider energy transfer in the questions answered after the station activity. “Record the evidence of energy transfer for each method of information transfer you obtained information about.” (Lesson 11 Handout, Stations Activity Sheet) In a discussion, questions about energy transfer arise. “How does the information you learned help us to understand how some clocks do not have to be set? Where does the energy come from? Where does the energy go?” (Lesson 11, Teacher Guide)

Lesson 12, Obtain and combine information about the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.

- In Lesson 12, Explore Section, Step 2, students read about different energy sources. The reading includes a summary of how energy is transferred. "We burn natural gas. This creates heat and steam that spin a turbine. The turbine rotates and spins a generator to generate electricity. This happens at natural gas power plants." (Natural Gas, Usable Energy Sources website)

Lesson 13, Combine information to evaluate the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.

- Lesson 13, Explore Section, Step 2: "As students share their responses encourage them to consider how energy transfer is related to the effects that they read about. Have them trace where the energy comes from and where the energy goes to get from the usable source to the devices that they use, and where effects on the environment may happen." (Lesson 13, Teacher Guide)

Lesson 14, **Define criteria and constraints** **for a device that can be powered and communicate with objects on Earth** using **energy transfer from** **a usable energy source**.

- Lesson 14, Synthesize Section, Step 3, "Individually identify criteria and constraints and refine solutions. Display slide F. Distribute (Sentence Frames) Powering a Mars Rover or Powering a Mars Rover." (Lesson 14, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

I.B. Three Dimensions

[All 3 dimensions must be rated at least "adequate" to mark "adequate" overall]

EXTENSIVE

Builds understanding of multiple grade-appropriate elements of the science and engineering practices (SEPs), disciplinary core ideas (DCIs), and crosscutting concepts (CCCs) *that are deliberately selected to aid student sense-making of phenomena and/or designing of solutions.*

Document evidence and reasoning, and evaluate whether or not there is sufficient evidence of quality for each dimension separately.

Evidence needs to be at the *element level* of the dimensions (see rubric introduction for a description of what is meant by "element")

The reviewers found **extensive** evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions because students regularly engage in elements of all three dimensions to make sense of the anchoring or lesson-level phenomenon. The unit centers on students using targeted elements of all three dimensions that are clearly identified and addressed throughout the unit to explain that winding clocks and plug-in clocks need something to make them turn on and stay on.

Rating for Criterion: SEP **EXTENSIVE**

i. Provides opportunities to *develop and use* specific elements of the SEP(s).

The pieces of evidence support an **extensive** rating because the materials provide opportunities to develop and use specific elements of the SEPs. Students use and develop grade-appropriate SEP elements to make sense of the phenomenon. The SEPs of INV and INFO offer several opportunities for students to develop their skills. The SEPs—Asking Questions and Defining Problems, Constructing Explanations and Designing Solutions, and Obtaining, Evaluating, and Communicating Information—are labeled as intentionally developed.

AQDP: Asking Questions and Defining Problems

Claimed Element: ADQP-E4: Use prior knowledge to describe problems that can be solved. Claimed in Lessons 12. Examples include:

- Lesson 12, Navigate Section, Step 1, "Summarize students' responses and say that we already have some good ideas about what effects could be, and that it sounds like we're starting to identify some criteria and constraints that might help us to compare and contrast the energy source and their effects. This information could help us to think about energy sources that might help us think about ways we can reduce the effects from plugging in our devices." (Lesson 12, Teacher Guide)

Claimed Element: AQDO-E5: Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. Claimed in Lessons 9 and 14. Examples include:

- Lesson 9, Explore Section, Step 4: "Define the criteria for our design problem. Display slide E. Explain that we will want to check our designs to make sure we were successful and achieved our goals, so first we need to be more specific about what those goals are. When engineers are designing solutions to problems they first define (or decide on) what their solution needs to do to be successful. These goals are called criteria. Co-construct a definition of criteria with students and add it to the Word Wall, something like what our design or solution needs to do. To define our criteria for the solutions we will design, we have to think about what the goal of our system will be and how we will know it will work. Use prompts on the slide to guide the class to consensus for the criteria for this design, and record their ideas on the chart." (Lesson 9, Teacher Guide)
- Lesson 14, Explore Section, Step 2: "Summarize students' responses and then tell students that scientists and engineers want to refine their design for their next rover. They want to learn from what happened to Opportunity to improve how the rover gets energy to move and communicate. We will now use what we have learned to help the scientists and engineers with their designs." (Lesson 14, Teacher Guide)

MOD: Developing and Using Models

Claimed Element: MOD-E4: Develop and/or use models to describe and/or predict phenomena. Claimed in Lessons 1 and 2. Examples include:

- Lesson 1, Synthesize Section, Step 3: After reminding students what scientific models are or introducing modeling to students, “Display slide H. Distribute the Initial Models handout and give students 8-10 minutes to draw their models. Encourage students to use arrows to show why the plug-in clock turns on and stays on, and to label what their arrows represent.” (Lesson 1, Teacher Guide)
- Lesson 2, Explore Section, Step 5, Slide M: “Work as a class to develop a model to explain how the winding clock turns on and stays on.” (Lesson 1, Slide M)

INV: Planning and Carrying Out Investigations

Claimed Element: INV-E1: 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 Claimed in Lesson 7 and 10. Examples include:

- Lesson 7, Synthesize Section, Step 5, “Facilitate a Building Understandings Discussion. Display slide J. Referring to the photo on the slide, discuss where the energy to power the motor is coming from and going to and what our evidence is. Remind students that we can look to our Class Data Display and back at the book for evidence. Students should be able to identify that the sun must be transferring energy to the solar panel and that their evidence is that the panel only worked in the sun.” (Lesson 7, Teacher Guide)
- In Lesson 10, Explore Section, Step 2, students engage in a class discussion to plan their investigation. Discussion questions include: “What data should we collect to make sure that our designs meet the criteria?, How should we collect the data?, What kinds of quantitative or qualitative data should we collect?, How can we carry out our tests fairly?, What could happen if we all test the same time?” (Lesson 10, Teacher Guide)

Claimed Element: INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Claimed in Lessons 1, 2, 3, 4, 5, and 8. Examples include:

- Lesson 1, Explore Section, Step 2: “Record our noticings and wonderings about the winding clock. Distribute the Notice and Wonder About Clocks handout to each student and then tell students that they will now focus on what they saw, heard, and felt while observing the clock.” “Record our noticings and wonderings about the plug-in. Display slide E. Give students time to fill in the “plug-in” clock column of their Notice and Wonder About Clocks handout.” (Lesson 1, Teacher Guide)
- Lesson 2, Explore Section, Step 4: “Make observations and predictions. Gather the class together and display slide G. Carefully remove the back of the clock (if necessary, using a screwdriver) and give students time to look inside. Invite students to share a part they observed and their prediction about how the part works to keep the clock on.” (Lesson 2, Teacher Guide)
- In Lesson 3, Explore Section, Step 2, students take apart a lantern and observe what makes the light turn on and off.
- In Lesson 4, Synthesize Section, Step 3, students connect their observations with their explanation. “We observed… …this helps us tell the story of why our plug-in clock turns on and stays on because it connects to our growing idea that…” (Lesson 4 Handout, Connecting Observations and Growing Ideas)

- Lesson 5, Explore Section, Step 2: "Make Observations What did you observe? What do you think is causing the blades to move? The LED to light up? What is your evidence that energy has been transferred?" (Lesson 5, Teacher Guide)
- Lesson 8, Synthesize Section, Step 2: "As you work to update the model, each time the class explains a part of the phenomenon, ask, "What evidence do we have to support that idea?" When prompting students for evidence, allow students 2-3 minutes to look through a science notebook for examples and discuss with table partners before sharing the whole group. If students need more guidance to know where to look for evidence you can provide a lesson number or recall investigations that we completed. Prompting for evidence will be important to support them in creating their evidence bank, which they will do after updating their Class Consensus Model." (Lesson 8, Teacher Guide)

MATH: Using Mathematics and Computational Thinking

Claimed Element: MATH-E1: **Decide if qualitative or quantitative data are best to determine whether a proposed object or tool meets criteria for success.** Claimed in Lesson 10. Examples include:

- In Lesson 10, Explore Section, Step 2, students discuss which data to collect for their design solution by answering the following question, "What kinds of quantitative or qualitative data should we collect?" Follow up questions are provided: "Is the data you described quantitative or qualitative? Why? How will that data help us determine if a design meets our criteria for success?" (Lesson 10, Teacher Guide)

Claimed Element: MATH-E3: Describe, measure, estimate, and/or graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems. Claimed in Lesson 3. Examples include:

- In Lesson 3, Explore Section, Step 3, students describe the voltage of each battery. "The lantern used many LEDs. If we wanted to light only one LED, how many batteries (or how much voltage) do you think we will need? (Lesson 3, Teacher Guide)

CEDS: Constructing Explanations and Designing Solutions

Claimed Element: CEDS-E1: Construct an explanation of observed relationships. Claimed in Lesson 6.

- In Lesson 6, Synthesize Section, Step 3, students first read the Electricity Generating Cards and then discuss and categorize the different kinds of electricity generation into renewable and nonrenewable categories. "Continue the Building Understandings Discussion. Specifically, students will build a shared understanding for two concepts: solar power is unique amongst the various methods for generating electricity, and some forms of generation can occur forever, and some can only be used for as long as we have the material needed (renewable compared with nonrenewable)." (Lesson 6, Teacher Guide)

Claimed Element: CEDS-E4: Apply scientific ideas to solve design problems. Claimed in Lesson 14.

- Lesson 14, Student Assessment, "Write on the lines below or add to your drawing above to explain how your design works. Explain where the energy comes from and where the energy goes to power your new Mars rover. Explain how your rover communicates with scientists and engineers on Earth. Explain where the energy comes from and where the energy goes to communicate with your rover." (Lesson 14, Student Assessment)

Claimed Element: CEDS-E5: Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Claimed in Lesson 10.

- Lesson 10, Synthesize Section, Step 5, "Sort the solutions based on how well they met our criteria and constraints. Display slide H. Display the Compare Solutions chart and pull over all the sticky notes with the implemented designs. As a class, establish what should qualify a design as "meeting," "partially meeting," or "not meeting" the focal class criteria and constraints. Based on what was focal, come to consensus about what makes a design fall into each category. Then have students use their peer feedback notes to collaboratively sort the designs they observed into the three categories. Have students jot down the name or description of the solution on a sticky note and place it into the appropriate place on the "Compare and Contrast Solutions" chart." (Lesson 10, Teacher Guide)

ARG: Engaging in Argumentation

Claimed Element: ARG-E2: Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation. Claimed in Lesson 13. Example includes:

- Lesson 13, Synthesize Section, Step: "Introduce the argumentation task. Display slide F. Ask students to look at Part 2 of their *Effects of Usable Energy Sources*. Call out the important features of the task, such as the scale students will use and how they will determine which number to fill in on the scale. Tell students that they must be able to use evidence to justify their choice. Then, ask students where they could find evidence to justify their choice." (Lesson 13, Teacher Guide)

Claimed Element: ARG-E6: Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem. Claimed in Lesson 10. Example includes:

- Lesson 10, Round 2 Design Handout, Round 2 Question: "Make a claim about how well your optimized solution solves our design problem." (Lesson 10 Handout, Round 2 Design Handout)

INFO: Obtaining, Evaluating, and Communicating Information

Claimed Element: INFO-E1: Read and comprehend grade-appropriate complex texts and/or other reliable media to summarize and obtain scientific and technical ideas and describe how they are supported by evidence. Claimed in Lessons 4 and 12. Examples include:

- Lesson 4, Connect Section, Step 5: "Continue the summary by using students' words to emphasize that even though power lines are bigger and much longer than the wires we used to investigate how electricity flows in our circuits, if the path is broken or disconnected, energy cannot be transferred. The electricity needs a path to travel along." (Lesson 4, Teacher Guide)
- Lesson 12, Explore Section, Step 2: "As you read, ask students to think about what they notice about the effects of using oil to generate electricity. As a class, discuss what they noticed about what constitutes helping or hurting plants, animals, land, water, and people and have them explain why they think that." (Lesson 12, Teacher Guide)

Claimed Element: INFO-E2: Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices. Claimed in Lesson 13. Example includes:

- Lesson 13, Synthesize Section, Step 4: "Students may say: Our research notes, the notes we took during the presentations, Benefits and Limitations of Usable Energy Sources chart, Electricity Generation Cards. Then give students time to complete part 2 individually." (Lesson 13, Teacher Guide)

Claimed Element: INFO-E3: Combine information in written text with that contained in corresponding tables, diagrams, and/or charts to support the engagement in other scientific and/or engineering practices. Claimed in Lessons 6 & 7. Examples include:

- Lesson 6, Explore Section, Step 2: "Let students know that each card has some specific information about each type of electricity generation that they can use to complete their sheet, and that they will be looking for patterns across all the various ways of generating electricity." (Lesson 6, Teacher Guide)
- Lesson 6, Explore Section, Step 2, Obtaining, Evaluating and Communicating Information sidebar: "One important element of this practice is combining information from multiple sources. As students obtain information from the various cards and sort them, they will combine the information from multiple cards to organize that information in a chart to look for patterns." (Lesson 6, Teacher Guide)
- Lesson 7, Connect Section, Step 4: "Have students discuss the main topic of the pages they read in their investigation groups. When done reading, give students time in their investigation groups to revisit their explanation to questions #2 and #3 on *Light Investigation*, and then use what they read to revise or add to their answers." (Lesson 7, Teacher Guide)

Claimed Element: INFO-E4: Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Claimed in Lessons 5, 9, 11, 12, and 14. Examples include:

- Lesson 5, Synthesize Section, Step 5: "Then, have students write an explanation (question #3) using evidence from their observations to describe how the wind turbine generates electricity. If needed, students can revisit the videos, book, and model turbine to help craft their model." (Lesson 5, Teacher Guide)
- In Lesson 9, Connect Section, Steps 3 and 5, students read a book and an infographic to determine the most effective method of communication. (Lesson 9, Teacher Guide)
- Lesson 11, Explore Section, Step 2: "Let's obtain some information to answer our questions about how some clocks know the time without being set. Stations Instructions: Each station has a small reading or activity with instructions. Your group will have about 10 minutes to complete each station. Fill out the prompts on your handout for each station. Every group will complete all stations. Stations: Language of computers Coding and decoding binary clocks Energy transfer Wireless communication" (Lesson 11 Slides, Slide D)
- Lesson 12, Explore Section, Steps 2 and 3: "Analyze the effects of a sample usable energy source together. Tell students that they will be researching an energy source with their group to figure out the effects of obtaining and using that source and then evaluating it based on our criteria and constraints. Suggest that we practice this first as a class with an example usable energy source. Follow the link on slide C to the Effects of Useable Energy Sources Website to research oil (petroleum)." "Investigate usable energy sources. Display slide D. Organize students into groups of 3-4 and distribute Energy Sources Research. Assign each group an energy source to research and then direct them where to write it on their handout." (Lesson 12, Teacher Guide)
- In Lesson 14, Explore Section, Step 2, students observe and discuss a Mars Rover before completing the assessment where they design a new rover. (Lesson 14, Teacher Guide)

INV: Planning and Carrying Out Investigations

Claimed Element: INV-P1: With guidance, plan and conduct an investigation in collaboration with peers (for K). Claimed in Lesson 2. Evidence was found in lessons 1, 2, and 9. Examples include:

- Lesson 7, Explore Section, Step 2: "Plan an Investigation Discuss how we could carry out an investigation: If we want to know where the energy is coming from, what could we do with the materials? What observations would we make? What evidence of energy transfer would we look for to know the solar panel is generating electricity?" (Lesson 7, Teacher Guide)
- Lesson 7, Explore Section, Step 3: Collaboratively carry out the investigation. Distribute Light Investigation to each student. Ask students to review the procedures together as a group and to decide if they align with what they discussed in class. Then, using the sentence frame on slide E, support students in writing a prediction of what they think will happen in their investigation. Then, distribute materials to students, providing them with any classroom and school-specific instructions for carrying out an investigation outside, and give them time to carry out the investigation." (Lesson 7, Teacher Guide)
- Lesson 10, Explore Section, Step 2: "What kinds of quantitative or qualitative data should we collect? We can record the distance number (quantitative data) since it is a part of the criteria. Distance is quantitative data. We need to write in words if people saw it or not. How can we carry out our tests fairly? We need to all do the same thing. We can only change one variable. We should all measure the same way." (Lesson 10, Teacher Guide) After planning the investigation, student groups carry out the investigation and collect data.

Criterion-Based Suggestions for Improvement

- Ensure that "[s]tudents are supported to develop deep competence in specific elements such that they could be applied to more than one context." [Detailed Guidance, p. 10] Though labeled as intentionally developed, the Practices of AQDP and CEDS have only one opportunity per claimed element to be developed. Consider how students can use those SEPs throughout the unit.

Rating for Criterion: DCI

EXTENSIVE

ii. Provides opportunities to *develop and use* specific elements of the DCI(s).

These pieces of evidence support the rating of **extensive** because the elements of the DCIs that are claimed are grade appropriate and well aligned to the tasks.

PS3.A Definitions of Energy

Claimed Element: PS3.A-E2: Energy can be moved from place to place by moving objects or through sound, light, or electric currents. Claimed in Lessons 2, 6, 7, and 8. Examples include:

- Lesson 2, Explore Section, Step 4: "Summarize the key takeaways from the discussion. Display slide H. Using the prompts on the slide, trace the path of causes and effects through the plug-in clock to see how everything could work together. Start with the plug and ask students what it is connected to and what they think it does, then continue to follow the path of wires to the clock display. As students trace the path, raise questions, such as what could be inside the wires or what could be causing the changes that we see (e.g., sounds coming from the clock or the display lighting up when it's on)." (Lesson 2, Teacher Guide)

- In Lesson 6, Synthesize Section, Step 3: Students summarize what they have figured out from sorting the Electricity Generation Cards. During this discussion they share that turbines are needed and that sun or wind energy can be used to make turbines generate electricity. (Lesson 6, Teacher Guide)
- Lesson 7, Explore Section, Step 3: "Briefly discuss our observations. Display slide F. Once students have finished answering the investigation question. ask student groups to briefly share what they observed and why. Look and listen for observations such as: The motor moved in the sun. The motor did not move in the shade. The motor went very slowly when there wasn't much sun. The motor went really fast in the sun. I think the sun caused the motor to spin." (Lesson 7, Teacher Guide)
- Lesson 8, Synthesize Section, Step 2: "Can someone trace the path of energy from the usable energy source to the clock? *The usable energy source transfers energy to the turbine and it spins. The spinning turbine transfers energy to the generator. It generates electricity. Electric current is transferred from the generator through the power lines and into the wall outlet. Sunlight hits solar panels and the panel changes the light to electricity. When we plug in the clock the current moves through the wires into the clock. The clock lights up/makes sound/heats up.*" (Lesson 8, Teacher Guide)
- Lesson 8, Student Assessment, Make Observations, "Look at the points labeled A, B, C, and D on the drawing. In the table below, describe what Alexa and Mina could observe that would be evidence that energy was transferred to and from each point. Then, describe using pictures and drawings where the energy comes from and where the energy goes." (Lesson 8, Student Assessment)

PS3.B Conservation of Energy and Energy Transfer

Claimed Element: **PS3.B-E3: Energy is present whenever there are moving objects, sound, light, or heat.** ~~**When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.**~~ Claimed in Lessons 2 and 8. Examples include:

- Lesson 2, Synthesize Section, Step 6: "What is our evidence that energy is getting passed along through the parts of the clock?" and "What evidence do we have that energy is present in the other devices we listed as related phenomena?" (Lesson 2, Teacher Guide)
- Lesson 8, Synthesize Section, Step 2: "What is all the evidence of energy transfer that we see on our model? *The electric current moves in wires to turn things on. The clock makes sound. The turbine spins.*" (Lesson 8, Teacher Guide)

Claimed Element: **PS3.B-E2: Light also transfers energy from place to place.** Claimed in Lessons 6, 7, and 8. Examples include:

- Lesson 6, Electricity Generation Cards, Students explore Solar Energy and learn that light comes from the sun and can be transferred. (Lesson 6, Electricity Generation Cards, Slide 3)
- Lesson 7, Synthesize Section, Step 5, 'Summarize what we learned. Remind students that we started our investigation wondering how solar panels are able to generate electricity and we carried out a fair test investigation to test solar panels in the sun. Give students 1-2 minutes in pairs to summarize what they learned from the discussion before sharing out. Look and listen for ideas such as: Sunlight transfers energy to the solar panel. The solar panel transfers energy to the wires as electrical current. The current makes the motor move." (Lesson 7, Teacher Guide)

- Lesson 8, Synthesize Section, Step 2, Students revise their class model and engage in the following questions during a discussion: How does (wind, solar, geothermal, coal, etc.) generate electricity? And Can someone trace the path of energy from the usable energy source to the clock?" (Lesson 8, Teacher Guide) The ideas to look and listen for imply that students could discuss solar panels in this discussion; however, the exemplar class model includes a wind turbine, and it is therefore not likely students would choose to discuss solar panels in this discussion.
- Lesson 8, Synthesize Section, Step 2: "Where does the electricity come from that moves into the power lines? *Solar panels.*" (Lesson 8, Teacher Guide) This learning occurred in the previous lessons and is only recalled here.

Claimed Element: PS3.B-E4: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. Claimed in Lessons 1, 3, 4, 5, 8, and 14. Examples include:

- Lesson 1, Synthesize Section, Step 4: "If students have done Unit 4.1: Why does an object's motion change?, they may name the arrows as representing energy transfer. However, if they are not sure (especially around what is happening inside the clock), continue to put question marks to indicate that uncertainty. If students have not done Unit 4.1: Why does an object's motion change?, try to use the terms students are mostly using, and feel free to leave this as an open question, including possible labels with question marks indicating we are not sure what's flowing or moving or going from place to place there." (Lesson 1, Teacher Guide)
- Lesson 3, Synthesize Section, Step 4: "Why is a path important for energy transfer? When the battery and LED light are not connected properly, the LED does not shine. Electricity needs a path to move along. The battery has to be connected in a certain way." (Lesson 3, Teacher Guide)
- Lesson 4, Synthesize Section, Step 4, Students engage in a discussion about the following questions: "Where is the energy coming from to make it light up, make noise, etc?, Where is that electricity coming from to get to the wall outlet?, And how does electricity get into our school?" (Lesson 4, Teacher Guide)
- Lesson 5, Synthesize Section, Step 5: "Draw a diagram explaining how a wind turbine generates electricity. Use arrows and labels to show where the energy is coming from and where the energy is going to." (Lesson 5 Slides, Slide J)
- Lesson 8, Synthesize Section, Step 2: "What is all the evidence of energy transfer that we see on our model? *The electric current moves in wires to turn things on. The clock makes sound. The turbine spins.*" (Lesson 8, Teacher Guide)
- Lesson 14, Step 4, Lesson 14 Student Assessment, "Explain where the energy comes from and where the energy goes to power your new Mars rover. Explain how your rover communicates with scientists and engineers on Earth. Explain where the energy comes from and where the energy goes to communicate with your rover. (Lesson 14, Student Assessment)

PS3.D Energy in Chemical Process and Everyday Life

Claimed Element: PS3.D-E1: The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. Claimed in Lesson 5. Example includes:

- Lesson 5, Synthesize Section, Step 6: "Explain that people sometimes like to say that a wind turbine "produces energy." Ask, 'Can that be what's happening? Does the wind turbine make the *energy?*' [...] Summarize that we cannot generate electricity from wind unless the wind is blowing." (Lesson 5, Teacher Guide)

PS4.C Information Technologies and Instrumentation

Claimed Element: PS4.C-E1: Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. Claimed in Lessons 9, 11, and 14. Examples include:

- Lesson 9, Connect Section, Step 5: "Divide the class into groups to read about different methods of communication. Distribute copies of one infographic (Morse Code Infographic, Communication Infographic, Braille Infographic) to each group, and have them read the infographic together, using the prompts on the slide as a guide." (Lesson 9, Teacher Guide) In the document "Alignment with the Three Dimensions of NGSS," it describes the goal of this lesson. "Students begin to consider solutions for transmitting information, such as the time, over a distance. While they do not yet figure out the relationship to digitized information and transfer across distances, they are building the foundation for that understanding will be solidified in Lesson 11." (Alignment with the Three Dimensions of NGSS)
- In Lesson 11, Synthesize Section, Step 3, students discuss the following questions, "What parts are involved in transferring information to wireless devices?, Where does information come from? Where does it go?, What form is the information in when it transfers?, How does the device use what's transferred to know the time?, Where is energy transferred?" (Lesson 11, Teacher Guide)
- Lesson 14, Student Assessment Powering a Mars Rover, Step 4, Part A & B: "Explain where the energy comes from and where the energy goes to power your new Mars rover. Explain how your rover communicates with scientists and engineers on Earth. Explain where the energy comes from and where the energy goes to communicate with your rover." (Lesson 14, Student Assessment)

ESS3.A Natural Resources

Claimed Element: ESS3.A-E1: 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. Claimed in Lessons 12, 13, and 14. Examples include:

- Lesson 12, Explore Section, Step 2: "Suggest that we practice this first as a class with an example usable energy source. Follow the link on slide C to the Effects of Useable Energy Sources Website to research oil (petroleum). Think aloud as you navigate the website and read the information about oil, noting that the information is located in two separate sections: Usable Energy Sources Facts and Effects of Energy Sources Blog." (Lesson 12, Teacher Guide)
- Lesson 13, Synthesize Section, Step 4: "Fill in the table below as you listen to the class presentations. Write at least one way that the usable energy source helps plants, animals, land, water, or people and one way it could hurt them." (Lesson 13 Handout, Effects of Usable Energy Sources)
- Lesson 14, Explore Section, Step 2: "How does the rover get energy to move and communicate? *It uses solar panels. It has a battery to use at night*." (Lesson 14, Teacher Guide)

ETS1.A Defining and Delimiting Engineering Problems

Claimed Element: ETS1.A-E1: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. Claimed in Lessons 9, 10, and 14. Examples include:

- Lesson 9, Synthesize Section, Step 6: "Our design problem: How can we design a way to communicate a time to someone who is far away? In the box below, design a solution to the problem using the class criteria and constraints. Make sure your sketch is labeled and that you have identified: How the time information will be sent. How the time information will be received. How your design for sending and receiving information meets our criteria and constraints." (Lesson 9 Handout, Develop a Design Solution)
- Lesson 10, Synthesize Section, Step 5, "Sort the solutions based on how well they met our criteria and constraints. Display slide H. Display the Compare Solutions chart and pull over all the sticky notes with the implemented designs. As a class, establish what should qualify a design as "meeting," "partially meeting," or "not meeting" the focal class criteria and constraints. Based on what was focal, come to consensus about what makes a design fall into each category. Then have students use their peer feedback notes to collaboratively sort the designs they observed into the three categories. Have students jot down the name or description of the solution on a sticky note and place it into the appropriate place on the "Compare and Contrast Solutions" chart." (Lesson 10, Teacher Guide)
- Lesson 14, Synthesize Section, Step 3: "Step 2. Identify criteria and constraints. The scientists and engineers have to consider what they need their new rover to do and how it might be limited. Criteria: Use the table below to list two things you think the scientists and engineers want their new Mars rover designs to do. Constraints: List one thing that could limit the design as scientists and engineers plan for their new rover." (Lesson 14 Student Assessment, Powering a Mars Rover)

ETS1.B Developing Possible Solutions

Claimed Element: **ETS1.B-E2: Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.** Claimed in Lesson 10. Examples include:

- Lesson 10, Explore Section, Step 7: "Then have groups review the feedback and use that, along with the updated criteria and constraints to revise and optimize their design. Have them record their ideas and data on the "Round 2" table of the Round 2 Design Testing handout. If needed, be sure to show slide D so that students can refer to the investigation procedures. Once all designs have been tested, take a moment for groups to report out on how they made their design better and, if applicable, move the sticky note for their design to a higher category on the Compare and Contrast Solutions chart." (Lesson 10, Teacher Guide)

ETS1.C Optimizing the Design Solution

Claimed Element: **ETS1.B-E1: Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.** Claimed in Lesson 10. Examples include:

- Lesson 10, Explore Section, Step 3: "Tell students that we will be evaluating the designs and therefore need a way to refer to each design. Have the students write a title or short description of the design they implemented on a sticky note (in a new color different from the others on the chart) and add it to the *Communication Design Ideas* chart…"(Lesson 10, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

Rating for Criterion: CCC **EXTENSIVE**

iii. Provides opportunities to *develop and use* specific elements of the CCC(s).

These pieces of evidence support the rating because the materials provide opportunities to develop and use specific elements of the CCCs. Students use and develop grade-appropriate CCC elements to make sense of the phenomenon.

PAT: Patterns

Claimed Element: PAT-E1: Similarities and differences in patterns can be used to sort, classify, communicate (and analyze simple rates of change for natural phenomena and designed products). Claimed in Lesson 11. Examples include:

- Lesson 11, Explore Section, Step 2: "Digital code Digital code is made of patterns of something turning on and off, like a light turning on and off. Electrical current can be turned on and off to make digital code. Computers send patterns of electrical current that have been turned on and off. These patterns of electrical current travel through the wires of the computer. Parts of the computer interact with these on and off patterns to do their job. A computer screen is made of thousands of little lights. The on and off patterns of electrical current tell each light what color it should be. Together, all the lights make what we see on screens." (Lesson 11 Handout, Digital Code)

Claimed Element: PAT-E3: Patterns can be used as evidence to support an explanation. Claimed in Lessons 6 and 7. Examples include:

- Lesson 6, Explore Section, Step 2: "Display slide D and ask the class to begin using the Electricity Generation Cards to help them complete the Generating Electricity Data Sheet. Tell the class it will be important to try and find patterns in the data they are finding on the cards. They should organize the cards as a small group, focusing on how the electricity is generated and whether or not the material changes after it is used to generate electricity. This will help them complete the handout afterward. After cards are sorted and students have filled in their tables with their observations, they should use the space at the bottom of the sheet to describe any patterns they found (question #1), so they will be ready to share with the whole class after we are done using the cards with our groups." (Lesson 6, Teacher Guide)
- Lesson 7, Explore Section, Step 3: "What patterns do we notice in the data? *The motor worked in the sun. The motor did not work in the dark.* Why is it helpful to combine our class data? *The patterns are easier to see. Our trial is an outlier. Having more trials makes it easier to figure out what we should have seen.*" (Lesson 7, Teacher Guide)

CE: Cause and Effect

Claimed Element: CE-E1: Cause and effect relationships are routinely identified, tested, and used to explain change. Claimed in Lessons 1, 2, 3, 5, 7,12, and 13. Examples include:

- Lesson 1, Synthesize Section, Step 4: "Display slide K. Point out the sentence starters and prompts for students to use during this discussion. You might say something like, We are trying to figure out what we think we know and where we have questions to investigate about why the plug-in clock turns on and stays on, so let's work together to discuss and combine our ideas." (Lesson 1, Teacher Guide) It is implied that students will be prompted by the term "why" to discuss "what causes," however, teachers are not supported with strategies to help students make the connection between "why" questions and the CCC of cause and effect.

- Lesson 2, Explore Section, Step 4: "Summarize the key takeaways from the discussion. Display slide H. Using the prompts on the slide, trace the path of causes and effects through the plug-in clock to see how everything could work together. Start with the plug and ask students what it is connected to and what they think it does, then continue to follow the path of wires to the clock display. As students trace the path, raise questions, such as what could be inside the wires or what could be causing the changes that we see (e.g., sounds coming from the clock or the display lighting up when it's on)." (Lesson 2, Teacher Guide)
- Lesson 3, Synthesize Section, Step 4: "Where does the energy come from that causes the clock to turn on? *Students will have a wide variety of ideas, such as: The battery. The outlet*." (Lesson 3, Teacher Guide)
- Lesson 5, Explore Section, Step 2: "What do you think is causing the blades to move? What do you think is causing the LED to light up? *The wind pushes the blades and makes them move. The turbine (or one of those other parts) is making electricity. Electricity moves from the wires to the LED. Energy is being transferred from the wind turbine to the LED.* (Lesson 5, Teacher Guide)
- Lesson 7, Synthesize Section, Step 5: "How does sunlight cause the solar panel to generate electricity?" (Lesson 7 Slides, Slide J)
- In Lesson 12, Explore Section, Step 2, students gather information about various sources of energy including how the energy source may affect the environment. "There are fewer hydropower plants in the U.S. because people are worried that building lots of hydropower plants will harm the environment. A hydropower plant also needs a reservoir or a dam. Reservoirs store water. Dams are walls built over rivers or streams to stop the flow of water. Building dams and reservoirs can ruin ecosystems and habitats. New reservoirs and dams can be built in the middle of a river. This blocks the water from flowing, and fish cannot swim up rivers to lay their eggs anymore." (Usable Energy Sources Don't Forget About Hydropower)
- Lesson 13, Explore Section, Step 2: "How could our electricity usage affect the environment? If we leave the lights on when we don't need them we could be using too much electricity. When energy is transferred from a usable energy source it could cause pollution." (Lesson 13, Teacher Guide)

EM: Energy and Matter

Claimed Element: EM-E3: Energy can be transferred in various ways and between objects. Claimed in Lessons 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14. Examples include:

- Lesson 2, Synthesize Section, Step 6, "Return to the "Why does the winding clock turn on and stay on?" chart and, using students' ideas and observations as a guide, draw the path of energy transfer on the clock, using a marker color other than what was used to draw it originally. Then, describe on the chart in words or drawings where the energy is coming from and where it is going. Students should note ideas such as: Energy is transferred from the winder to the spring. Energy is transferred from the gears to the bell and then to our ears. Energy is transferred from the gears to the clock hands, making the clock hands move." (Lesson 2, Teacher Guide)
- Lesson 3, Synthesize Section, Step 4: "Where does the energy go in the clock? *Students will have a wide variety of ideas, such as: To the numbers in the clock. Heat coming off of the clock. Sound of the alarm.*" (Lesson 3, Teacher Guide)
- Lesson 4, Synthesize Section, Step 3: "Similar to what was done in Lesson 3, use the same color marker as the questions, 'Where did the energy come from? Where did the energy go?' to help students track where the energy is present on our model and where we can see evidence of energy transfer." (Lesson 4, Teacher Guide)

- Lesson 5, Navigate Section, Step 1, "Make predictions about energy transfer. Display slide C. Using the image on the slide, tell students that you have a wind turbine for them to explore today. Ask students if they have seen or heard of a wind turbine before, then point out the three major parts of the turbine (blades, tower, head). Have students turn and talk with a neighbor about how they think energy could be transferred by/in a wind turbine." (Lesson 5, Teacher Guide)
- Lesson 6, Explore Section, Step 2: "Choose one usable energy source. Explain how electricity can be generated from that source." (Lesson 6 Handout, Generating Electricity Data Sheet)
- Lesson 7, Synthesize Section, Step 5: "Participate in a Discussion Where does the energy come from? Where does the energy go? How does the energy get from the solar panel to the motor? How does sunlight cause the solar panel to generate electricity?" (Lesson 7, Teacher Guide)
- Lesson 8, Synthesize Section, Step 2: "What is all the evidence of energy transfer that we see on our model? *The electric current moves in wires to turn things on. The clock makes sound. The turbine spins*." (Lesson 8, Teacher Guide)
- Lesson 9, Lesson Assessment Guidance, "You should not expect your students to be making connections with energy transfer or evaluating design ideas. These concepts will be developed in the next two lessons, using the ideas of this lesson." (Lesson 9, Teacher Edition, p7)
- Lesson 10, Synthesize Section, Energy and Matter Sidebar, "Students may not be making connections between energy and energy transfer and information transfer, and that's ok. We are building toward this idea in the next lesson, where they will gather additional evidence for how clocks receive information to always have the right time." The materials indicate students should not be expected to use the specific element of the crosscutting concept.
- Lesson 11, Synthesize Section, Step 3, "Have students look to their Evidence Bank for Identifying Energy Transfer from Lesson 8. Ask students to turn and talk with a partner about the evidence on the chart and the evidence of energy transfer they added to their Class Consensus Model. Ask them to consider if they need to revise their Evidence Bank. As a class come to a consensus that we should add "information transfer" as evidence of energy transfer. Then, have students provide examples from their stations or design solutions." (Lesson 11, Teacher Guide)
- Lesson 12, Explore Section, Step 2: "Nuclear power plants heat water to produce steam. The steam is used to spin large turbines that generate electricity." (Usable Energy Sources, Nuclear)
- Lesson 14, Synthesize Section, Energy and Matter Sidebar, "This is students' final opportunity to demonstrate their understanding of energy and energy transfer. Encourage students to use different colors on their drawings and/or in their descriptions to illustrate where the energy is coming from and where the energy is going, similar to what they see on their Class Consensus Model." (Lesson 14, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

I.C. Integrating the Three Dimensions

EXTENSIVE

Student sense-making of phenomena and/or designing of solutions requires student performances that integrate elements of the SEPs, CCCs, and DCIs.

These pieces of evidence support the **extensive** rating because student sensemaking of the phenomena requires student performances that integrate elements of the SEPs, CCCs, and DCIs. In the unit, students are expected to explain what winding clocks and plug-in clocks need to make them turn on and stay on, which requires them to use grade-appropriate elements of the three dimensions simultaneously. The three dimensions are not used in isolation. There are many strong instances of integration of the three dimensions throughout the unit. There are two instances in Lessons 9 and 10 in which students are not required to use the CCC to make sense of the phenomena, which means that learning is integrated with only two dimensions.

Throughout the unit, learning is integrated, and the integration is used to support students making sense of the phenomenon.

- Lesson 1, Synthesize Sections, Step 3 students integrate the use of the elements when they develop an initial model to explain why the plug-in clock turns on and stays on, in the three dimensions: **CE-E1: Cause and effect relationships are routinely identified, tested and used to explain change, DCI 4-PS3.B-E3: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy** and **MOD-E4: Develop and/or use models to describe and/or predict phenomena.**
- Lesson 2, Synthesize Section, Step 6: “Then, return to the “Why does the winding clock turn on and stay on?” chart and, using students’ ideas and observations as a guide, draw the path of energy transfer on the clock, using a marker color other than what was used to draw it originally. Then, describe on the chart in words or drawings where the energy is coming from and where it is going. Students should note ideas such as: Energy is transferred from the winder to the spring. Energy is transferred from the gears to the bell and then to our ears. Energy is transferred from the gears to the clock hands, making the clock hands move.” (Lesson 2, Teacher Guide) **CCE: 2E1: Cause and effect relationships are routinely identified, tested, and used to explain change, 4-PS3.A-E2: Energy can be moved from place to place by moving objects or through sound, light, or electric currents.** (PS3.A-E2) and **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**
- Lesson 3 Section, Explore, Step 3 students integrate the use of the elements when they [draw and label how they set up their system and compare it with other groups to determine what caused the light to shine] in the three dimensions: **CCE: 2E1: Cause and effect relationships are routinely identified, tested, and used to explain change, 4-PS3.B-E3: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.** (PS3.B-E3). and **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**
- Lesson 4, Synthesize Section, Step 3 students integrate the use of the elements when they [connect their current observations with ideas they have already figured out] in the three dimensions:**EM: 5E3: Energy can be transferred in various ways and between objects. 4-PS3.B-E3: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.** (PS3.B-E3). and **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**

- Lesson 5, Synthesize Section, Step 5 students integrate the use of the elements when they complete the model and explanation in the Observing Wind Turbines handout, in the three dimensions: **EM-M3:Energy can be transferred in various ways and between objects, 4-PS3.B-E3: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy, INV-E3:Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**
- Lesson 6, Synthesize Section, Step 3, students write in their My Growing Ideas chart expressing the patterns they noticed in sorting the cards with information about different energy sources. **PAT-E3: Patterns can be used as evidence to support an explanation. PS3.A-E2: Energy can be moved from place to place by moving objects or through sound, light, or electric currents. CEDS-E1: Construct an explanation of observed relationships.**
- Lesson 7, Synthesize Section, Step 5 students integrate the use of the elements when they [use evidence they gathered from the Light Investigation and Meet the Scientists: Electricity Producers to explain that light can transfer energy from the sun to a solar panel.] in the three dimensions:**EM: 5E3: Energy can be transferred in various ways and between objects. 4-PS3.B-E2: Light also transfers energy from place to place. (PS3.B-E2)** and **INV-E1: 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**
- Lesson 8, Synthesize Section, Step 3 students integrate the use of the elements when they use their understanding of usable energy sources to identify evidence that could be used to explain energy transfer in a game console, in the three dimensions: **EM-M3:Energy can be transferred in various ways and between objects, 4-PS3.A-E2: Energy can be moved from place to place by moving objects or through sound, light, or electric currents,** and **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**
- Lesson 9, Explore Section, Step 4 students integrate the use of the elements when they [define the design problem of developing a process for communicating (transferring) time information over a distance.] in the three dimensions: **EM: 5E3: Energy can be transferred in various ways and between objects. 3-5-ETS1.A-E1: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (ETS1.A-E1).** and **ADQP-E5: Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.** Students are not asked to engage in the Crosscutting Concept in this lesson. Therefore, this is two dimensional integration.
- Lesson 10, Synthesize Section, Step 3 students integrate the use of the elements when they [use evidence gathered from their fair test investigation to identify which criteria and constraints their design solution meets for communicating time, refining design solutions based on data collected during testing so their optimized design for communicating time is a clear iteration from their first design, using data from their investigations combined with their peer feedback to refine their design solution] in the three dimensions: **EM: 5E3: Energy can be transferred in various ways and between objects. 3-5-ETS1.B-E2: Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved (ETS1.B-E2).** and **INV-E1: 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** Students are not asked to engage in the Crosscutting Concept in this lesson. Therefore, this is two dimensional integration.
- Lesson 10, Explore Section, Step 2 students integrate the use of the elements when they [use their criteria and constraints to compare and contrast multiple solutions based on how well they transfer information from a sender

to a receiver.] in the three dimensions: **EM: 5E3: Energy can be transferred in various ways and between objects. 3-5-ETS1.B-E1: Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints.** (**ETS1.B-E1**) and **INV-E1: 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**

- Lesson 11, Explore Section, Step 2, students integrate the use of the elements when obtaining information at stations about how some clocks do not have to be set, using their Station Activity Sheet, in the three dimensions: **PAT-E1: Similarities and differences in patterns can be used to sort, classify, communicate and analyze simple rates of change for natural phenomena and designed products, EM-M3:Energy can be transferred in various ways and between objects, 4-PS4.C-E1:Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information— convert it from digitized form to voice—and vice versa,** and **INFO-E4: Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.**
- Lesson 12, Explore Section, Step 2, students integrate the use of the elements when they [obtain information on their Energy Sources Research about a usable energy source and evaluate it based on criteria and constraints that the class created.] in the three dimensions: **CE: 2E1: Cause and effect relationships are routinely identified, tested, and used to explain change. 4-ESS3.A-E1: 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.** and INFO-E4**: Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.**
- Lesson 13, Synthesize Section, Step 4, students integrate the use of the elements when they argue for what energy source has more benefits than harms, in the three dimensions: **EM-M3:Energy can be transferred in various ways and between objects, 4-ESS3.A-E1: 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,** and **ARG-E2: Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.**
- Lesson 14, Synthesize Section, Step 3, students integrate the use of the elements when they individually complete the assessment, Powering a Mars Rover, in the three dimensions: **EM-M3:Energy can be transferred in various ways and between objects, 3-5-ETS.1A-E1:Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account, 4-PS3.B-E3: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy,** and **ADQP-E5: Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.**

Criterion-Based Suggestions for Improvement

- Consider making a stronger connection between the tasks and the CCC of energy and matter. For example, in Lessons 9 and 10, the materials state, "Students may not be making connections [among] energy and energy transfer and information transfer, and that's ok[ay]."

I.D. Unit Coherence

EXTENSIVE

Lessons fit together to target a set of performance expectations.

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.

ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

The evidence supports a rating of **extensive** because the lessons build on one another, which results in an increased understanding of the science ideas that are needed to explain the phenomena and design solutions to the unit's engineering problems. This building of understanding across the unit is motivated by student questions and experiences.

Evidence includes, but is not limited to, the following:

i. Each lesson builds on prior lessons by addressing questions raised in those lessons, cultivating new questions that build on what students figured out, or cultivating new questions from related phenomena, problems, and prior student experiences.

- OpenSciEd Elementary Handbook, Navigate Component, "The Navigate component directly supports coherence for students from lesson to lesson. This component generally happens at the beginning and end of each lesson and provides opportunities for the class to take stock of where they are in finding answers to their questions, remind themselves what they figured out last time, and decide where they want to go next. Often this navigation will come naturally from questions generated by students, but occasionally the teacher will "problematize" an idea or investigation result by asking a salient question or pushing the class to consider other situations or new directions." (OpenSciEd Elementary Handbook, p15)
- Lesson 1, Synthesize Section, Step 5: "Build our Driving Question Board. Display slide N. Explain that we want to gather and organize our questions in a way that will help guide the investigations we do and help us track the ideas we figure out along the way." (Lesson 1, Teacher Guide)
- Lesson 2, Navigate Section, Steps 1 and 7, "Briefly review our questions from last time. Display slide A. Prompt students to look at the "Why does the plug-in clock turn on and stay on?" chart from Class 1 and our Driving Question Board. Ask students to restate some of the big questions we had last time." "What new questions do you have? How could we investigate them?" (Lesson 2 Slides, Slide R)
- Lesson 3, Navigate Section, Step 1: "Revisit our related phenomena lists and DQB. Display slide A. Have students look over the class lists of related phenomena we created after the school tour in Lesson 2 and our Driving Question Board. Remind them that they had asked questions about batteries in Lesson 2. Ask them to identify the devices that we think are powered by a battery. Have students turn and talk with a partner about the slide questions, then share aloud with the class." (Lesson 3, Teacher Guide)
- Lesson 4, Navigate Section, Step 4: "Review the DQB and our Class Consensus Model: Where have we made progress in figuring out our questions? What do we still need to figure out in order to tell the story of why the plug-in clock stays on?" (Lesson 4 Slides, Slide O)
- Lesson 6, Navigate Section, Step 5: "As a class, add questions to our DQB that focus on how solar panels are using sunlight to make electricity without any moving parts." (Lesson 6, Teacher Guide)

- Lesson 7, Navigate Section, Step 6: "Review previously posed questions on the DQB. Display slide M. Review the questions students had previously added to the DQB up to this lesson. As you read through the questions, ask students if we can answer them. Ask students if they think they have enough information to explain why the plug-in clock turns on and stays on? Students should be able to answer many of the questions related to energy transfer and powering a device and should notice that they have gathered a lot of evidence. Have students turn and talk with a partner to summarize how they would answer the question based on their learning in the unit. Then, have students briefly share their responses with the class." (Lesson 7, Teacher Guide)
- Lesson 9, Navigate Section, Step 1: "Think of devices you use to tell time. Then turn and talk with a partner: How are clocks that need to be set similar or different from clocks that always have the right time? How do you think some clocks know the time without being set?" (Lesson 9 Slides, Slide A)
- Lesson 11, Navigate Section, Step 4, "Briefly review the work we did in this lesson set. Display slide H. Point out questions on the DQB related to wireless communication and how some clocks do not need to be set and ask students to turn and talk about how they would answer them. If time allows, invite a few students to share with the whole class, and to jot down their answers on the sticky note, or on another one that will be placed nearby it." (Lesson 11, Teacher Guide)
- Lesson 12, Navigate Section, Step 1, "Review where we left off last time. Remind students that we left the last session with some questions about the effects of usable energy sources after thinking about the effects of plugging in clocks or other devices that we use.
- Suggest that we might need more evidence about usable energy sources and their effects. Have students brainstorm ways that we could answer these questions and share their ideas with the class." (Lesson 12, Teacher Guide)
- Lesson 13, Navigate section, Step 4: Take stock of what we have figured out and what questions we still have. Display slide J. As a class, go through the remaining questions on the Driving Question Board. Quickly review with students the answers to the questions. Determine if any questions have been left unanswered or if there are any that we can partially answer." (Lesson 13, Teacher Guide)
- Lesson 14, Navigate Section, Step 1, "Ask questions about generating electricity. Display Slide A. Ask students what they have learned so far about how we get electricity to power devices like clocks or other devices on our Lesson 2 Related Phenomena/Things that turn on lists." (Lesson 14, Teacher Guide)

ii. The lessons help students develop toward proficiency in a targeted set of performance expectations.

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (Assessment Boundary: Assessment does not include quantitative measurements of energy.)

- Lesson 2, Explore Section, Step 4, "Explore Section, Step 4: Summarize the key takeaways from the discussion. Display slide H. Using the prompts on the slide, trace the path of causes and effects through the plug-in clock to see how everything could work together. Start with the plug and ask students what it is connected to and what they think it does, then continue to follow the path of wires to the clock display. As students trace the path, raise questions, such as what could be inside the wires or what could be causing the changes that we see (e.g., sounds coming from the clock or the display lighting up when it's on)." (Lesson 2, Teacher Guide)
- Lesson 6, Synthesize Section, Step 3, "Invite students to continue sharing their observations using a similar line of discussion and questioning until students have shared about many ways that energy can be transferred from place to place." (Lesson 6, Teacher Guide)

- Lesson 7, Synthesize Section, Step 5, "Referring to the photo on the slide, discuss where the energy to power the motor is coming from and going to and what our evidence is. Remind students that we can look to our Class Data Display and back at the book for evidence. Students should be able to identify that the sun must be transferring energy to the solar panel and that their evidence is that the panel only worked in the sun." (Lesson 7, Teacher Guide)
- Lesson 8, Make Observations Student Handout, "Look at the points labeled A, B, C, and D on the drawing. In the table below, describe what Alexa and Mina could observe that would be evidence that energy was transferred to and from each point. Then, describe using pictures and drawings where the energy comes from and where the energy goes. (Lesson 8 Handout, Make Observations)

4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.) (Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.) While working towards this PE in the unit, students do not refine a device.

- Lesson 3, Synthesize Section, Step 4: "Update our circuit diagrams. Distribute the Explain a Simple Circuit handout to students. Using their Dissect a Lantern and Make a Light Shine handouts as references, have students generate a model of a simple circuit using their understanding of batteries, electrical current, electricity, and circuits" (Lesson 3, Teacher Guide) Students do not design or refine this device.
- In Lesson 4, Synthesize Section, Step 4, Students discuss the question: "Where is the energy coming from to make it light up, make noise, etc?" (Lesson 4, Teacher Guide) Students do not design or refine this device.
- Lesson 5, Observing Wind Turbines, "Draw a Model and share it with a partner. Use arrows and labels to show where the energy is coming from and where the energy is going. Use evidence from your observations. Talk with a partner and revise your model as needed." (Lesson 5, Observing Wind Turbines) Students do not design or refine this device.
- Lesson 8, Make Observations Assessment: "Look at the points labeled A, B, C, and D on the drawing. In the table below, describe what Alexa and Mina could observe that would be evidence that energy was transferred to and from each point. Then, describe using pictures and drawings where the energy comes from and where the energy goes." (Lesson 8, Make Observations Assessment). In this assessment, students do not design, test, or refine a device.
- Lesson 14 Assessment: "Step 3. Refine the device: Use the lines and box below to draw and describe at least one way that NASA scientists and engineers could improve their Mars rovers." (Lesson 14 Assessment, Powering a Mars rover)

4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information. (Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.)

- In Lesson 9, Explore Section, Step 2, "Facilitate an Initial Ideas discussion to brainstorm solutions to a problem." Display slide B. Direct students to talk with a partner about different ways we could communicate information across a distance, like from the front of the room to someone in the back of the room. (Lesson 9, Teacher Guide) Students generate solutions; however, the task does not ask students to generate solutions that use patterns to transfer information.
- In Lesson 10, Connect Section, Step 4, "Distribute Comparing Design Solutions to each student. Explain that all the criteria and constraints can be considered, but since we have limited time, we should focus on those we think are more important. As a class, decide which criteria and constraints should be prioritized for providing peer feedback. Have students write these in the left column. If a couple criteria or constraints seem extra important, such

as communicating the time correctly, draw a star by those rows." (Lesson 10, Teacher Guide) Students compare solutions; however, those solutions do not use patterns to transfer information.

- In Lesson 11, Student handout, Students answer the question, "Which was easier to read at a distance, the dots or the hand writing? Why might this be?" (Lesson 11, Teacher Edition, p2)
- Lesson 14, Powering a Mars Rover Assessment: "Step 3. Refine the device: Use the lines and box below to draw and describe at least one way that NASA scientists and engineers could improve their Mars rovers. Be sure to include how your device meets the criteria and constraints you listed in Step 2." (Lesson 14, Powering a Mars Rover Assessment) Students only generate one idea on the assessment and do not compare these solutions.

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. (Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.)

- In Lesson 12, Explore Section, Step 2, "Analyze the effects of a sample usable energy source together. Tell students that they will be researching an energy source with their group to figure out the effects of obtaining and using that source and then evaluating it based on our criteria and constraints." (Lesson 12, Teacher Guide)
- In Lesson 13, Explore Section, Step 2, "Allow each group to present the information they obtained about the effects of using renewable and nonrenewable sources for generating electricity." (Lesson 13, Teacher Guide)

3-5 ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

- Lesson 9, Explore Section, Step 4: "Transition to developing our solutions. Display slide K. Point out that since we have brainstormed some ideas and defined our criteria and constraints, we can try to use those criteria and constraints to come up with more specific designs. Engineers call this "developing" a solution." (Lesson 9 Slides, Slide E) "Our problem: How can we design a way to communicate the time to someone who is far away? What are our constraints? What limitations are there to what we can do?" (Lesson 9, Slide F)
- Lesson 10, Navigate Section, Step 1: "What have we done so far to solve our problem? *Brainstormed ideas. Defined criteria and constraints. Designed a solution. We need to build them now.*" (Lesson 10, Teacher Guide)
- Lesson 14 Assessment: "Step 1. Define the problem. Use the lines below to describe the problem the scientists and engineers need to solve with their rovers." (Lesson 14 Assessment, Powering a Mars Rover)

3-5 ETS1-3 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.

- Lesson 10, Explore Section, Step 2: "How can we carry out our tests fairly? *We need to all do the same thing. We can only change one variable. We should all measure the same way.*" (Lesson 10, Teacher Guide)
- Lesson 10, Explore Section, Step 3: "Carry out an investigation to build and test our designs. Display slide E. Distribute Round 1 Design Testing and review the directions. Give students time to build and test their design solutions. Students discuss the question, What do you think went wrong on the first try? What could you do to improve?" (Lesson 10, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

I.E. Multiple Science Domains

EXTENSIVE

When appropriate, links are made across the science domains of life science, physical science, and Earth and space science.

i. Disciplinary core ideas from different disciplines are used together to explain phenomena.

ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

These pieces of evidence support the rating of **extensive** because the unit incorporates ideas from the physical and Earth science domains. These ideas are used together to help make sense of renewable and non-renewable resources, as well as how energy is transferred using these resource types.

i. Disciplinary core ideas from different disciplines are used together to explain phenomena.

The following DCIs are used in this unit.

- 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. (ESS3.A-E1)
- PS3.A Definitions of Energy: Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (PS3.A-E2)
- PS3.B Conservation of Energy and Energy Transfer: Energy is present whenever there are moving objects, sound, light, or heat. ~~When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced.~~ (PS3.B-E1).
- PS3.D Energy in Chemical Process and Everyday Life: The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use.
- PS4.C Information Technologies and Instrumentation: Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa.
- ETS1.A Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.
- ETS1.B Developing Possible Solutions: Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved.
- 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.

The unit uses science ideas from both the physical science domain and the earth science domain to explain that winding clocks and plug-in clocks need something to make them turn on and stay on.

- About the Science, "Because an understanding of how we use natural resources to generate electricity is an important component of this unit along with the practice of obtaining, evaluating, and communicating information, in Lesson 6 students begin to research how to generate electricity without wind. At this point in the unit, students sort cards that include very brief information about various usable energy sources to notice a pattern that some energy sources we have available to us can be used again and again (renewable resources), while others cannot be reused (nonrenewable resources). Students also recognize from this card sort that in all cases except solar panels, energy is transferred from moving objects (a turbine) to electrical current. This latter point leads students to want to further investigate sunlight as a usable energy source, and in Lesson 7, students explore where the energy comes from for solar panels to generate electricity. Using a solar panel and a motor, students investigate where the energy comes from (the sun and sunlight) and where the energy goes (into the panel, through the wires as electricity, and to the motor which spins). They conclude that light can indeed transfer energy. Students now have all the information they need to explain how devices (like a plug-in clock) can get the energy they need to work. They put all the pieces together in Lesson 8 to identify evidence that can be used to explain how a game console turns on and stays on, revisit their Driving Question Board, and plan what to investigate next." (About the Science)

- Unit Overview: there is a description for teachers about where the DCIs for the 6 performance expectations that are addressed in this unit. For example, "In Lessons 4-6, students investigate where electricity comes from, how electrical currents are generated from renewable and nonrenewable usable energy sources (e.g., coal, wind, solar, nuclear, oil), and how those currents transfer energy from place to place along lines or wires to be used locally." (Unit Front Matter, p16)

ii. The usefulness of crosscutting concepts to make sense of phenomena or design solutions to problems across science domains is highlighted.

The focal CCCs for the unit: Patterns, Energy and Matter, and Cause and Effect. Cause and effect and energy and matter are used to make sense of phenomena where an understanding of both physical science and earth science is required.

- Lesson 12, Explore Section, Step 2: "How It Works Water and steam is pulled from underground. The water or steam has high temperatures ranging from 300 - 700 degrees Fahrenheit. Water and steam spins turbines that generate electricity." (Effects of Usable Energy Sources Website, Geothermal) "There are a lot of benefits to using geothermal sources. However, there are some risks, too. Some scientists think that new ways of collecting steam from geothermal sources could cause earthquakes. New technology allows people to drill further into the Earth to find hot water. Most of the time, geothermal sources are found naturally in places like hot springs. However, new technology pulls steam from geothermal sources from places that are not a hot spring or a volcano." (Effects of Usable Energy Sources Website, Can Geothermal Replace Fossil Fuels)
- Lesson 13, Explore Section, Step 2: "How could our electricity usage affect the environment? If we leave the lights on when we don't need them we could be using too much electricity. When energy is transferred from a usable energy source it could cause pollution." (Lesson 13, Teacher Guide)
- Lesson 14, Synthesize Section, Step 3, Powering a Mars Rover handout, Step 4: Explain where the energy comes from and where the energy goes to power your new Mars rover. Explain how your rover communicates with scientists and engineers on Earth. Explain where the energy comes from and where the energy goes to communicate with your rover." (Lesson 14, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

I.F. Math and ELA

EXTENSIVE

Provides grade-appropriate connection(s) to the Common Core State Standards in Mathematics and/or English Language Arts & Literacy in History/Social Studies, Science and Technical Subjects.

The reviewers found **extensive** evidence that the materials provide grade-appropriate connections to the Common Core State Standards in Mathematics and/or English Language Arts and Literacy in History/Social Studies, Science, and Technical Subjects because the materials explicitly state the mathematics and ELA standards that are used in the unit, and in the case of ELA and Math standards, support students to grasp the connections between content areas (Math and ELA) and science.

ELA

CCSS.ELA-LITERACY.RI.4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.Claimed as supported in Lessons 4, 7, and 9. Evidence was found in Lessons 4, 7, and 9. Examples include:

- Lesson 4, Connect Section, Step 5, Sidebar: "Literacy Supports As students think about and share the main idea and key details in the text, they are using text information as evidence to explain different ways that devices turn on and stay on. This work helps students gain practice with determining the main idea of a text and the key details that support it (RI.4.2). (Lesson 4, Teacher Edition, p23)
- Lesson 7, Connect Section, Step 4 Sidebar:" Literacy Supports Identifying the main topic and retelling details in a text helps students to actively engage with a text and supports comprehension. Encouraging students to use this kind of information in their explanations will support them in making progress towards RI.4.2." (Lesson 7, Teacher Edition, p18)
- Lesson 9, Connect Section, Step 3 Sidebar: "Literacy Supports Asking students to name the main topic of the book and to summarize the main points, supported with details from the book, helps them make progress towards RI.4.2. Doing so helps students to actively engage with text through retelling details and identifying the main topic, and also supports comprehension of science ideas like criteria and constraints." (Lesson 9, Teacher Edition, p14-15)

CCSS-ELA-LITERACY.RI.4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears. Claimed as supported in Lessons 9 and 11. Evidence was found in Lesson 9 and 11. Examples include:

- Lesson 9, Connect Section, Step 5: "Distribute copies of one infographic (*Morse Code Infographic, Communication Infographic, Braille Infographic*) to each group, and have them read the infographic together, using the prompts on the slide as a guide." (Lesson 9, Teacher Guide)
- Lesson 11, Explore Section, Step 2: "Suggest that it seems important that we gather more information to learn more about how some clocks do not have to be set. Introduce the activity groups will use to gather information. Display slide D. Use the text on the slide to explain the process that students will go through to move from one station to the next and the titles of the four stations." (Lesson 11, Teacher Guide)

CCSS-ELA-LITERACY.RI.4.8 Explain how an author uses reasons and evidence to support particular points in a text. Claimed as supported in Lessons 12. Evidence was found in Lesson 12. Examples include:

- In Lesson 12, Explore Section, Step 3, students research energy sources and record evidence of how the energy source both helps and harms plants, animals, land, water, and people.

CCSS-ELA-LITERACY.RI.4.9 Integrate information from two texts on the same topic in order to write or speak about the subject knowledgeably. Claimed as supported in Lessons 9 and 11. Evidence was found in Lesson 9 and 11. Examples include:

- Lesson 9, Connect Section, Step 5: "Explain to students that there are many ways that people communicate information, and we've already identified some ways that can happen on our design chart. To help us think about other possible designs, let's gather more information about ways people can communicate with one another." Earlier in the lesson, students read a text about the process engineers go through to design solutions to problems, and then, they read an infographic about possible design solutions. Using all this information, Synthesize Section, Step 6: "Direct them to sketch their own design solution and be sure that the parts of the design are labeled... " (Lesson 9, Teacher Guide)
- Lesson 11, Explore Section, Step 2: "Suggest that it seems important that we gather more information to learn more about how some clocks do not have to be set. Introduce the activities groups will use to gather information. Display slide D. Use the text on the slide to explain the process that students will go through to move from one station to the next and the titles of the four stations." (Lesson 11, Teacher guide)

CCSS-ELA-LITERACY.W.4.2C Link ideas within categories of information using words and phrases (e.g., another, for example, also, because). Claimed as supported in Lessons 6. Evidence was found in Lesson 6. Examples include:

- Lesson 6, Explore Section, Step 2 Sidebar: "Giving students an opportunity to use linking words supports in making progress towards W.4.2C. Students use linking words like because or for example to provide additional details that provide rationale for their observations. As students transition to Synthesize, prompts are provided on slide E to further support them in practicing linking information." (Lesson 6, Teacher Guide)

CCSS-ELA-LITERACY.W.4.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. Claimed as supported in Lessons 1. Evidence was found in Lesson 1. Examples include:

- Lesson 1, Synthesize Section, Literacy Supports, "Encourage students to refer back to their Notice and Wonder About Clocks and add details to their model to explain what they noticed and to try to explain what they wondered. Also remind students that their classmates are their audience for this task--students will use their models to explain their thinking as the class identifies what we need to figure out in this unit. Considering the audience supports W.4.4 as students develop and organize their writing to be appropriate to the task, purpose, and audience." (Lesson 1, Teacher Guide)

CCSS-ELA-LITERACY.W.4.5 With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, and editing. Claimed as supported in Lessons 10. Evidence was found in Lesson 10. Examples include:

- Lesson 10, Explore Section, Step 7 Sidebar: "Peer review and feedback offers students the opportunity to develop and strengthen their written argument by revising and editing it. This work supports W.4.5 and students gain practice revising and editing their designs based on peer feedback." (Lesson 10, Teacher Guide)

CCSS-ELA-LITERACY.W.4.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of one page in a single sitting. Claimed as supported in Lessons 13. Evidence was found in Lesson 13. Examples include:

- Lesson 13, Navigate Section, Step 1 Sidebar: "Support students' use of technology as they maneuver through using a slide to support their presentation of their research. This supports W.4.6 and W.4.7 and offers students an opportunity to publish their research using technology and collaboration with peers." (Lesson 13, Teacher Guide)

CCSS-ELA-LITERACY.W.4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic. Claimed as supported in Lessons 13. Evidence was found in Lesson 13. Examples include:

- Lesson 13, Navigate Section, Step 1 Sidebar: " Literacy Supports Support students' use of technology as they maneuver through using a slide to support their presentation of their research. This supports W.4.6 and W.4.7 and offers students an opportunity to publish their research using technology and collaboration with peers. (Lesson 13, Teacher Guide)

CCSS-ELA-LITERACY.SL.4.1B Follow agreed-upon rules for discussions and carry out assigned roles. Claimed as supported in Lessons 1 and 2. Evidence was found in Lesson 1 and 2. Examples include:

- Lesson 1, Synthesize Section, Step 4 Sidebar: "Establishing classroom agreements provides an opportunity for students to develop and follow agreed-upon rules for discussion. This work supports Le.1B." (Lesson 1, Teacher Guide)
- Lesson 2, Synthesize Section, Step 6, Literacy Supports, "Use discussions as opportunities to revisit Classroom Agreements so that students can follow agreed-upon rules for discussions. Supporting students in making progress toward SL.4.1B can help students communicate effectively in large group settings." (Lesson 2, Teacher Guide)

CCSS-ELA-LITERACY.SL.4.2 Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally. Claimed as supported in Lessons 4 and 7. Evidence was found in Lesson 4 and 7. Examples include:

- Lesson 4, Connect Section, Step 5: "What does it mean for the power to go out?" (Lesson 4, Teacher guide)
- Lesson 7, Connect Section, Step 4: Although the class reads a book, there are no teacher prompts to have students paraphrase parts of the text.

CCSS-ELA-LITERACY.SL.4.2 Paraphrase portions of a text read aloud or information presented in diverse media and formats, including visually, quantitatively, and orally. Claimed as supported in Lessons 4 and 7. Evidence was found in Lesson 7. Examples include:

- Lesson 4, This standard is not explicitly used and named in the lesson with specific support for teachers.
- Lesson 7, Synthesize Section, Step 5 Sidebar: "Literacy Supports As students summarize what they have figured out, they gain practice paraphrasing orally presented information. This supports SL.4.2 and provides students the opportunity to share their science ideas clearly and coherently. (Lesson 7, Teacher Guide)

CCSS-ELA-LITERACY.SL.4.5 Add audio recordings and visual displays to presentations when appropriate to enhance the development of main ideas or themes. Claimed as supported in Lessons 13. Evidence was found in Lesson 13. Examples include:

- Lesson 13, Explore Section, Step 2 Sidebar: "Literacy Supports Giving students opportunities to report on the information they obtained from their research, allows them to practice using facts and relevant details to support claims. When students practice this they gain experience organizing their oral language in preparation for presenting their ideas to others (SL.4.5)." (Lesson 13, Teacher Guide)

CCSS-ELA-LITERACY.L.4.2D Spell grade-appropriate words correctly, consulting references as needed. Claimed as supported in Lessons 8. Evidence was found in Lesson 8. Examples include:

- Lesson 8, Synthesize Section, Step 3 Sidebar: "Literacy Supports As students complete their assessment, encourage them to remember to use the Word Wall to spell words correctly, or to use other references available in the classroom, such as dictionaries or glossaries. This supports students in making progress towards L.4.2D, which states that students be able to spell grade-appropriate words correctly, consulting references as needed." (Lesson 8, Teacher Guide)

CCSS-ELA-LITERACY.L.4.4B Use common, grade-appropriate Greek and Latin affixes and roots as clues to the meaning of a word (e.g., telegraph, photograph, autograph). Claimed as supported in Lessons 6. Evidence was found in Lesson 6. Examples include:

- Lesson 6, Synthesize Section, Step 3 Sidebar: "Literacy Supports Introducing the words "renewable" and "nonrenewable" is another opportunity to reiterate how students can use root words and prefixes to figure out what a word means. Consider looking at both words simultaneously to point out that the root of both words is the same, but the prefix non- is what differs between them. The prefix non- means "the opposite of." The meaning of this prefix can help students distinguish between the meanings of these two words and be applied to other words that use the prefix non- (L.4.4B)." (Lesson 6, Teacher Guide)

CCSS-ELA-LITERACY.L.4.5 Demonstrate understanding of figurative language, word relationships, and nuances in word meanings. Claimed as supported in Lessons 3. Evidence was found in Lesson 3. Examples include:

- Lesson 3, Synthesize Section, Step 4 Sidebar: "Literacy Supports Remind students that words can have multiple meanings. Scientists understand these different meanings and can use words with multiple meanings differently depending on the context (e.g., formal and informal presentations). Electricity and current are added to the Word Wall at this moment to support students when they need to use precise scientific language, like when describing the path of energy transfer in their diagram. However, students can interchangeably use the words electricity and electrical current in moments when describing how energy transfer is occurring. This work supports L.4.5 as students demonstrate an understanding of word relationships and nuances in word meanings." (Lesson 3, Teacher Guide)

Mathematics

CCSS-MATH-Practice.MP1 Make sense of problems and persevere in solving them. Claimed as supported in Lessons 10. Evidence was found in Lesson 10. Examples include:

- Lesson 10, Explore Section, Step 2: "Have students make sense of the criteria for their designs and how to measure the distance between the sender and receiver of the message by discussing what data they should collect for their tests ." (Lesson 10 Sidebar, Teacher Guide)

CCSS-MATH-Practice.MP2 Reason abstractly and quantitatively. Claimed as supported in Lessons 10. Evidence was found in Lesson 10. Examples include:

- Lesson 10, Connect Section, Step 4 Sidebar: "Students engage in qualitative and quantitative reasoning to determine how well each design meets the class' criteria and overcomes their constraints." (Lesson 10, Teacher Guide) Though the sidebar identifies the opportunity for students to use quantitative and qualitative reasoning, it is not evident that students are asked to provide feedback using either qualitative or quantitative reasoning.

CCSS-MATH-Practice.MP3 Construct viable arguments and critique the reasoning of others. Claimed as supported in Lessons 10. Evidence was found in Lesson 10. Examples include:

- Lesson 10, Synthesize Section, Step 5 Sidebar: "As students share their peer feedback for the designs, have them take turns explaining their group's design and critiquing their classmates' designs on how well they meet the class' criteria and overcome the constraints based on the demonstrations." (Lesson 10 Sidebar, Teacher Guide)

CCSS-MATH-Practice.MP5 Use appropriate tools strategically. Claimed as supported in Lessons 10. Evidence was found in Lesson 10. Examples include:

- Lesson 10, Explore Section, Step 2: "Provide students access to appropriate measuring tools (e.g. measuring tape, meter stick) to collect their quantitative data."(Lesson 10, Teacher Edition)

CCSS-MATH-Practice.MP6 Attend to precision. Claimed as supported in Lessons 3. Evidence was found in Lesson 3. Examples include:

- Lesson 3, Explore Section, Step 3 Sidebar: "Model the precision of language and have students also use precise language (e.g., calling 1.5 as 1 and five tenths) when reading the decimal voltages to support students' sensemaking of its magnitude by connecting decimals to their understanding of fractions." (Lesson 3, Teacher Guide)

CCSS-MATH-Practice.MP7 Look for and make use of structure. Claimed as supported in Lessons 11. Evidence was found in Lesson 11. Examples include:

- Lesson 11, Explore Section, Step 2 Sidebar: "Students make use of the structure of binary and Morse code as they generate and analyze patterns to send and receive coded messages." (Lesson 11, Teacher Guide)

CCSS-MATH-4.OA.C.5 Generate a number or shape pattern that follows a given rule. Identify apparent features of the pattern that were not explicit in the rule itself. For example, given the rule "Add 3" and the starting number 1, generate terms in the resulting sequence and observe that the terms appear to alternate between odd and even numbers. Explain informally why the numbers will continue to alternate in this way. Claimed as supported in Lessons 11. Evidence was found in Lesson 11. Examples include:

- Lesson 11, Explore Section, Step 2 Sidebar: "Students make use of the structure of binary and Morse code as they generate and analyze patterns to send and receive coded messages." (Lesson 11 Sidebar, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

CATEGORY II
NGSS Instructional Supports

II.A. Relevance and Authenticity

EXTENSIVE

Engages students in authentic and meaningful scenarios that reflect the practice of science and engineering as experienced in the real world.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations).

ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community and/or culture as appropriate.

iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

These pieces of evidence support the rating of **extensive** because the materials engage students in authentic and meaningful scenarios that reflect the practices of science and engineering as experienced in the real world, as students have opportunities to explain the phenomena of how a winding clock and a plug-in clock work and stay turned on. Students experience phenomena or design problems as directly as possible by observing the inner workings of a clock and dissecting a lantern. The materials include suggestions for how to connect instruction to the students' home and community, such as researching energy sources that directly affect their communities. The materials provide opportunities for students to connect their explanation of a phenomenon and/or their design solution to questions from their own experiences when students reflect on the way energy sources could help or hurt their community.

i. Students experience phenomena or design problems as directly as possible (firsthand or through media representations)

- Lesson 1, Explore Section, Step 2: "Observe and manipulate a winding clock. Display slide B and tell students that the first clock they will observe is a winding clock. Before you give students time to observe and manipulate its parts, ask students if they have seen or heard about a clock that "winds up." Give students 1-2 minutes to respond, and then show them the winding clock that you have already started. Ask them to think about what had to happen to make it turn on and stay on. After 1-2 minutes of response time, give each student an opportunity to manipulate the pieces on the winding clock." (Lesson 1, Teacher Guide)
- Lesson 1, Synthesize Section, Step 5: "Ask something like, Are there other things in your lives that are similar to the plug-in clock? Other things that turn on? How do you know they are "on"? Rather than sharing ideas aloud right now, distribute What else turns on? and give students a minute to look around the classroom and think. Then, have students look for examples of other devices that turn on/use power on their way home and in their home and record them on the first side of the page." (Lesson 1, Teacher Guide)
- Lesson 2, Explore Section, Step 4, "Make observations and predictions. Gather the class together and display slide G. Carefully remove the back of the clock (if necessary, using a screwdriver) and give students time to look inside. Invite students to share a part they observed and their prediction about how the part works to keep the clock on." (Lesson 2, Teacher Guide)
- Lesson 2, Explore Section, Step 5, "Explain to students that you have a clear winding clock that has the same parts as the one they saw in the last lesson. Be sure students can see the clear winding clock. Then, ask students to pay attention to what happens inside the clear clock when you turn the winder, and to notice the parts that they see." (Lesson 2, Teacher Guide)

- Lesson 3, Explore Section, Step 2, "Distribute the Dissect a Lantern handout and a lantern and screwdriver to each group of students. Review the handout with students, and give students about 10 minutes to work with their group to dissect the lantern," (Lesson 3, Teacher Guide)

ii. Includes suggestions for how to connect instruction to the students' home, neighborhood, community, and/or culture as appropriate.

- Lesson 1, Connect Section, Step 7: "Connect to Our Experiences When you leave school today, look for and think about other devices like a clock: How are they like the clock? What can you observe (see, hear, and/or feel) about them? You might talk with other people in your family or community to gather some of their ideas, too." (Lesson 1 slides, Slide Q)
- Lesson 2, Connect Section, Step 2: "What else turns on? When you leave school today, find other devices that turn on or use power. You might work with other people in your family or community to gather their ideas, too. Use words and/or drawings in this table to record your evidence that the object is "on."" (Lesson 2 Handout, Community Connection)
- Lesson 2, Connect Section, Step 2: "Prepare to connect to our experiences. Display slide C and review the directions for taking a school tour. Add any necessary steps specific to your building or tour route. Distribute clipboards and have students take out the What else turns on? handout you distributed at the end of Lesson 1." (Lesson 2, Teacher Guide)
- Lesson 4, Navigate Section, Step 1 Sidebar: "Community Connections If you have students who have lived outside of North or Central America, invite them to describe how outlets and plugs look different in other places." (Lesson 4, Teacher Guide)
- Lesson 4, Explore Section, Step 2 Sidebar: "Community Connections Students may be curious to go home and investigate the electrical system where they live to compare it with the system at school. Be sure students understand they must be accompanied by a trusted adult if they want to do this." (Lesson 4, Teacher Guide)
- Lesson 5, Explore Section, Step 2 Sidebar: "Community Connections If there is a wind farm in or near your community, consider organizing a field trip for students to see and observe first-hand how wind turbines generate electricity. Following the field trip, have students update their models and explanations in Synthesize to include evidence from their field trip." (Lesson 5, Teacher Guide)
- Lesson 6, Synthesize Section, Step 3, "Use this conversation to highlight usable energy sources that students may have seen or have experience within their own community. Students will likely have seen solar panels, power plants, and/or wind turbines. Discuss with students if those community connections are renewable or nonrenewable to reinforce understanding of these concepts." (Lesson 6, Teacher Guide)
- Lesson 7, Synthesize Section, Step 5 Sidebar: "Community Connections Ask students to consider where a solar panel (or several) could be used in their community. Where might it fit well and get enough sun? How could it help provide electricity to more people? The class will return to this line of thinking in Lesson 12 and 13. If your school uses solar panels, consider taking students to see them to explain where the energy comes from and where the energy goes." (Lesson 7, Teacher Guide)
- Lesson 12, Synthesize Section, Step 4 Sidebar: "Community Connections Students may have family connections to usable energy sources, such as having solar panels on their homes, family members who work in mines, or family members that service or install wind turbines. Encourage students to share their own photos of energy sources and understanding of the effects the sources could have on people and the environment." (Lesson 12, Teacher Guide)

- Lesson 13, Synthesize Section, Step 4 Sidebar: "Community Connections Communities are impacted in different ways by usable energy sources. Some rely upon the economic inputs generated by coal mining, for example. Others are more impacted by air pollution produced by burning coal. During this discussion, support students in recognizing that even though some energy sources have more known harmful effects than others, there are still important benefits to people, such as jobs and electricity access." (Lesson 13, Teacher Guide)

iii. Provides opportunities for students to connect their explanation of a phenomenon and/or their design solution to a problem to questions from their own experience.

- Lesson 1, Synthesize Section, Step 5, "Individually record our questions. Display slide L. Explain that we have made a lot of great observations about why the plug-in clock turns on and stays on, but we know in our model we were not sure about everything. Similarly, scientists are always looking for questions to answer, things they want to figure out about the world that they do not understand yet. Let's take some time to think about what we're wondering about how the plug-in clock is working." (Lesson 1, Teacher Guide)
- Lesson 2, Connect Section, Step 2: "Distribute clipboards and have students take out the *What else turns on?* handout you distributed at the end of Lesson 1. Reassure students that they will also get to share the ideas they collected at home when we share examples from the school tour." (Lesson 2, Teacher Guide)
- Lesson 4, Navigate Section, Step 6: "Remind students that all of our learning so far has been focused on the evidence of energy transfer that we observed in our investigations and that we are trying to figure out why the plug-in clock stays on." AND "Emphasize that we needed an energy source to light up the LED and that our model doesn't have a power source connected to the outlet yet. If there are questions on the DQB that have not been answered about where energy or electricity comes from, make connections to those questions." (Lesson 4, Teacher Guide)
- Lesson 6, Navigate Section 1, "Facilitate an Initial Ideas Discussion. Present slide B and invite students to consider other potential ways we can generate electricity." (Lesson 6, Teacher Guide)
- Lesson 8, Navigate Section, Step 4: "Remove several questions from the DQB, enough to give each group at least one question to discuss, possibly more if you want. Distribute questions from the DQB to each group. Each should discuss their question(s) and be ready to sort them into one of three categories; answered, partially answered, or still need to be answered." (Lesson 8, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

II.B. Student Ideas

EXTENSIVE

Student Ideas: Provides opportunities for students to express, clarify, justify, interpret, and represent their ideas and respond to peer and teacher feedback orally and/or in written form as appropriate.

These pieces of evidence support the rating of **extensive** because there are opportunities for students to express, clarify, justify, interpret, and represent their ideas across the unit. Students provide feedback to peers and receive feedback from peers and their teacher when appropriate. Throughout the unit, students show their thinking has evolved using the My Growing Ideas Chart. Teachers are provided with guidance and support to provide feedback to students through the lesson assessment section in each lesson and in additional guidance provided during Key Formative Assessments, as in Lesson 4. Most of the opportunities to receive and respond to feedback from peers is done collaboratively, not individually. Most of the opportunities in which students receive feedback from the teacher and use it to revise their work are optional.

Student ideas are clarified, justified, and built upon.

- Lesson 1, Connect Section, Step 1 Sidebar: “The purpose of an Initial Ideas Discussion is to provide an opportunity for students to share and make sense of their ideas, even while the ideas may be tentative or uncertain. Ask questions such as Can you say more about that? and Who wants to add on to what _____ is saying? The goal is to surface multiple ideas, so avoid privileging some ideas over others. Draw out possible competing ideas to help motivate students to want to further investigate them. This conversation also helps to promote curiosity about how things turn on and stay on. Read more about Initial Ideas Discussions in the Teacher Handbook.” (Lesson 1, Teacher Guide)
- Lesson 1, Synthesize Section, Step 4, “In a Consensus Discussion, we capture agreed- or disagreed-on ideas. This collective work moves us toward a more complete model. Here, we are co-constructing our initial consensus model, so we do not need to agree on everything. We are finding whether we agree on some ideas and finding places of uncertainty. This will motivate questions and ideas for investigation that we will generate later in the lesson.” (Lesson 1, Teacher Guide)
- Lesson 2, Synthesize Section, Step 6: “Then, return to the “Why does the winding clock turn on and stay on?” chart and, using students’ ideas and observations as a guide, draw the path of energy transfer on the clock, using a marker color other than what was used to draw it originally. Then, describe on the chart in words or drawings where the energy is coming from and where it is going.” (Lesson 2, Teacher Guide)
- Lesson 4, Navigate Section, Step 6: “Recall previous experiences. Display slide N. Ask students to think back to the activities from the last couple of lessons. Using the prompt on the slide, have them turn and tell a partner about one thing they are starting to understand and one thing that they are still unsure about.” (Lesson 4, Teacher Guide)
- Lesson 5, Synthesize Section, Step 6: “Participate in a Discussion How does a wind turbine generate electricity? We figured out _____ because _______ I would like to add on ______ I think I understand, but can you explain some more? We all seem to be saying ________” (Lesson 5 Slides, Slide K)
- Lesson 7, Connect section, Step 4: “Have students discuss the main topic of the pages they read in their investigation groups. When done reading, give students time in their investigation groups to revisit their explanation to questions #2 and #3 on Light Investigation, and then use what they read to revise or add to their answers.” (Lesson 7, Teacher Guide)
- Lesson 9, Explore Section, Step 2, “Facilitate an Initial Ideas discussion to brainstorm solutions to a problem. Display slide B. Direct students to talk with a partner about different ways we could communicate information across a distance, like from the front of the room to someone in the back of the room.” (Lesson 9, Teacher Guide)

- Lesson 10, Explore Section, Step 7: "Review peer feedback. Display slide K. Distribute the peer feedback pages that you assembled from Comparing Design Solutions to each group and return their Round 1 Design Testing. Then have groups review the feedback and use that, along with the updated criteria and constraints to revise and optimize their design. Have them record their ideas and data on the "Round 2" table of the Round 2 Design Testing handout. If needed, be sure to show slide D so that students can refer to the investigation procedures." (Lesson 10, Teacher Guide)

Artifacts show evidence of students' reasoning and changes in their thinking over time.

- Lesson 1, Synthesize Section, Step 3, "Individually create initial models. Display slide H. Distribute the Initial Model handout and give students 8-10 minutes to draw their models. Encourage students to use arrows to show why the plug-in clock turns on and stays on, and to label what their arrows represent. Students will have time to refine their models after talking with a partner in the next step." (Lesson 1, Teacher Guide)
- Lesson 2, Explore Section, Step 5: "Use words, drawings, and arrows to explain your ideas about the question: Why does a winding clock turn on and stay on? Think about what you saw, heard, and felt while observing the winding clock. Use arrows to show how the parts of your model interact and label what your arrows represent." (Lesson 2 Handout, Winding Clock Model)
- Lesson 3, Synthesize Section, Step 4, "Prompt students to individually reflect on new information they have and to look back to the diagrams on Make a Light Shine. Ask students what they should revise on their diagrams." (Lesson 3, Teacher Guide)
- Lesson 3, Navigate Section, Step 5 Sidebar: "The My Growing Ideas chart will be used multiple times throughout this unit. This is a space for students to write and/or draw what they have figured out in a lesson, and to see how their thinking changes over time. It is not intended to be graded. See the Teacher Handbook for more information. Have students keep this chart easily accessible so they can see how their ideas develop throughout the unit. The next use of the My Growing Ideas chart will be as a resource throughout Lesson 4." Lesson 3, Teacher Guide)
- Lesson 7, Synthesize Section, Step 5: "Summarize what we learned. Remind students that we started our investigation wondering how solar panels are able to generate electricity and we carried out a fair test investigation to test solar panels in the sun. Give students 1-2 minutes in pairs to summarize what they learned from the discussion before sharing out. Look and listen for ideas such as: Sunlight transfers energy to the solar panel. The solar panel transfers energy to the wires as electrical current. The current makes the motor move. Then, give students another minute or two to return to their Light Investigation handout to individually update their response to question #3. Encourage students to explain where the energy is coming from and where the energy is going that causes the solar panel to make the motor move. As students are revising their handouts, guiding questions to ask include: What revisions are you making? What did you figure out that you are now including in your explanation? What is your evidence to support the changes you are making?" (Lesson 7, Teacher Guide)
- Lesson 8, Synthesize Section, Step 3, "Individually identify evidence for energy transfer. Display slide D. Distribute Make Observations and Self-Reflection to students. Tell students they will be using their understanding of usable energy sources and how a plug-in clock turns on to identify evidence that could be used to explain energy transfer in a game console." (Lesson 8, Teacher Guide)
- Lesson 10, Lesson 10 Handout, Round 2 Design, "After reviewing your peer feedback and the updated criteria and constraints, use the space below to plan an optimized design. Use words and/or drawings to explain your changes." (Lesson 10, Student Handout)

- Lesson 12, Explore Section, Step 3: "Direct students to explore the Effects of Useable Energy Sources Website resources that are provided on their handout and record their ideas to complete chart and questions. As students are working, assist in finding and/or determining if an effect helps or hurts the environment and everything that lives in it." (Lesson 12, Teacher Guide)
- Lesson 13, Synthesize Section, Step 4, "Update My Growing Ideas Chart. Present slide I. Distribute My Growing Ideas to students. Give students time to think and record their ideas about light and energy transfer and what questions they have." (Lesson 13, Teacher Guide)

Students receive feedback and revise their thinking accordingly.

- Lesson 1, Synthesize Section, Step 3, "Share models with partners. Display slide I. Read the directions on the slide and remind students that scientists revise their thinking as they learn more. Depending on your preference, you can have students compare similarities/differences/additions using sticky notes on their models, or have them make revisions with another colored pencil. Ask students to record questions they may have on the sticky notes about things they are unsure about after seeing their partners' models." (Lesson 1, Teacher Guide)
- Lesson 3, Explore Section, Step 3: "Each student should individually prepare a one-sentence explanation of their diagram and share it with another student in their small group. Remind students that when we explain something, we need to use evidence from our investigation. ..... Students should then update their individual explanations based on talking to their peers." (Lesson 3, Teacher Guide)
- Lesson 4, Key Formative Assessment Tool Key, "Use the information provided in this Key Formative Instructional Guidance document, along with Lessons 2- 7 Following Student Sensemaking and the Assessment Guidance in the Lesson 4 Teacher Edition, to assess and support student understanding." This document also contains guidance to provide constructive feedback to students.
- Lesson 5, Synthesize Section, Step 5, "Develop a model. Display slide J. Give students 5-7 minutes to develop their model (question #2) explaining how a wind turbine generates electricity before sharing it with a partner. Remind them to use arrows to show how and where energy is being transferred." (Lesson 5, Teacher Guide) Support is not provided to guide constructive feedback to students from both the teacher and peers. Students do not have an opportunity to revise their thinking after sharing with a peer before their model is collected.
- Lesson 7, Synthesize Section, 5: "Then, give students another minute or two to return to their Light Investigation handout to individually update their response to question #3. Encourage students to explain where the energy is coming from and where the energy is going that causes the solar panel to make the motor move. As students are revising their handouts, guiding questions to ask include: What revisions are you making? What did you figure out that you are now including in your explanation? What is your evidence to support the changes you are making? Then, collect student handouts." (Lesson 7, Teacher Guide)
- Lesson 7, Assessment Opportunity: "Consider providing students with feedback and giving them an opportunity to revise their explanations again." (Lesson 7, Teacher Guide) Because this is optional, students are not guaranteed feedback to use to revise their explanations.
- Lesson 8, Lesson Assessment Guidance: "Consider allowing them to revise their assessment using feedback provided to them. Opportunities to revise explanations will provide students with additional support in making progress on their understanding of how to make observations to provide evidence that energy can be transferred in various ways." (Lesson 8, Teacher Guide)Because this is optional, students are not guaranteed feedback to use to revise their explanations.

- Lesson 8, Assessment Opportunity: "Use *Scoring Guidance for Student Assessment* and consider providing feedback to students to revise their work. *Make Observations* is an opportunity for students to self-assess and reflect on their progress towards Learning Goal 8, and to help them identify improvements they can make the next time they are asked to complete similar tasks. Consider using the self-assessment in combination with *Scoring Guidance for Student Assessment* to provide feedback to students on *Self-Reflection*." (Lesson 8, Teacher Guide) Because this is optional, students are not guaranteed feedback to use to revise their explanations.
- Lesson 9, Connect Section, Step 4: "Distribute Comparing Design Solutions to each student. Explain that all the criteria and constraints can be considered, but since we have limited time, we should focus on those we think are more important. As a class, decide which criteria and constraints should be prioritized for providing peer feedback. Have students write these in the left column. If a couple criteria or constraints seem extra important, such as communicating the time correctly, draw a star by those rows." (Lesson 9, Teacher Guide)
- Lesson 10, Connect Section, Step 4, "Engage in a gallery tour to compare designs. Display slide G. Describe the feedback process to students: two students from each group will stay to demonstrate their design solution to others, even if it did not work, and the rest of the group will rotate to see the other designs and provide peer feedback." (Lesson 10, Teacher Guide)
- Lesson 10, Explore Section, Step 7: "Distribute the peer feedback pages that you assembled from *Comparing Design Solutions* to each group and return their Round 1 Design Testing. Then have groups review the feedback and use that, along with the updated criteria and constraints to revise and optimize their design. Have them record their ideas and data on the "Round 2" table of the Round 2 Design Testing handout." (Lesson 10, Teacher Guide) Though students are receiving feedback loops from peers, and possibly their teacher, this is all done collaboratively. Students do not receive individual feedback and then make revisions based on this individual feedback.
- Lesson 14, Synthesize Section, Step 3: "Consider providing feedback to students using Scoring Guidance for Student Assessment and allowing them to revise their responses. Refer to the Scoring Guidance for Student Assessment tool and the Assessment Guidance at the beginning of the lesson for more information." (Lesson 14, Teacher Guide) Being optional, students are not guaranteed feedback to use to revise their explanations.

Criterion-Based Suggestions for Improvement

- Consider including strategies in which students receive feedback from the teacher and/or peers individually, then have the opportunity to respond and revise based on the feedback.

II.C. Building Progressions

EXTENSIVE

Identifies and builds on students' prior learning in all three dimensions, including providing the following support to teachers:

i. Explicitly identifying prior student learning expected for all three dimensions

ii. Clearly explaining how the prior learning will be built upon.

These pieces of evidence support the **extensive** rating because the learning students are expected to have when beginning this unit, for all three dimensions, is identified both in the teacher overview and within specific lessons where applicable. In addition, explanations for how this prior learning will be added to during instruction is explained in the Unit Overview and within specific lessons.

i. Explicitly identifying prior student learning expected for all three dimensions

Disciplinary Core Ideas: Unit Front Matter: Energy

- In Unit 4.1: Why does an object's motion change? students defined energy and explored evidence of energy transfer, specifically via moving objects and collisions, which result in sound and can cause us to feel heat. In this unit, students build on their understanding of energy transfer by identifying light and electrical currents as additional ways that energy can be transferred, and they continue to identify changes in sound, light, motion, or heat as evidence of energy transfer. Students who have not had the Unit 4.1: Why does an object's motion change? are likely to have heard that food gives them energy or have been told they have too much or too little energy during a day's activities, so they likely have some intuitive understanding that energy is related to moving. Students also have many experiences with making things move and change and may use words or phrases such as "oomph" or "it's getting something to turn on". These kinds of phrases can be leveraged in Lesson 2 when students identify energy as something has the ability to cause change (like causing something to turn on, make sound, move, etc.)
- A common idea that students may bring to the classroom is that energy is a thing, such as a material object, that can be given to another object or taken from an object. Use these ideas as opportunities to reinforce that we cannot see energy, but we can see the changes or differences that energy causes, such as the evidence of energy transfer that we gather through our investigations (e.g., changes in motion, temperature changes, sounds, lights turning on). Students may also say things like "the battery lost its energy". Use this as an opportunity to discuss with students how usable energy sources are changed and how energy gets transferred from one to another and that we can look for evidence to let us know that has happened.

Similar explanations of prior learning are provided for the science of light, electrical current and electricity, sound, and coding and digitized information.

- The information in the front matter is general and does not reference specific elements of the DCIs.

Science and Engineering Practices: Unit Front Matter: Planning and carrying out investigations

- In Unit 3.1: How can we design objects to balance and move in different ways? students were introduced to the idea of procedures, changing only one variable at a time during an investigation, and recording detailed observations and data from their investigations. In the Unit 4.1: Why does an object's motion change? students built on these ideas to plan and carry out fair tests that included multiple trials, to consider variables that stay the same and that change, and to identify the evidence we gathered through analysis and interpretation of recorded data. In this unit, we apply those foundational understandings to figure out how sunlight can be used to generate electricity, and apply it to the engineering design process and consider how we can plan and carry out a fair test to determine how well our design solutions meet our criteria and constraints for a successful solution. While students will have had varied opportunities for carrying out investigations to support their learning of science ideas, they may not have had a lot of experience in carrying out investigations, particularly fair test investigations, to gather evidence for refining and optimizing a design solution. Leverage all their experiences with investigations to discuss the similarities and differences in the kinds of information they are seeking when they are testing a design solution versus when they are testing to figure out how sunlight causes a solar panel to generate electricity.

Similar information is given about the SEPs of defining problems and designing solutions.

- The information in the front matter is general and does not reference specific elements of the SEPs.

Crosscutting Concepts: Unit Front Matter: Patterns:

- From prior grades, students have developed ideas about observable changes that can be used to describe phenomena and as evidence to support explanations of phenomena. They also will have had many opportunities to look for patterns in numbers and shapes. In this unit, students build on their foundational understanding of patterns to identify similarities and differences in how usable energy sources can be used to generate electricity, and they look for patterns in how information is sent and received.

Similar information about the CCC of cause and effect is provided.

- The information in the front matter is general and does not reference specific elements of the CCCs.

ii. Clearly explaining how the prior learning will be built upon.

- Alignment With The Three Dimensions Of NGSS: "The following three tables explain how students engage in Science and Engineering Practices, use Crosscutting Concepts, and figure out Disciplinary Core Ideas in this unit's lessons. The codes used to identify each dimension's elements are described in the Teacher Handbook." This document explains at the element level "How Students Engage in this Practice." (Alignment with the Three Dimensions of NGSS)
- Lesson 2, Explore Section, Step 4: "Facilitate a brief discussion with students about how we can plan the investigation. As you facilitate the conversation, review with students, as necessary, words that they have encountered if they have experienced *Unit 4.1: Why does an object's motion change?* or *Unit 3.1: How can we design objects to balance and move in different ways?*, such as observe (to notice details) and evidence (a collection of facts or information that can help us decide whether an idea is true). Students may suggest, based on their experience with Unit 4.1: Why does an object's motion change?, that they should do a fair test investigation. If students suggest this, discuss with them if there is a variable for us to change and/or something to measure. Explain that fair test investigations are important but that sometimes scientists also just need to observe something to understand better how its parts work together." (Lesson 2, Teacher Guide)
- Lesson 2, Synthesize Section, Step 6: "If students have experience with Unit 4.1: Why does an object's motion change?, summarize students' ideas by making a connection to the previous unit. Remind them about how in Unit 4.1: Why does an object's motion change?, we learned that energy is present when we observe changes in motion, sound, or heat. (Add a question to your DQB about light and energy, if that's helpful. You can revisit this question in Lesson 7.) Continue by reminding students that we figured out in the *Unit 4.1: Why does an object's motion change?* that collisions cause energy to be transferred from one to another, moving energy from place to place. Consider asking something like, Is energy also being transferred in the clocks we were examining and the other devices we saw around the school? How do we know that? Students should identify that energy is transferred from the hand to the winder, from the winder to the spring and gears, and from the gears to the clock hands." (Lesson 2, Teacher Guide)

- Lesson 3, Synthesize Section, Step 4: "Point out that we have been describing a lot of important ideas and maybe using words today we have not all talked about yet, so let's be sure we know what they mean. Explain that we were just describing the way energy can be transferred from the battery to the LED to make it light up, but that energy has to travel along a specific path." This discussion continues on to co-develop definitions for electricity, current and circuit based on student experiences. (Lesson 3, Teacher Guide)
- Lesson 6, Explore Section, Step 2: "Let students know that each card has some specific information about each type of electricity generation that they can use to complete their sheet, and that they will be looking for patterns across all the various ways of generating electricity. Distribute a set of cards to each group and give each student a Generating Electricity Data Sheet handout to collect their information." (Lesson 6, Teacher Guide)
- Lesson 7, Explore Section, Step 2: "Summarize student conversations by saying that it sounds like they are suggesting they need the sun to test the solar panel, and if we want to make sure that it's the sun making it work, then we should also test it in the shade. If students have experienced *Unit 3.1: How can we design objects to balance and move in different ways?* and/or *Unit 4.1: Why does an object's motion change?*, remind students that for our investigation, the solar panel, the motor, and the sun for our investigation are variables (something that stays the same or changes in an investigation and that the sun is the variable we are changing (sun/no sun). You may also consider referencing Fair Test Investigation Infographic. If students have not yet experienced Unit 3.1: How can we design objects to balance and move in different ways? and/or *Unit 4.1: Why does an object's motion change?*, use the discussion as a way to connect variables and fair tests (we only change one variable at a time and keep everything else the same) to the ideas they are mentioning for testing the solar panels. Using their developing understanding of variables, help students come up with an investigation question to guide their fair test, something like "how does changing the amount of sunlight affect the movement of the motor?" (Lesson 7, Teacher Guide)
- Lesson 10, Explore Section, Step 2: "Explain that scientists and engineers often consider the types of data they will be able to collect from their tests. Data that can be counted are called quantitative data. If we can count a quantity of something, it's quantitative data. Data that cannot be measured with numbers or counting are called qualitative data. We often use words or images to describe the qualities of something, and that's qualitative data. Display slide C and continue to plan the test, determining the types of data to collect and the steps they will follow. If students have had *Unit 4.1: Why does an object's motion change?*, you may find it helpful to reference the Fair Test Investigation Infographic as students make their investigation plan." (Lesson 10, Teacher Guide)

Criterion-Based Suggestions for Improvement

- Consider adding the notations present in the Alignment with the Three Dimensions of *NGSS* (e.g., AQDP-E4) to the summaries of previous learning in the unit's front matter so that teachers can connect the information about prior learning in the Front Matter section with the information about elements of the dimensions in the document "Alignment with the Three Dimensions of *NGSS*."

II.D. Scientific Accuracy

EXTENSIVE

Scientific Accuracy: Uses scientifically accurate and grade-appropriate scientific information, phenomena, and representations to support students' three-dimensional learning.

These pieces of evidence support the **extensive** rating because the science ideas and representations in the materials are accurate. The student- facing materials include precise, grade-appropriate wording to help students scaffold their understanding of concepts in all three dimensions.

A document called "About the Science" discusses the important science ideas of the unit, the boundaries of science ideas, and some science informational resources to build teacher understanding. The unit materials include a document, "About the Science," which describes the science ideas that students will encounter in each of the lessons. It also has a section called "What are the boundaries of science ideas in this unit?" that describes science ideas that are above grade level and are outside the learning in the unit. The section "What are recommended adult-level learning resources for the science concepts in this unit?" provides the teacher with background information on the important science topics.

- Example of science ideas students will encounter: "In Lesson 5 students explore where the electricity comes from as it gets to their school and home via wires. What's happening at the end of the wires to make the electricity in the first place? They use a wind turbine to light up an LED and figure out that energy is transferred from a moving object to an electric current, and that the electrical current is then transferred through wires for people to use. Students also begin to track the benefits and limitations of usable energy sources, such as wind, noting that wind is not always available to use, so they need to figure out how we can generate electricity in places or times when the wind is not available to us. In this lesson and throughout the rest of the unit, the unit authors use the phrase "generate electricity" rather than "produce energy." There is an opportunity in Lesson 5 to explicitly discuss with students to consider whether the wind is making energy (no) or transferring energy it already had (yes). Using the term "generate electricity" is helpful for two reasons (1) students can connect to the generator, a component they will see in all methods of generating electricity except solar panels, and (2) electricity, or an electrical current, is a way energy can be transferred from place to place. Importantly, students come to notice that energy is not created when electricity is generated, it is just being passed along. However, conservation of energy is not named in this unit; we are only building students' foundational understandings of this scientific law. (About the Science)
- Example of the boundaries of the science ideas: "Although energy is the central focus of this unit, we only describe it in terms of its ability to do something or cause a change. We do not ascribe the words "potential" or "kinetic" to describe energy. Potential energy is useful as a term if we are discussing the structure of a system concerning its configuration. For example, A Framework for K-12 Science Education (NRC, 2012) suggests that potential energy becomes useful and relevant for student understanding if they are explaining something like a spring that is compressed and stretched, or if we are discussing objects and their relative height to earth. Students do not investigate either of those ideas in this unit. Potential energy also is often used to describe the energy an object has when it is at rest at the top of a hill or other high-up surface. Although we talk about usable energy sources such as fossil fuels, we do not discuss or explain the origin of the energy those sources have, such as from plants that stored it from the sun. We only talk about energy in terms of its ability to cause change and evidence we can observe to tell us it has been transferred from object to object or place to place. Relatedly, we do not talk about kinetic energy concerning the speed of objects or temperature changes (see Heat). Students will begin using these more specific ways of describing energy in middle school." (About the Science)

- Example of adult level learning resources: "National Research Council. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Washington, DC: The National Academies Press. Download for free: https://nap.nationalacademies.org/catalog/13165/a-framework-for-k-12-science-education-practices-crosscutting-concepts
  - Read about PS3.A and PS3.C on pages 120-127.
  - Read about PS4.C on pages 136-137.
  - Read about ESS3.A on pages 191-192.
  - Read about ETS1.A, ETS1.B, and ETS1.C on pages 204-210." (About the Science)

Criterion-Based Suggestions for Improvement: N/A

II.E. Differentiated Instruction

EXTENSIVE

Provides guidance for teachers to support differentiated instruction by including:

i. Supportive ways to access instruction, including appropriate linguistic, visual, and kinesthetic engagement opportunities that are essential for effective science and engineering learning and particularly beneficial for multilingual learners and students with disabilities.

ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

These pieces of evidence support the **extensive** rating because the materials provide multiple and varied individualized learning strategies that support three-dimensional sensemaking throughout a majority of the materials. Differentiation strategies explicitly clarify how the materials address the needs of multilingual students, learners with special needs, learners who read well below grade level, and struggling students. Multiple extension opportunities are provided for students who have already met the performance expectation(s) or who have high interest in the subject matter. The unit materials contain picture support through infographics, as in lesson 9, and translations of materials will be provided.

i. Supportive ways to access instruction, including appropriate linguistic, visual, and kinesthetic engagement opportunities are essential for effective science and engineering learning and particularly beneficial for multilingual learners and students with disabilities.

- K-5 Draft Elementary Teacher Handbook, Building an Equitable Classroom Community for Science, "The OpenSciEd Elementary program aims to create equitable science instruction for all students, centering students' resources, interests, and identities in the classroom community's sensemaking work. In particular, there are five principles that guide our equity design stance. Though described separately, it is important to note that these principles are not mutually exclusive and often intersect in critical ways." The five principles are:
  - Principle 1 - Engage and value students' diverse identities, cultures, experiences, and communities.
  - Principle 2 - Center students' language resources and practices.

    - Principle 3 - Dismantle barriers to participation.
    - Principle 4 - Build and sustain inclusive, collaborative norms and routines.
    - Principle 5 - Use science to figure out and better understand meaningful phenomena, and to solve meaningful problems. (K-5 Draft Elementary Teacher Handbook)
- K-5 Draft Elementary Teacher Handbook, "Broadening Access callouts focus on moments during instruction in which a certain population may benefit from a particular strategy--for example, supporting language development for emergent multilingual learners, providing extended learning opportunities or readings for students with high interest, providing specific strategies for students with special learning needs." (K-5 Draft Elementary Teacher Handbook)
- K-5 Draft Elementary Teacher Handbook, "OpenSciEd units provide multiple means for students to access information; lessons incorporate models, data tables, texts, graphs, videos, and discussions. The units and lessons are carefully designed so that all materials incorporate accessibility features (e.g., alternative text, alternative representations, video captions, described videos, descriptive transcripts, color contrast) that foster the use of multiple access and entry points and appropriate representations that will accentuate the assets and mitigate the barriers of diverse learners as they work toward a rich understanding of science." (K-5 Draft Elementary Teacher Handbook)
- Unit Front Matter: "There are many ways differentiation occurs in classroom settings. You can address students' diverse learning needs in terms of student readiness, interest, and special learning needs and can make adjustments in terms of the content, the learning processes, and the student products that result from a learning experience. All Teacher Guides include UDL and differentiation guidance via callouts titled Broadening Access, Community Connections, Teaching Tips, and Literacy and Math Supports. If there is a need for assistive technologies and additional modes of access, please see the *Additional Accessibility Resources* for further strategies and resources." (Unit Front Matter)
    - Additional Accessibility Resources: This is a teacher tool that provides teachers with a variety of strategies to use/try meet the needs of the students in their classroom. These strategies," will give [the teacher] ideas for how to include all of your students meaningfully in your science lessons. In fact, many of these strategies will just be good teaching strategies for all of your students." (Additional Accessibility Resources)

The Unit Front Matter also includes additional recommendations, such as:

- "Consider ways to engage all students in science discussions through the Scientists Circle. This is an opportunity for students to see and hear one another to build community learning across the class. During the Scientists Circle discussions, it is important to look for how students are sharing their ideas in addition to what ideas and questions they might be sharing. Students might share ideas through talk, motions, gestures, facial expressions, etc. Young children have many rich ways of communicating, and it is important to welcome, recognize, and value all their ways of communicating. Throughout this unit, students will develop additional language resources and practices that will further support their scientific communication." (Unit Front Matter, p44)
- "For students with visual impairments, consider labeling key features of circuits and in-class models with larger symbols that are easier to see or touch, to aid with noticing key pieces." (Unit Front Matter)
- "For students who are unable to see LEDs light up or motors turn as evidence of energy transfer, consider using a buzzer (such as the one that may be included in the kit materials) instead. Another option is to pair visually impaired students with partners who can verbally describe what they are seeing as they build simple circuits, use wind turbines, test solar panels, and design ways to communicate the time." (Unit Front Matter)

- "For students with visual impairments to explore how energy is transferred via electricity around the school building, consider having the custodian accompany a smaller group of students so they can help students touch the parts of the system that are safe to touch, thereby physically tracing the path that electric currents take to transfer electricity from place to place." (Unit Front Matter)

Differentiation strategies address the needs of students when an obvious need arises:

Emerging multilingual students learning English.

- Lesson 1, Connect Section, Step 1 Sidebar:, "Broadening Access This Initial Ideas Discussion provides an authentic opportunity for you to enhance students' language learning and language use for sensemaking work. You might find it helpful to use the Discussion Type Prompts teacher reference from Unit 4.1: Why does an object's motion change? during the discussion. This handout provides teacher prompts that you could use to elicit and elevate students' ideas around the changing motion of objects." (Lesson 1, Teacher Guide)
- Lesson 1, Synthesize Section Sidebar, Step 3: "Provide multiple means of action and expression by encouraging students to write in whatever languages (or combinations of written words and drawings) that allow them to comfortably express their ideas." (Lesson 1, Teacher Guide)
- Lesson 2, Explore Section, Step 5 sidebar: "Broadening Access As the focus of the lesson is not identifying the parts of a winding clock, but rather how the parts are working together, accept all ways of sharing observations about this relationship. Encourage students to share what they are observing through gestures, words, or multiple languages." (Lesson 2, Teacher Guide)
- Lesson 4, Synthesize Section, Step 4 Sidebar: "Broadening Access To support equitable discussions for all learners, encourage students to share their thinking in a variety of ways. Validate and invite all the ways we communicate our ideas, such as with gestures or body movements, pointing at places in the classroom or images from the video or tour, drawings, and words from any languages students use." (Lesson 4, Teacher Guide)
- Lesson 5, Connect Section, Step 4: "Support your students' access to the information in these videos by turning on captions and varying the playback speed if needed. These strategies can help multilingual students, students developing their literacy skills and practices, and students whose processing preferences are not auditory." (Lesson 5, Teacher Guide)
- Lesson 6, Navigate Section, Step 1: "Sentence stems are provided on slide B, but students may use other ways of talking about how electricity is generated and that is fine too." (Lesson 6, Teacher Guide)
- Lesson 8, Synthesize Section, Step 2 Sidebar: "Broadening Access When you create the Evidence Bank chart, capture the rich ways your students express their ideas. This is especially important for multilingual students because their language resources and practices are not always noticed or valued in school spaces. If a student shares an idea using words or phrases in a named language other than English (e.g., in Spanish, Arabic, Mandarin, etc.), record their idea exactly as they shared it and then add a translation in English next to it." (Lesson 8, Teacher Guide)
- Lesson 11, Navigate Section, Step 1 Sidebar: Broadening Access "Offering students an opportunity to work with peers before the whole class discussion gives them a chance to use their linguistic and nonlinguistic resources to express their ideas (and learn from other students' uses of these resources too) before sharing their ideas in a larger discussion." (Lesson 11, Teacher Guide)
- Lesson 13, Navigate Section, Step 1 Sidebar: "An alternative to having students present their slides via a computer and projector is to have students pre-record or share their presentations in their home language. This sends the message that their language resources and practices are valuable for the classroom community's sensemaking work. This is an important message for all students to receive, and especially for those whose language resources are not always valued in school spaces, such as multilingual students." (Lesson 13, Teacher Guide)

Learners with special needs (visual impairments, tactile engagement, etc.)

- Lesson 2, Explore Section, Step 4 Sidebar: "Using gestures (such as thumbs up or thumbs down) can be a way to engage all students in the learning process and allow you, as the teacher, to quickly gauge students' developing understanding informally." (Lesson 2, Teacher Guide)
- Lesson 4, Synthesize Section, Step 3 Sidebar: "Broadening Access For this assessment moment, select the format that is more appropriate for students and for your assessment needs. The written handout provides individual artifacts for assessment but may be too challenging for some students to complete in the allotted time. If using the class discussion format, you will need to assess students based on their contributions to the discussion and their exit ticket responses, which are less individualized." (Lesson 4, Teacher Guide)
- Lesson 9, Synthesize Section, Step 6 Sidebar: "Broadening Access To facilitate equitable participation and promote multiple means of action and expression, have the building materials available for students to interact with as they plan their designs. Being able to physically manipulate the materials can support students in developing and sharing their ideas with the group in ways beyond verbal communication." (Lesson 9, Teacher Guide)

Learners reading below grade level

- Lesson 5, Synthesize Section, Step 6 Sidebar: "Literacy Supports The words "limitation" and "benefit" may be unfamiliar to some students. You could spend some time discussing these words and their meaning to ensure that all students are able to engage in a discussion about the limitations and benefits of using wind as an energy source. You can share several synonyms and antonyms for each word to provide students an opportunity to compare, contrast, and consider the nuances in the meaning of limitation (synonyms: block, obstacle, barrier; antonyms: strength, help) and benefit (synonyms: advantage, help; antonyms: hurt, loss). As you go over what the words mean together, students can share examples from contexts in and out of science when they may have been limited or experienced a limitation (e.g., running out of time on a test, only using their feet to play soccer) or a benefit (e.g., extra recess time) (L.4.5C and L.4.5)." (Lesson 5, Teacher Guide)
- Lesson 9, Connect Section, Step 5 Sidebar: "Literacy Supports Call-Out Box The infographics help students interpret information about different languages, writing systems, and codes using words and images. This work supports students' sensemaking about methods of communication and provides opportunities to integrate information from multiple texts on the same topic to speak about the topic knowledgeably. (RI.4.7, RI.4.9)." (Lesson 9, Teacher Guide)
- Lesson 11, Explore Section, Step 2 Sidebar: "Broadening Access To support students reading at the stations, consider encouraging students to take turns reading paragraphs out loud with their group or have one group member read aloud while everyone else follows along. Additionally, you may want to encourage students to circle, underline, or highlight things as they read and to pause at the end of each paragraph and talk with each other (in any language) about what it said and if there were any unfamiliar words or phrases." (Lesson 11, Teacher Guide)
- Lesson 12, Synthesize Section, Step 4 Sidebar: "Teaching Tip Call-Out Box The single-sentence-plus-photo format is approachable for students because it allows them to present their information succinctly, visually, and in words. You might point out that presentations adults make often use a simple, easy-to-read format like this." (Lesson 12, Teacher Guide)

ii. Extra support (e.g., phenomena, representations, tasks) for students who are struggling to meet the targeted expectations.

- Lesson 3, Lesson Assessment Guidance, "We suggest also collecting student handouts after the Synthesize to look for evidence that they are making progress toward unit performance expectations. As you observe students individually and in groups, consider using the following scaffolds to support students: Say something like, I heard you say that something must be inside the wires. What is your evidence? Create with students an evidence chart based on what they gathered in their investigations and add to the chart throughout the unit. As needed, direct students to the Word Wall to review vocabulary, and encourage students to use the Word Wall as they describe where they see evidence of energy transfer. Students will have additional opportunities in future lessons to explore and gather evidence on how electrical currents flow along a certain path for energy to be transferred and make something move, heat up, light up, or make sound." (Lesson 3, Teacher Guide)

- Lesson 4, Explore Section, Step 2 Sidebar: "Broadening Access Call-Out Box If you have additional time or students need additional support making and recording observations, the video on slide D (School Electricity Tour) can be used as a review after the tour. Consider having students watch the video and take notes on what they observe that can explain the energy transfer to the plugged-in clock (or add to the notes they already took during the tour)." (Lesson 4, Teacher Guide)
- Lesson 6, Lesson Assessment Guidance, "You can use this formative assessment to see if students need more support in understanding that there is a pattern for generating electricity; while almost every method requires the use of moving parts, only solar panels do not. Use this formative assessment to look and listen for students to notice patterns in whether energy sources are available again for reuse or not. We suggest also collecting student handouts after Synthesize to look for evidence that they are making progress towards unit performance expectations. Refer to Lessons 2- 7 Following Student Sensemaking for examining students' understanding based on their current sensemaking. The tool can be used as a guide for assessing either group or individual progress, depending on your assessment needs." (Lesson 6, Teacher Guide)
- Lesson 10, Lesson Assessment Guidance, "This formative assessment moment can be used to gather evidence about students' developing understanding of the engineering design process: how well they understand how to develop a solution that considers criteria and constraints and then refine that solution based on test results. If students are having difficulty coming up with designs in small groups, prompt them to describe their challenges and successes so they can bring those ideas to their group redesign conversation. Encourage groups that are having difficulties by reminding them that testing a design that doesn't work can sometimes be more informative than having a design that works right away." (Lesson 10, Teacher Guide)
- Lesson 12, Lesson Assessment Guidance, "If your students do not collectively (in their small groups) generate examples of ways the usable energy source could hurt or help the environment and everything that is in it, like plants, animals, land, water, and people help students find one effect of using the usable energy source. After finding one effect, ask students if this helps or hurts the people or environment. It is OK if students are not fully able to explain how and why an effect could hurt or help. This can be developed through discussion as a class in Lesson 13. You may also consider having available the Electricity Generation Cards if students need to review what is the usable energy source and how it is used to generate electricity." (Lesson 12, Teacher Guide)
- Lesson 14, Explore Section, Step 2 Sidebar: "Broadening Access Call-Out Box To support students with making observations, you can have them complete the observations in pairs and you can also begin by going over some observations as a whole class." (Lesson 14, Teacher Guide)
- Lesson 14, Synthesize Section, Step 3 Sidebar: "Broadening Access Call-Out Box Two versions of the assessments are provided each with a different level of scaffolding. (Sentence Frames) Powering a Mars Rover will benefit students who prefer sentence frames to help them with their writing. Powering a Mars Rover will benefit students who feel more comfortable expressing their ideas without sentence frames. Consider offering both options and inviting students to choose the one that best meets their needs." (Lesson 14, Teacher Guide)

iii. Extensions for students with high interest or who have already met the performance expectations to develop deeper understanding of the practices, disciplinary core ideas, and crosscutting concepts.

- Lesson 4, Explore Section, Step 2 Sidebar:" Broadening Access: If you have additional time or students need additional support making and recording observations, the video on slide D (School Electricity Tour) can be used as a review after the tour. Consider having students watch the video and take notes on what they observe that can explain the energy transfer to the plugged-in clock (or add to the notes they already took during the tour). The video can also serve as an extension opportunity by having students look for similarities and differences between their school and the school in the video and/or between the school and the home shown in the second part of the video (about 6.5 minutes into the video)." (Lesson 4, Teacher Guide)
- Lesson 4, Connect Section, Step 5, Teaching Tip: "Extension opportunity: If you would like to use this book as an opportunity to support students in developing their understanding of Obtaining, Evaluating, and Communicating Information, you could have students do this as an individual or paired reading. Consider having students read this book, or one of the sections, on their own or with a partner. Create a handout for them with the evidence table you would have made as a class on the board. Then, regroup afterward to come to a consensus about the evidence they gathered and how it helps them to understand electrical circuits." (Lesson 4, Teacher Guide)
- Lesson 5, Explore Section, Step 2, Teaching Tip: "Extension opportunity: For students who are ready to go beyond this activity or if your students need an individual way to make sense of energy transfer to and from a wind turbine, you can have them research how to build their own wind turbines with cardboard, cork, motors, and LED's. Then, have them explain how energy is transferred from wind to the LED's in their wind turbine." (Lesson 5, Teacher Guide)
- Lesson 9, Synthesize Section, Step 6, Teaching Tip: "Extension Opportunity: If you have groups that are interested in using Morse code as part of their design, use the optional demonstration in *Morse Code Extension* on how to use an LED circuit to send words with Morse code. Then provide the Morse code infographic as a resource, which includes numbers." (Lesson 9, Teacher Guide)
- Lesson 11, Explore Section, Step 2, Teaching Tip: "Extension Opportunity: Consider using the extra reading and binary activity included in the Binary Extension. Within the extension, students will have an opportunity to learn more about how computers use digital binary code, and deepen their understanding of the patterns and relationships within binary code. This extension also allows students to practice making sense of the structure of each number system to generate and analyze patterns, which is part of the 4th-grade math standards. (part of 4.OA.C.5 and MP7)" (Lesson 11, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

II.F. Teacher Support for Unit Coherence

EXTENSIVE

Supports teachers in facilitating coherent student learning experiences over time by:

i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

These pieces of evidence support the **extensive** rating because this unit includes sufficient support to facilitate coherent and explicit links between student sensemaking of phenomena or designing of solutions and their learning in all three dimensions over time. Strategies for connecting student engagement across lessons include a navigation component at the end and beginning of every lesson. Strategies for ensuring student sensemaking is linked to the three dimensions include sidebar callouts of specific dimensions to support instructors, as well as a consensus model that teachers and students add information to up to Lesson 11 of the unit.

i. Providing strategies for linking student engagement across lessons (e.g. cultivating new student questions at the end of a lesson in a way that leads to future lessons, helping students connect related problems and phenomena across lessons, etc.).

- Open SciEd Elementary Teacher Handbook (p17): Elementary Teacher Handbook, Navigate Component.
  - What is the instructional purpose of this component? The Navigate component directly supports coherence for students from lesson to lesson. This component generally happens at the beginning and end of each lesson and provides opportunities for the class to take stock of where they are in finding answers to their questions, remind themselves what they figured out last time, and decide where they want to go next. Often this navigation will come naturally from questions generated by students, but occasionally the teacher will "problematize" an idea or investigation result by asking a salient question or pushing the class to consider other situations or new directions.
  - What are the potential outcomes of this component? During the Navigate component, students ask questions, define problems, and make predictions. The class builds their sense of shared purpose, sees progress toward answering their questions, and takes ownership of their science work.
- 4.2 Lesson 1 Teacher Reference Unit Models, "Keep in mind as you develop and revise the model in collaboration with your students, that its purpose is to help them try to explain how something works. In Unit 4.2: How do we power clocks and other devices?, students are trying to figure out why a clock (like the plug-in clock) turns on and stays on. As they figure out important ideas through their investigations, students develop a set of ideas about the phenomenon they are studying. When they come together to develop and revise their Class Consensus Model, they are making their ideas about how the phenomenon works explicit to one another. Engaging in modeling helps students understand the underlying mechanisms causing the phenomenon to occur, and it helps them to identify what they can explain, and what they still have questions about. The model then becomes an important tool for students to use to make sense of the phenomenon they are exploring and that they could apply to related phenomena to explain as well." (4.2 Lesson 1 Teacher Reference Unit Models)
- Lesson 1, Navigate Section, Step 6, "Accept all ideas, but also feel free to use prompts such as How could we test that in our classroom? to push students to look for ways to investigate these questions firsthand. If it's not feasible to investigate a question in the classroom, ask students to think about what kind of information we would need to look for from other scientists to find the answer." (Lesson 1, Teacher Guide)

- Lesson 2, Navigate, Step 1, "Briefly review our questions from last time. Display slide A. Prompt students to look at the "Why does the plug-in clock turn on and stay on?" chart from Class 1 and our Driving Question Board. Ask students to restate some of the big questions we had last time." (Lesson 2, Teacher Guide)
- Lesson 3, Navigate Section, Step 1, "Revisit our related phenomena lists and DQB. Display slide A. Have students look over the class lists of related phenomena we created after the school tour in Lesson 2 and our Driving Question Board. Remind them that they had asked questions about batteries in Lesson 2. Ask them to identify the devices that we think are powered by a battery. Have students turn and talk with a partner about the slide questions, then share aloud with the class." (Lesson 3, Teacher Guide)
- Lesson 5, Navigate Section, Step 7: "Plan next time's work. Ask students how they think we could figure out more about what happens to generate electricity in places that aren't windy. Ideas to look and listen for: Ask an expert/ read more of the book we started today. Read a different book(s). Search online or watch a video. Suggest that we do something like that next time." (Lesson 5, Teacher Guide)
- Lesson 7, Navigate Section, Step 1, "Review our My Growing Ideas charts. Ask students to find their My Growing Ideas from Lesson 6 and present slide A. Give students 1-2 minutes to read their notes from the last lesson and have students turn and talk about the prompts on the slide before sharing with the class. Then, emphasize that we noticed that solar panels were different from the other usable energy sources we learned about because there is no turbine." (Lesson 7, Teacher Guide)
- Lesson 10, Navigate Section, Step 8: "Display slide M. Remind students that one big part of why we did this task was to start to make sense of how some clocks know the time without being set manually. Have students turn and tell a partner how they think clocks such as the ones on our phones, computers, or other electronics receive information about the time, based on what we have figured out in our own designs. After students talk for about a minute, ask a few students to share. Accept all answers. Say that it sounds like we have some different ideas, so maybe we need to gather some more evidence to help us learn about how devices like clocks receive information from a distance." (Lesson 10, Teacher Guide)
- Lesson 12, Navigate Section, Step 1, "Review where we left off last time. Remind students that we left the last session with some questions about the effects of usable energy sources after thinking about the effects of plugging in clocks or other devices that we use. Suggest that we might need more evidence about usable energy sources and their effects. Have students brainstorm ways that we could answer these questions and share their ideas with the class." (Lesson 12, Teacher Guide)

Ii. Providing strategies for ensuring student sense-making and/or problem-solving is linked to learning in all three dimensions.

- K-5 Teacher Handbook, "The Importance of the Three Dimensions in a Storyline: Each OpenSciEd unit is anchored in a phenomenon or set of phenomena and strategically integrates the DCIs, SEPs, and CCCs to create a storyline path in which the students and teachers, as a learning community, work together to manage the trajectory of their knowledge-building. The class, as a whole, incrementally develops ideas over time that are motivated by questions about phenomena in the world, where each step is an attempt to address a question or a gap in the class's current explanatory model, while developing, using, and extending parts of the DCIs, SEPs, and CCCs as needed. The storyline approach supports students' agency in sensemaking: WE figure out the science ideas and WE put those ideas together over time." (K-5 Teacher Handbook, p11)
- Lesson 2, Navigate Section, Step 7: "Summarize what we learned. Display slide Q. Summarize for students that we have some ideas about what caused the winding clock to work and how energy and energy transfer made the parts move and the alarm go off. Then, briefly return to our observations of the plug-in clock. Summarize for students what they observed and how they thought the parts worked together to help the clock turn on and stay on. Ask students if they

have any evidence of energy and energy transfer in their observations." (Lesson 2, Teacher Guide) In this activity, the teacher guides the students to ask questions (SEP) using their understanding of the energy transfer (DCI and CCC).

- Lesson 6, Explore Section, Step 2: "Explore Generating Electricity Cards. Divide students into groups of 3-4 students and display slide C. Tell students that you have a set of cards for each group, and that they will be making sense of them by recording information on their Generating Electricity Data Sheet handout. Let students know that each card has some specific information about each type of electricity generation that they can use to complete their sheet, and that they will be looking for patterns across all the various ways of generating electricity. Distribute a set of cards to each group and give each student a Generating Electricity Data Sheet handout to collect their information." (Lesson 6, Teacher Guide) The teacher slides students to use their understanding of patterns (CCC) to gather information (SEP) about generating electricity (DCI).

Criterion-Based Suggestions for Improvement: N/A

II.G. Scaffolded differentiation over time

ADEQUATE

Provides supports to help students engage in the practices as needed and gradually adjusts supports over time so that students are increasingly responsible for making sense of phenomena and/or designing solutions to problems.

These pieces of evidence support the **adequate** rating because there is evidence of a change in how independently students use SEP elements from the beginning to the end of the unit. In some of the lessons, the supports are slowly removed to provide students with an opportunity to be more responsible for using the practice on the formative assessment. Other practices are encountered in only one lesson, and there is no opportunity for students to become more independent.

These SEP elements are claimed as the major focal elements.

AQDP: Asking Questions and Defining Problems

AQDP-E4: Use prior knowledge to describe problems that can be solved. Claimed in Lessons 12:

- Lesson 12, Navigate Section, Step 1: "Suggest to students that we decide on some criteria and constraints that will help us to understand better the problem that when we plug in our devices, our community could be causing effects on the environment–good or bad. What other resource(s) could we use? Alternatively, students may ask about the energy source used in their community to generate electricity. Consider finding that information for students and using it to define the problem with students. Together, construct a question similar to "When we use X energy source we could be affecting the environment. Is there a better resource we could use?" (Lesson 12, Teacher Guide) This element is used only once, and there are insufficient opportunities for students to develop proficiency with it.

AQDP-E5: Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost. Claimed in Lessons 9 and 14. Evidence was found in 9, 10, and 14. Examples include:

- Lesson 9, Explore Section, Step 5: "Use the prompt on the slide to return to the Communicating Design Ideas chart and work together to sort the ideas into ones that fit the criteria and constraints, and those that do not. Label a part of the chart "Do Not Meet the Criteria and Constraints." When ruling out a design, have students identify which criteria or constraint rules it out before placing the sticky note in the eliminated section. Display slide H. Distribute Defining Problems Exit Ticket to each student. Have students review the problem on the Communication Design Ideas chart and the criteria and constraints the class has developed. Give students a few minutes to describe on their own what they think are the design problem and the including criteria and constraints." (Lesson 9, Teacher Guide) This task is completed as a group.

- Lesson 10, Explore Section, Step 7: "Review peer feedback. Display slide K. Distribute the peer feedback pages that you assembled from Comparing Design Solutions to each group and return their Round 1 Design Testing. Then have groups review the feedback and use that, along with the updated criteria and constraints to revise and optimize their design. Have them record their ideas and data on the "Round 2" table of the Round 2 Design Testing handout. If needed, be sure to show slide D so that students can refer to the investigation procedures." (Lesson 10, Teacher Guide) This task is done in small groups.
- Lesson 14: Lesson 14, Synthesize Section, Step 3, "Individually identify criteria and constraints and refine solutions. Display slide F. Distribute (Sentence Frames) Powering a Mars Rover or Powering a Mars Rover." (Lesson 14, Teacher Guide)
- 4.2 Energy Transfer Electricity Unit Front Matter, "Students' development of this practice is supported by formative assessment opportunities in Lesson 9 and 12, and a summative assessment opportunity in Lesson 14." There is not a formative assessment for this practice or element in Lesson 12. The assessment in Lesson 12 focuses on Obtaining, Evaluating, and Communicating Information.

INV: Planning and Carrying Out Investigations

INV-E1: 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. Claimed in Lessons 7 and 10.

- Lesson 7, Explore Section, Step 2: "…use the discussion as a way to connect variables and fair tests (*we only change one variable at a time and keep everything else the same*) to the ideas they are mentioning for testing their solar panels. Using their developing understanding of variables, help students come up with an investigation question to guide their fair test." (Lesson 7, Teacher Guide)
- Lesson 7, Explore Section, Step 3: Collaboratively carry out the investigation. Distribute Light Investigation to each student. Ask students to review the procedures together as a group and to decide if they align with what they discussed in class. Then, using the sentence frame on slide E, support students in writing a prediction of what they think will happen in their investigation. Then, distribute materials to students, providing them with any classroom and school-specific instructions for carrying out an investigation outside, and give them time to carry out the investigation." (Lesson 7, Teacher Guide) Students first work with a group and then individually.
- Lesson 10, Explore Section, Step 2: "What kinds of quantitative or qualitative data should we collect? We can record the distance number (quantitative data) since it is a part of the criteria. Distance is quantitative data. We need to write in words if people saw it or not. How can we carry out our tests fairly? We need to all do the same thing. We can only change one variable. We should all measure the same way." (Lesson 10, Teacher Guide) After planning the investigation, student groups carry out the investigation and collect data.

INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. Claimed in Lessons 1, 2, 3, 4, 5, 8

- Lesson 1, Explore Section, Step 2: "Record our noticings and wonderings about the winding clock. Distribute the Notice and Wonder About Clocks handout to each student and then tell students that they will now focus on what they saw, heard, and felt while observing the clock." "Record our noticings and wonderings about the plug-in. Display slide E. Give students time to fill in the "plug-in" clock column of their Notice and Wonder About Clocks handout." (Lesson 1, Teacher Guide) Students work individually and then share with the class.

- Lesson 2, Explore Section, Step 4: "Make observations and predictions. Gather the class together and display slide G. Carefully remove the back of the clock (if necessary, using a screwdriver) and give students time to look inside. Invite students to share a part they observed and their prediction about how the part works to keep the clock on." (Lesson 2, Teacher Guide) This task is done as a whole class activity.
- Lesson 3, Explore Section, Step 2: "Organize students into small groups. Distribute the Dissect a Lantern handout and a lantern and screwdriver to each group of students. Review the handout with students, and give students about 10 minutes to work with their group to dissect the lantern, following the steps on the handout and answering the questions." (Lesson 3, Teacher Guide)
- Lesson 4, Synthesize Section, Step 3: "Build connections between observations and growing ideas. To process the observations from the tour and put the pieces together with our ideas so far, students can create a written artifact individually or in pairs, or create a class artifact through a whole group discussion." (Lesson 4, Teacher Guide)
- Lesson 5, Explore Section, Step 2: "Make Observations What did you observe? What do you think is causing the blades to move? The LED to light up? What is your evidence that energy has been transferred?" (Lesson 5, Teacher Guide) This is a whole class task.
- Lesson 5, Synthesize Section, Step 5: "Then, have students write an explanation (question #3) using evidence from their observations to describe how the wind turbine generates electricity. If needed, students can revisit the videos, book, and model turbine to help craft their model." (Lesson 5, Teacher Guide)
- Lesson 8, Synthesize Section, Step 3: "Distribute *Make Observations and Self-Reflection* to students. Tell students they will be using their understanding of usable energy sources and how a plug-in clock turns on to identify evidence that could be used to explain energy transfer in a game console." (Lesson 8, Teacher Guide)

CEDS: Constructing Explanations and Designing Solutions

CEDS E5: Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. Claimed in Lesson 10.

- Lesson 10, Connect Section, Step 4: "Decide how we will compare and contrast our designs. Display slide F. Tell students that they have done a lot of work to design and test solutions and that some groups may have been successful and some may not have been, and that is okay. When engineers are designing solutions it's important that they work as a team to compare and contrast their designs even when they do not work." (Lesson 10, Teacher Guide) Students compare designs as they rotate around the classroom observing different designs.
- Lesson 10, Synthesize Section, Step 5: "As a class, establish what should qualify a design as "meeting," "partially meeting," or "not meeting" the focal class criteria and constraints. Based on what was focal, come to consensus about what makes a design fall into each category. Then have students use their peer feedback notes to collaboratively sort the designs they observed into the three categories. Have students jot down the name or description of the solution on a sticky note and place it into the appropriate place on the "Compare and Contrast Solutions" chart." (Lesson 10, Teacher Guide) Students work in small groups to sort the designs and students refine their thinking about how different designs meet the criteria and constraints. These two tasks may not provide enough practice in using this element.

INFO: Obtaining, Evaluating and Communicating Information

INFO-E4: Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem. Claimed in Lessons 5, 9, 11, 12, 14

- Lesson 5, Connect Section, Step 3: "Read a book and discuss wind farms. Read aloud pages 1-10 of the Meet the Scientists: Electricity Producers book, using the associated prompts." "Navigate to watching a video, too. Say something like, 'That book gave us a lot of great information about how wind turbines work to produce electricity, but some of you also suggested watching a video. How could a video help us figure out more?'" (Lesson 5, Teacher Guide)
- In Lesson 9, Connect Section, Steps 3 and 5, the class reads a book and an infographic to determine the most effective method of communication. (Lesson 9, Teacher Guide)
- Lesson 11, Explore Section, Step 2: "Let's obtain some information to answer our questions about how some clocks know the time without being set. Stations Instructions: Each station has a small reading or activity with instructions. Your group will have about 10 minutes to complete each station. Fill out the prompts on your handout for each station. Every group will complete all stations. Stations: Language of computers Coding and decoding binary clocks Energy transfer Wireless communication" (Lesson 11 Slides, Slide D) Individual students read the handouts at the stations.
- Lesson 12, Explore Section, Steps 2 and 3: "Analyze the effects of a sample usable energy source together. Tell students that they will be researching an energy source with their group to figure out the effects of obtaining and using that source and then evaluating it based on our criteria and constraints. Suggest that we practice this first as a class with an example usable energy source. Follow the link on slide C to the Effects of Useable Energy Sources Website to research oil (petroleum)." "Investigate usable energy sources. Display slide D. Organize students into groups of 3-4 and distribute Energy Sources Research. Assign each group an energy source to research and then direct them where to write it on their handout." (Lesson 12, Teacher Guide) This task is completed in small groups.
- Lesson 14, Explore Section Step 2: "Distribute Observations of a Space Rover and read aloud page 1 with students. Display slide D. Give students some quiet time to look at the picture of the Opportunity rover and to notice its parts." (Lesson 14, Teacher Guide)

INFO E5: Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts. Claimed in Lessons 13.

- Lesson 13, Explore Section, Step 2: "Then, allow each group to present the information they obtained about the effects of using renewable and nonrenewable sources for generating electricity." (Lesson 13, Teacher Guide) This element is used only once, and there are insufficient opportunities for students to develop proficiency with it.

Criterion-Based Suggestions for Improvement

- Ensure that students have multiple opportunities to use each element of the focal SEPs with decreasing scaffolding as the unit progresses.
- Consider how students can engage with intentionally developed SEPs (Constructing Explanations and Designing Solutions and Asking Questions and Defining Problems) throughout the unit. Currently, these SEPs are the focus only in Lessons 9 and 10, and students have few opportunities to engage with them outside of those lessons.

CATEGORY III
Monitoring NGSS Student Progress

III.A. Monitoring 3D Student Performance

EXTENSIVE

Elicits direct, observable evidence of three-dimensional learning; students are using practices with core ideas and crosscutting concepts to make sense of phenomena and/or to design solutions.

These pieces of evidence support the **extensive** rating because the materials elicit direct, observable evidence of three-dimensional learning. Student artifacts are produced and require grade-appropriate elements of all three dimensions to be used together to evaluate targeted learning objectives. When the observable evidence is from group activities, support is provided to teachers in the form of an assessment tool for both lesson sets. The assessments that students engage in support them in sensemaking about how the clock turns on and has the correct time.

The unit materials identify the formative assessment in Lesson 4 as a key assessment and two summative assessments in Lessons 8 and 14. In the Lesson 8 assessment, students are asked to explain why a game console turns on and stays on. In the Lesson 14 assessment, students are asked to use their understanding of the anchor phenomenon to explain how a Mars rover sends messages.

- Lesson 4, Synthesize Section, Step 3, "Distribute Connecting Observations and Growing Ideas to each individual or pair of students. Display slide F. Use the prompt on the slide and the first prompt of the handout to have students document their observations. Give students a few minutes to complete this task individually or in pairs." (Lesson 4, Teacher Edition, p16)
- Lesson 4, Synthesize Section, Step 3, "Display slide K and distribute Exit Ticket - Building Connections to each student. Use the prompt on the slide to have students use the class list of observations and connections to write out one connection using the sentence stem. Collect this as an exit ticket for formative assessment. Keep the class list visible for the Consensus Discussion that comes next." (Lesson 4, Teacher Guide)
- Lesson 8, Synthesize Section, Step 3, "Individually identify evidence for energy transfer. Display slide D. Distribute Make Observations and Self-Reflection to students. Tell students they will be using their understanding of usable energy sources and how a plug-in clock turns on to identify evidence that could be used to explain energy transfer in a game console. Read through the directions with students and point out the model on the handout that has four different points labeled A, B, C, and D. Then mention that the handout includes a table that is divided into sections like the model and students will have to explain where the energy is coming from, where the energy is going, and their evidence they would look for to tell them energy transfer has happened." (Lesson 8, Teacher Guide)
- Lesson 14, Assessment Opportunity, " In this assessment moment for Learning Goals 14.A and 14.B, look for evidence that students can apply their understanding of the engineering design process, usable energy sources, and energy transfer to refine a design for a new Mars rover." (Lesson 14, Teacher Guide)

Student artifacts are produced throughout the unit, and these artifacts show three-dimensional learning.

- Lesson 1, Synthesize Section, Step 4: "Individually create initial models. Display slide H. Distribute the Initial Model handout and give students 8-10 minutes to draw their models. Encourage students to use arrows to show why the plug-in clock turns on and stays on, and to label what their arrows represent. Students will have time to refine their models after talking with a partner in the next step." (Lesson 1, Teacher Guide) **MOD-E4: Develop and/or use models to describe and/or predict phenomena.** **PS3.B-E4: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy.** **CE-E1: Cause and effect relationships are routinely identified, tested, and used to explain change.**

- Lesson 2, Explore Section, Step 4, "Make observations and predictions. Gather the class together and display slide G. Carefully remove the back of the clock (if necessary, using a screwdriver) and give students time to look inside. Invite students to share a part they observed and their prediction about how the part works to keep the clock on." (Lesson 2, Teacher Guide) Teachers use the Teacher Assessment Tool Lessons 2-7 to record student evidence. **CCE: 2E1: Cause and effect relationships are routinely identified, tested, and used to explain change, 4-PS3.A-E2: Energy can be moved from place to place by moving objects or through sound, light, or electric currents.** (**PS3.A-E2**) and **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**
- Lesson 3, Explore Section, Step 3, "Remind students that once they have made the light shine, they should draw and label how they set it up so they can compare with other groups to determine what caused the light to shine. Each student should individually prepare a one-sentence explanation of their diagram and share it with another student in their small group. Remind students that when we explain something, we need to use evidence from our investigation." (Lesson 3, Teacher Guide) **CCE: 2E1: Cause and effect relationships are routinely identified, tested, and used to explain change, 4-PS3.B-E3: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (PS3.B-E3).** and **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**
- Lesson 4, Synthesize Section, Step 3: "Pick one observation and story connection pair to write out using the following sentence starter: We observed... ...this helps us tell the story of why our plug-in clock turns on and stays on because it connects to our growing idea that..." (Lesson 4 Handout, Connecting Observations and Growing Ideas) **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution. PS3.B-E4: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. EM-E3: Energy can be transferred in various ways and between objects.**
- Lesson 5, Synthesize Section, Step 5, "Develop a model. Display slide J. Give students 5-7 minutes to develop their model (question #2) explaining how a wind turbine generates electricity before sharing it with a partner. Remind them to use arrows to show how and where energy is being transferred. Then, have students write an explanation (question #3) using evidence from their observations to describe how the wind turbine generates electricity. If needed, students can revisit the videos, book, and model turbine to help craft their model. Collect this handout as a formative assessment before students put it in their notebooks. (Lesson 5, Teacher Guide) **EM: 5E3: Energy can be transferred in various ways and between objects. 4-PS3.B-E3: Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (PS3.B-E3).** and **INV-E3: Make observations and/or measurements to produce data to serve as the basis for evidence for an explanation of a phenomenon or test a design solution.**
- Lesson 7, Synthesize Section, Step 5, "Summarize what we learned. Remind students that we started our investigation wondering how solar panels are able to generate electricity and we carried out a fair test investigation to test solar panels in the sun. Give students 1-2 minutes in pairs to summarize what they learned from the discussion before sharing out. Look and listen for ideas such as: Sunlight transfers energy to the solar panel. The solar panel transfers energy to the wires as electrical current. The current makes the motor move. Then, give students another minute or two to return to their Light Investigation handout to individually update their response to question #3. Encourage students to explain where the energy is coming from and where the energy is going that causes the solar panel to make the motor move." (Lesson 7, Teacher Guide) **EM: 5E3: Energy can be transferred**

in various ways and between objects. 4-PS3.B-E2: Light also transfers energy from place to place. (PS3.B-E2) and **INV-E1: 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**

- Lesson 9, Explore Section, Step 4, "Display slide H. Distribute Defining Problems Exit Ticket to each student. Have students review the problem on the Communication Design Ideas chart and the criteria and constraints the class has developed. Give students a few minutes to describe on their own what they think are the design problem and the including criteria and constraints." (Lesson 9, Teacher Guide) **EM: 5E3: Energy can be transferred in various ways and between objects. 3-5-ETS1.A-E1: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (ETS1.A-E1).**and **ADQP-E5: Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.** Students are not asked to engage in the Crosscutting Concept in this lesson. Therefore, this is two dimensional integration.

- Lesson 10, Assessment Opportunity, "Formative: Use the feedback process as an opportunity to formatively assess learning goal 10.B. You will collect the Comparing Design Solutions at the end of this section or at the end of the lesson, whichever is more convenient in terms of how you will facilitate this lesson. You can also assess the class collectively during the following discussion." (Lesson 10, Teacher Guide) **EM: 5E3: Energy can be transferred in various ways and between objects.. 3-5 ETS1.A-E1 Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. CEDS-E5 Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution**

- Lesson 12, Assessment Opportunity, "Formative: Use the Energy Sources Research as an opportunity to assess Learning Goal 12 and students' progress toward obtaining information to explain the effects of usable energy sources on the environment." (Lesson 12, Teacher Guide) **CE: 2E1: Cause and effect relationships are routinely identified, tested, and used to explain change. 4-ESS3.A-E1: 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.** and **INFO-E4: Obtain and combine information from books and/or other reliable media to explain phenomena or solutions to a design problem.**

- Lesson 13, Synthesize Section, Step 4, "Write an individual argument. Display slide G and focus students on Part 3 of Effects of Usable Energy Sources. Now that we have determined how well we think each usable energy source meets our criteria and constraints, we need to decide which source we think best meets them." (Lesson 13, Teacher Guide) **CE: 2E1: Cause and effect relationships are routinely identified, tested, and used to explain change. 4-ESS3.A-E1: 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.** and **INFO-E2: Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.**

Students routinely produce artifacts with evidence of using the grade-appropriate elements of SEPs, CCCs, and DCIs that are targeted as learning objectives

Lesson 1 Learning Target: Develop a model to describe the causes of why a clock turns on and stays on (effects).

- In Lesson 1, Synthesize Section, Step 3, students individually develop initial models to explain how a plug-in clock works

Lesson 2 Learning Target: Make observations to gather evidence that energy transfer causes changes in motion, sound, and heat (effect).

- Lesson 2, Explore Section, Step 4, Students (as a whole group) explore the inside of a plug-in clock and record observations of how the insides are connected and what could make the clock turn on and stay on. The teacher records student evidence using a provided checklist (Assessment Tool Lessons 2-7)

Lesson 3 Learning Target: Make observations of a simple circuit to gather evidence that the **light bulb turns on (effect)** because **batteries transfer energy through electrical currents (cause)**.

- In Lesson 3, Explore Section, Step 3, students make observations to determine what caused the light to shine and record their thinking on their student handout.

Lesson 5 Learning Target: Make observations to gather evidence for how energy from moving objects can be transferred to electrical current.

- In Lesson 5, Synthesize Section, Step 5, students use evidence from their observations to explain the light bulb turned on because energy was transferred from the turning turbine blades.

Lesson 6 Learning Target: Combine information and **describe patterns** about **how different sources of energy can be used to generate electricity.**

- In Lesson 6, Synthesize Section, Step 3, students use evidence they gathered from the card sort activity to identify that only generating electricity from light doesn't involve spinning a turbine and that usable energy sources can be categorized as renewable or nonrenewable.

Lesson 9 Learning Target: Define a simple design problem and **identify criteria and constraints for transferring information across a distance**.

- In Lesson 9, Explore Section, Step 4, students review the problem on the Communication Design Ideas chart and the criteria and constraints the class has developed. They describe on their own what they think are the design problem, including criteria and constraints using the provided exit ticket.

Lesson 11 Learning Target: Obtain information to explain how devices use digitized patterns to communicate information (energy) across long distances.

- In Lesson 11, Explore Section, Step 2, students obtain information from each station and combine the information to explain how wireless devices are designed to transfer information using digitally coded patterns. They record their thinking on the Stations Activity Sheet.

Lesson 12 Learning Target: Obtain and combine information about the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.

- In Lesson 12, Explore Section, Step 3, students obtain information to explain the effects of usable energy sources on the environment using the Energy Sources Research Handout.

Lesson 13 Learning Target: Combine information to evaluate the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.

- In Lesson 13, Synthesize Section, Step 4, students combine all the evidence they have gathered to support their claim about which energy source they think best meets the criteria and constraints.

Criterion-Based Suggestions for Improvement: N/A

III.B. Formative

EXTENSIVE

Embeds formative assessment processes throughout that evaluate student learning to inform instruction.

These pieces of evidence support the **extensive** rating because formative assessment processes that evaluate student learning to inform instruction are embedded throughout the unit. Each lesson contains a formative assessment, and one lesson contains two identified formative assessments. Formative assessments provide multiple ways for students to demonstrate their thinking, as in Lessons 4 and 14. The majority of formative assessments include suggestions on how to modify instruction within the same lessons and occasionally mention when the teacher will have an additional opportunity to check for understanding, as in Lesson 5 Assessment Guidance. The Key Formative Assessments in Lessons 4 and 11 include an Assessment Tool for Teachers to help them attend to students' individual levels and needs and modify instruction accordingly.

Materials include explicit, frequent, and varied supports for formative assessment processes.

- Elementary Teacher Handbook, "Formative assessment opportunities include prompts (verbal, gestures, written) embedded into activities that allow teachers to "quickly" determine whether students are building understanding. These prompts are included in tables that have ideas that teachers should look for and listen for in student responses. There are also suggestions for follow-up questions or prompts for teachers to use to support students' ongoing learning. In addition, at the beginning of each lesson, there is a table that provides information for teachers on how to use the information that they elicit to best support learning." (Elementary Teacher Handbook)
- Lesson 2, Lesson Assessment Guide: "Use the assessment moment as an opportunity to see where students in your class are in their learning about planning and carrying out investigations, energy transfer, and evidence of energy transfer. If students have experienced Unit 4.1: Why does an object's motion change?, this lesson reviews what students learned about connecting observations to evidence of energy and energy transfer. If this is the first science unit of the year, it supports students in developing their understanding of energy and energy transfer. Refer to Lessons 2- 7 Following Student Sensemaking for examining students' understanding based on their current sensemaking." (Lesson 2, Teacher Guide)

- Lesson 2, Teacher Assessment Tool Lessons 2-7: "Use this document to monitor students' sensemaking in the first lesson set, remembering that students often use multiple means of communication at the same time to express their sensemaking. You can use the example table below, a seating chart, your class list, etc. This can be used to monitor group or individual sensemaking from Lessons 2-7". This document includes the learning targets for the lesson, a checklist of "Listen/Look-fors" and a column for teachers to keep notes about their individual or group sensemaking. (Lesson 2, Teacher Assessment Tool)
- Lesson 3, Lesson Assessment Guide: "You can use this formative assessment to see if students need more support in understanding that electricity has to follow a specific path to flow. Refer to Lessons 2- 7 Following Student Sensemaking for examining students' understanding based on their current sensemaking. The tool can be used as a guide for assessing either group or individual progress, depending on your assessment needs. We suggest also collecting student handouts after the Synthesize to look for evidence that they are making progress toward unit performance expectations." (Lesson 3, Teacher Guide)
- Lesson 4, Lesson Assessment Guide: "This is a Key Formative assessment moment as students will shift from looking for evidence that energy has been transferred from place to place to making observations to provide evidence for how electrical currents have been produced (Lessons 5-7). Refer to the Lessons 2- 7 Following Student Sensemaking for examining students' developing understanding. You can look for evidence of student learning via two pathways provided in this lesson: an individual and/or partner assessment (Connecting Observations and Growing Ideas) and an exit ticket option (Exit Ticket - Building Connections)" (Lesson 4, Teacher Guide)
- Lesson 6, Lesson Assessment Guide: "You can use this formative assessment to see if students need more support in understanding that there is a pattern for generating electricity; while almost every method requires the use of moving parts, only solar panels do not. Use this formative assessment to look and listen for students to notice patterns in whether energy sources are available again for reuse or not. We suggest also collecting student handouts after Synthesize to look for evidence that they are making progress towards unit performance expectations." (Lesson 6, Teacher Guide)

Teachers are given guidance on how to modify instruction based on student responses: Key Formative Assessment Tasks in Lesson 4 and 11.

- Lesson 4, Key Formative Instructional Guidance, This document provides teachers with support based on a range of possible student responses or levels of student proficiency. "If you notice: Students are listing observations, but not capturing that the wires connect to create a path." "Possible next steps: "If this applies to a few students in your class: Encourage students to think about what would happen if a wire was cut or unplugged. What would happen to the device? How would we know? If this applies to most or all of your class: Refer students back to the circuits they built in Lesson 3 and how the wires needed to all be connected for the light to turn on. Ask students to use their finger or pencil to trace the path on their drawing from Lesson 3 or on the physical circuit from that lesson. You may also consider having students draw the path using their finger on the Class Consensus Model at the end of the Synthesize in Lesson 4." (Lesson 4, Key Formative Instructional Guidance, p1)
- Lesson 11, Key Formative Instructional Guidance, This document provides teachers with support based on a range of possible student responses or levels of student proficiency. "If you notice: Students are obtaining information from each station but not yet building connections across stations to build understanding." "Possible Next Steps: If this applies to a few students in your class: Give students extra guiding prompts about what connections to focus on, then give students independent or partner time to reflect on the stations before returning to the group discussion about connections across stations. Example prompts include: Across the stations, how were patterns used to transfer information? What do computers do to understand and use digital code? If this applies to most or all of your class: Expand the discussion at the end of the station activities to scaffold building connections between the stations. For

example, ask students to identify where code and/or patterns are involved in each station or identify similarities and differences between what each station is presenting. Consider creating a list of "big ideas" on chart paper, a whiteboard, or other virtual space and have students discuss in groups what they think the big ideas were at each station, and then jot them down on chart paper as they are described by students. Then, have students look for how the big ideas could help us explain." (Lesson 11, Key Formative Instructional Guidance, p1-2)

Formative assessment processes routinely provide varied support for student thinking across all three dimensions. The Elementary Teacher Handbook: "Formative assessment opportunities include prompts (verbal, gestures, written) embedded into activities that allow teachers to "quickly" determine whether students are building understanding." (Elementary Teacher Handbook). Each formative assessment includes a three-dimensional learning goal, what the teacher can look for in student responses and ideas on how to use the assessment information. For example,

Lesson 3, Lesson Assessment Guidance

- Three-Dimensional Learning Goal: **Make observations of a simple circuit to gather evidence** that the **light bulb turns on (effect)** because **batteries transfer energy through electrical currents (cause)**.
- Where to Check for Understanding: On the Make a Light Shine handout in the Explore
- What to look and listen for: Look for evidence that students have: **built and drawn** a **complete circuit with 2 wires, a battery, and an LED light.** Used labeled arrows to **show energy being transferred from the battery to the LED.** Used **evidence (observations) from their investigation** to explain that **the light bulb turned on because energy was transferred through electrical currents (effect).** Used **evidence (observations) from their investigation** to explain that **electrical currents travel along a path.**
- How can I use this assessment information?: You can use this formative assessment to see if students need more support in understanding that electricity has to follow a specific path to flow. Refer to Lessons 2- 7 Following Student Sensemaking for examining students' understanding based on their current sensemaking. The tool can be used as a guide for assessing either group or individual progress, depending on your assessment needs. We suggest also collecting student handouts after the Synthesize to look for evidence that they are making progress toward unit performance expectations. (Lesson 3, Teacher Guide)

Formative assessment processes routinely attend to multiple aspects of student equity.

- Lesson 2, Explore Section, Step 5, Broadening Access Sidebar, "As the focus of the lesson is not identifying the parts of a winding clock, but rather how the parts are working together, accept all ways of sharing observations about this relationship. Encourage students to share what they are observing through gestures, words, or multiple languages." (Lesson 2, Teacher Guide)
- Lesson 3, Synthesize Section, Step 4, Broadening Access Sidebar, "If time and resources allow, you might have students record a video of themselves explaining what happened in the circuit to make the light shine as an alternative or supplement to writing and/or drawing about it." (Lesson 3, Teacher Guide)
- Lesson 4, Lesson Assessment Guidance, "You can look for evidence of student learning via two pathways provided in this lesson: an individual and/or partner assessment (Connecting Observations and Growing Ideas) or an exit ticket option (Exit Ticket - Building Connections)." (Lesson 4, Teacher Guide)
- Lesson 8, Lesson Assessment Guidance: "Consider allowing them to revise their assessments using feedback provided to them. Opportunities to revise explanations will provide students will additional support in making progress on their understanding of how to make observations to provide evidence that energy can be transferred in various ways." (Lesson 8, Teacher Guide)

- Lesson 9, Synthesize Section, Step 6, Broadening Access: "To facilitate equitable participation and promote multiple means of action and expression, have the building materials available for students to interact with as they plan their designs. Being able to physically manipulate the materials can support students in developing and sharing their ideas with the group in ways beyond verbal communication." (Lesson 9, Teacher Guide)
- Lesson 10, Connect Section, Step 4, Broadening Access Sidebar, "Before starting the peer feedback process in the next step, remind students of their Classroom Agreements and make connections to what they identify as good feedback and how they want to interact with their peers as written in their agreements." (Lesson 10, Teacher Guide)
- Lesson 11, Explore Section, Step 2, Broadening Access Sidebar, "To support students reading at the stations, consider encouraging students to take turns reading paragraphs out loud with their group or have one group member read aloud while everyone else follows along. Additionally, you may want to encourage students to circle, underline, or highlight things as they read and to pause at the end of each paragraph and talk with each other (in any language) about what it said and if there were any unfamiliar words or phrases." (Lesson 11, Teacher Guide)
- Lesson 13, Navigate Section, Step 1, Broadening Access Sidebar, "An alternative to having students present their slides via a computer and projector is to have students pre-record or share their presentations in their home language. This sends the message that their language resources and practices are valuable for the classroom community's sensemaking work. This is an important message for all students to receive, and especially for those whose language resources are not always valued in school spaces, such as multilingual students." (Lesson 13, Teacher Guide)
- Lesson 14, Synthesize Section, Step 3, Broadening Access: "Two versions of the assessments are provided each with a different level of scaffolding. (*Sentence Frames*) *Powering a Mars Rover* will benefit students who prefer sentence frames to help them with their writing. Powering a Mars Rover will benefit students who feel more comfortable expressing their ideas without sentence frames. Consider offering both options and inviting students to choose the one that best meets their needs." (Lesson 14, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

III.C. Scoring Guidance

EXTENSIVE

Includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to support teachers in (a) planning instruction and (b) providing ongoing feedback to students.

These pieces of evidence support the **extensive** rating because this unit includes aligned rubrics and scoring guidelines that provide guidance for interpreting student performance along the three dimensions to help teachers plan instruction and provide ongoing support to students. Each lesson contains an identified formative assessment that is aligned to an assessment target. Teachers are provided with "look fors" related to the element of the three dimensions within the assessment target. Through various assessment tools— such as the Lessons 2–7 Assessment Tool and Key Formative Assessment Tools in Lessons 4 and 11—explicit guidance is provided for teachers to interpret student progress. In addition, students have the opportunity to interpret their own progress through two self-reflections in Lessons 8 and 14. The unit has two identified summative assessments, and each includes a rubric with detailed scoring guidance for teachers. Lesson 8 summative assessment includes sample student responses, and Lesson 14 includes expected student responses within the rubric.

Every lesson has a Lesson Assessment Guidance and Assessment Opportunity section that provides teachers with the three dimensional learning goal and what to look and listen for from students for the lesson, but a variety of student responses or feedback ideas that will support the growth in proficiency for individual students is not consistently provided. For example,

Lesson 2, Lesson Assessment Guidance, **Make observations to gather evidence that energy transfer causes changes in motion, sound, and heat (effect)**. (Lesson 2, Teacher Guide)

Where to check for understanding:

- In the Explore when students begin gathering evidence for how plug-in and winding clocks turn on and stay on, and in the Synthesize when discussing as a class how energy is transferred in the winding and plug-in clocks.

What to look and listen for:

- Students identifying that **energy** is needed to **make the winding clock work** and that **energy transfer causes changes in the motion of the clock hands and gears and as sound** (the effects)
- **Observations of hands moving when the clock is wound**
- **Observations of sound when the clock is wound or plugged in**
- **Observations of heat when the clock is plugged in**

Support for planning instruction

- Lesson 5, Synthesize Section, Assessment Opportunity: "This is a formative assessment opportunity for learning goal 5. Look for evidence that students have synthesized ideas from the wind turbine demonstration, read aloud, and video to explain how a wind turbine generates electricity. Refer to the *Sample Wind Turbine Model* for ideas to look and listen for and *Lessons 2-7 Following Student Sensemaking* to track student progress." (Lesson 5, Teacher Guide)
- Lesson 5, Lesson Assessment Guidance: "Use this as an opportunity to continue to assess students' understanding of using evidence gathered from investigations to explain how energy is transferred from place to place. You can also use this as an opportunity to see how they are obtaining, evaluating and communicating evidence from different sources to understand how electricity is generated and transferred from place to place." (Lesson 5, Teacher Guide)

- Lesson 6, Lesson Assessment Guidance: "You can use this formative assessment to see if students need more support in understanding that there is a pattern for generating electricity; while almost every method requires the use of moving parts, only solar panels do not. Use this formative assessment to look and listen for students to notice patterns in whether energy sources are available again for reuse or not. We suggest also collecting student handouts after Synthesize to look for evidence that they are making progress towards unit performance expectations. Refer to *Lessons 2- 7 Following Student Sensemaking* for examining students' understanding based on their current sensemaking. The tool can be used as a guide for assessing either group or individual progress, depending on your assessment needs." (Lesson 6, Teacher Guide)
- Lesson 6, Key for Generating Electricity Data Sheet: "The following responses are just samples; your students may have expressed their ideas differently." (Lesson 6, Teacher Guide)
- Lesson 8, Scoring Guidance for Student Assessment: This document includes where the elements of the three dimensions can be evaluated in the assessment. This document also includes a rubric for the steps of the assessment, and what a student response might look like for a beginning, developing or secure response on the assessment. (Lesson 8, Scoring Guidance)
- Lesson 9, Lesson Assessment Guidance: "This formative assessment can be used to show that students understand how to define a design problem that includes criteria and constraints. Use the information you gain from this assessment to determine how much support to give students or groups while designing their solution during the Synthesize at the end of the lesson. You can also refer to the *Following Student Sensemaking* (*Lesson Set 2*) toll to help identify evidence that students are making progress towards learning goal 9, among others, in this lesson set (lessons 9-11)." (Lesson 9, Teacher Guide)
- Lesson 12, Key for Energy Sources Research: "These are possible student responses from researching usable energy sources. Answers may vary." (Lesson 12, Teacher Guide)

The first and second lesson sets each contain a teacher assessment tool. This tool supports the teacher in planning lesson assessments and capturing student evidence to determine the appropriate feedback to provide.

- Lesson 2, Lessons 2- 7 Following Student Sensemaking, "Use this document to monitor students' sensemaking in the first lesson set, remembering that students often use multiple means of communication at the same time to express their sensemaking. You can use the example table below, a seating chart, your class list, etc. This can be used to monitor group or individual sensemaking from Lessons 2-7." (Lessons 2- 7 Following Student Sensemaking)
- Lesson 9, Following Student Sensemaking (Lesson Set 2), "Use this document to monitor students' sensemaking in the second lesson set, remembering that students often use multiple means of communication at the same time to express their sensemaking. You can use the example table below, a seating chart, your class list, etc. This can be used to monitor group or individual sensemaking from Lessons 9-11.) (Following Student Sensemaking (Lesson Set 2), p1)

Support for ongoing feedback

- Lessons 4 and 11 are identified as Key Formative Assessments in Unit 2. Each lesson contains a document entitled, "Key Formative Instructional Guidance" which provides detailed support to the teacher to provide feedback to specific students and groups of students depending on student responses within those lessons. For example,
    - Lesson 4, Key Formative Instructional Guidance, This document provides teachers with support based on a range of possible student responses or levels of student proficiency. "If you notice: Students are listing observations, but not capturing that the wires connect to create a path." "Possible next steps: "If this applies to a few students in your class: Encourage students to think about what would happen if a wire was cut or

unplugged. What would happen to the device? How would we know? If this applies to most or all of your class: Refer students back to the circuits they built in Lesson 3 and how the wires needed to all be connected for the light to turn on. Ask students to use their finger or pencil to trace the path on their drawing from Lesson 3 or on the physical circuit from that lesson. You may also consider having students draw the path using their finger on the Class Consensus Model at the end of the Synthesize in Lesson 4." (Lesson 4, Key Formative Instructional Guidance, p1)

- Lesson 8, Lesson Assessment Guidance: "Consider allowing them to revise their assessments using feedback provided to them. Opportunities to revise explanations will provide students with additional support in making progress on their understanding of how to make observations to provide evidence that energy can be transferred in various ways. They will continue to draw on this understanding throughout Lesson Sets 2 and 3." (Lesson 8, Teacher Guide)
- Lesson 9, Lesson Assessment Guidance: "This is also an opportunity for students to provide peer feedback to each other. Use the Comparing Design Solutions to look for evidence that students can identify criteria and constraints that are met (or not) by other devices, and on their Round 2 Design Testing that they can use the feedback they received to refine their design solutions and retest their new designs." (Lesson 9, Teacher Guide)
- Lesson 10, Explore Section, Step 7: "Review peer feedback. Display slide K. Distribute the peer feedback pages that you assembled from Combining Design Solutions to each group and return their Round 1 Design Testing. Then have groups review the feedback and use that, along with the updated criteria and constraints to revise and optimize their design." (Lesson 10, Teacher Guide)
- Lesson 11, Key Formative Instructional Guidance: "Use the information provided in this Key Formative Guidance document and the Assessment Guidance in the Lesson 11 Teacher Edition to assess and support student understanding." (Lesson 11, Teacher Guide)
- Lesson 14, Lesson Assessment Guidance: "Use the Scoring Guidance for Student Assessment teacher assessment tool to support your evaluation of students' assessments and to provide them with feedback. If you would like to extend your students' learning, consider allowing them to revise their assessments using the provided feedback." (Lesson 14, Teacher Guide)
- Lesson 14, Teacher Assessment Tool Scoring Guidance for Student Assessment: This document includes where the elements of the three dimensions can be evaluated in the assessment. This document also includes a rubric for the steps of the assessment, and what a student response might look like for a beginning, developing or secure response on the assessment. (Lesson 14, Scoring Guidance)

Rubrics are included for Summative Tasks in Lesson 8 and 14.

- Lesson 8, Scoring Guidance for Student Assessment: This document contains scoring guidance for the Lesson 8 summative assessment for teachers across three levels: Beginning, Developing, and Secure. The assessment targets are incorporated into the guidance within each level. The teacher is provided with a sample response for beginning and secure. A developing sample response is not provided.
- Lesson 8, Lesson Assessment Guidance, "If you find that some students are not yet demonstrating an understanding the way that energy is transferred, review the mechanics of the circuits built in lessons 3, 5, and 7, and have students identify where the energy comes from and where the energy goes in each circuit." (Lesson 8, Teacher Guide) Teacher support for providing feedback to students is provided within the teacher edition of the lesson where the summative assessment takes place.

- Lesson 14, Scoring Guidance for Student Assessment: This document contains scoring guidance for the Lesson 14 summative assessment for teachers across a range of responses: Beginning, Developing, and Secure. Within each level, the assessment targets are incorporated into the guidance. Expected student responses are provided for each of the three levels: Beginning, Developing, and Secure.
- Lesson 14, Synthesize Section, Assessment Opportunity, "Consider providing feedback to students using Scoring Guidance for Student Assessment and allowing them to revise their responses. Refer to the Scoring Guidance for Student Assessment tool and the Assessment Guidance at the beginning of the lesson for more information." This suggestion does not provide teachers with support on what feedback to provide to students.

Criterion-Based Suggestions for Improvement: N/A

III.D. Unbiased Tasks/Items

EXTENSIVE

Assesses student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students.

These pieces of evidence support the **extensive** rating because the unit materials assess student proficiency using methods, vocabulary, representations, and examples that are accessible and unbiased for all students. Supports for students exist in the form of information shared in different ways, as in books, videos, and blog posts. When new vocabulary is introduced, it is first explored with students in their everyday language, and then it is recommended that a class definition be co-constructed. For longer assessments, teachers read through directions to ensure that students are prepared to engage in the task. The unit tasks include a range of modalities that the students can respond with throughout the unit, including writing, gestures, video, and drawing. The unit includes one Key Formative moment, in Lesson 4, that offers students a choice across multiple modalities.

Students are encouraged to demonstrate their understanding in various ways. After they have experienced the science ideas, new vocabulary is introduced.

- Elementary Teacher Handbook: "Students develop their scientific language through reading science texts and communicating their science ideas in classroom discussions or written communication. Students learn to explain and use scientific words or vocabulary throughout completing an OpenSciEd unit. These units have been designed to intentionally build student understanding of vocabulary. In the work of the lessons, students make sense of a science idea before discussing the word used to name that idea. For this reason, it is important not to teach this vocabulary all at once before starting the unit (sometimes called "pre-teaching vocabulary"). Rather, teach vocabulary in particular lessons as described in the Teacher Guide." (Elementary Teacher Handbook)
- Lesson 2, Synthesize Section, Step 6, " Invite students to demonstrate what transfer looks like using gestures and to share other examples of transferring things. Construct a class definition for transfer and post the Word Wall card, or use the Word Wall card for "transfer" from Unit 4.1: Why does an object's motion change? if your class has completed that unit already. Then, return to the "Why does the winding clock turn on and stay on?" chart and, using students' ideas and observations as a guide, draw the path of energy transfer on the clock, using a marker color other than what was used to draw it originally." (Lesson 2, Teacher Guide)

- Lesson 4, Synthesize Section, Step 3, Broadening Access: "For this assessment moment, select the format that is more appropriate for students and for your assessment needs. The written handout provides individual artifacts for assessment but may be too challenging for some students to complete in the allotted time. If using the class discussion format, you will need to assess students based on their contributions to the discussion and their exit ticket responses, which are less individualized." (Lesson 4, Teacher Guide)
- Lesson 9, Explore Section, Teaching Tip Sidebar, "Students who completed OpenSciEd Grade 3 units will already be familiar with the idea of criteria and constraints. You will reinforce and build on these ideas during this lesson and the upcoming unit, Unit 4.3: What causes Earth's landscape to change and how do the changes impact humans? (Islands Unit)." (Lesson 9, Teacher Guide)
- Lesson 13, Navigate Section, Step 1, Broadening Access: "An alternative to having students present their slides via a computer and projector is to have students pre-record or share their presentations in their home language. This sends the message that their language resources and practices are valuable for the classroom community's sensemaking work. This is an important message for all students to receive, and especially for those whose language resources are not always valued in school spaces, such as multilingual students." (Lesson 13, Teacher Guide)
- Lesson 14, Synthesize Section, Step 3, Literacy Supports: "As students complete their assessments, remind them to use precise and relevant vocabulary and that they can go back to the Word Wall to help them do so. This will help students to develop domain-specific vocabulary to explain a topic (W.4.2D)." (Lesson 14, Teacher Guide)

The unit includes various ideas for supporting all students.

- Lesson 1, Connect section, Step 1 Sidebar. "The purpose of an Initial Ideas Discussion is to provide an opportunity for students to share and make sense of their ideas, even while the ideas may be tentative or uncertain. Ask questions such as Can you say more about that? and Who wants to add on to what _____ is saying? The goal is to surface multiple ideas, so avoid privileging some ideas over others. Draw out possible competing ideas to help motivate students to want to further investigate them. This conversation also helps to promote curiosity about how things turn on and stay on. Read more about Initial Ideas Discussions in the Teacher Handbook." (Lesson 1, Teacher Guide)
- Lesson 4, Explore Section, Step 2, Broadening Access Sidebar, "If you have additional time or students need additional support making and recording observations, the video on slide D (School Electricity Tour) can be used as a review after the tour. Consider having students watch the video and take notes on what they observe that can explain the energy transfer to the plugged-in clock (or add to the notes they already took during the tour)." (Lesson 4, Teacher Guide)
- Lesson 8, Synthesize Section, Step 3, "Read through the directions with students and point out the model on the handout that has four different points labeled A, B, C, and D. Then mention that the handout includes a table that is divided into sections like the model and students will have to explain where the energy is coming from, where the energy is going, and their evidence they would look for to tell them energy transfer has happened. They can use their own Class Consensus Model and their Evidence Bank to help them. They can also use their Word Wall, or other references available in the classroom, such as dictionaries or glossaries as resources to spell words correctly. Give students about 20-25 minutes to answer the handout questions individually." (Lesson 8, Teacher Guide)
- Lesson 12, Synthesize Section, Step 4, "While the lesson materials include a student slide deck to use, to optimize student choice and autonomy, consider letting each group choose how they would like to communicate their information. Be sure to modify the lesson slides and timing to account for this change. Additionally, it will still be important that students focus on the effects and criteria and constraints to help us understand what resources we could use in our community to reduce our effects on the environment." (Lesson 12, Teacher Guide)

- Lesson 14, Synthesize Section, Step 3, Broadening Access Sidebar "Two versions of the assessments are provided each with a different level of scaffolding. (Sentence Frames) Powering a Mars Rover will benefit students who prefer sentence frames to help them with their writing. Powering a Mars Rover will benefit students who feel more comfortable expressing their ideas without sentence frames. Consider offering both options and inviting students to choose the one that best meets their needs." (Lesson 14, Teacher Guide)

In many places in the unit, students have a choice of modalities to express their understanding.

- Lesson 4, Exit Ticket - Building Connections, "Pick one observation and story connection pair to write out using the following sentence starter:" (Lesson 4, Student Handout). Students can use "a combination of words, drawings, or symbols" to express their ideas. (Lesson 4 Handout, Connecting Observations and Growing Ideas). Students have a choice in modality for this exit ticket.
- In Lesson 5, Observing Wind Turbines Handout, Students engage in the modalities of drawing and writing to share their thinking.
- Lesson 9, Defining Problems Exit Ticket, "In the lines or box below, use any combination of words and/or drawings to summarize our design problem, including the criteria and constraints." (Lesson 9, Student Handout)
- Lesson 10, Round 1 Design Testing, "Based on your data, how could your design be improved? What changes will you make? Why will you make those changes? Describe your plans in words and/or drawings." (Round 1 Design Testing)
- Lesson 12, Synthesize Section, Step 4, Broadening Access: "While the lesson materials include a student slidedeck to use, to optimize student choice and autonomy, consider letting each group choose how they would like to communicate their information. Be sure to modify the lesson slides and timing to account for this change. Additionally, it will still be important that students focus on the effects and criteria and constraints to help us understand what resources we could use in our community to reduce our effects on the environment." (Lesson 12, Teacher Guide)

Criterion-Based Suggestions for Improvement: N/A

III.E. Coherent Assessment System

EXTENSIVE

Includes pre-, formative, summative, and self-assessment measures that assess three-dimensional learning.

These pieces of evidence support the **extensive** rating because the assessments are connected to learning objectives and require students to apply grade-appropriate elements of the three dimensions to make sense of the phenomena of how the clock stays on. All four of the assessment types mentioned in the criterion are present, and assessment opportunities are found throughout the learning experience. The assessment purpose and rationale are coherent across the materials and are explicitly described for all three dimensions, and support is provided for teachers to provide feedback to students.

The assessments in the unit match the three dimensional learning goal. Each lesson has a section called "Three-dimensional Learning Goal(s)". The assessments for each lesson are designed to show student thinking aligned with the learning goals. Examples include,

In Lesson 2: (Lesson 2, Teacher Guide) Learning Objective: **Make observations** to **identify the effects** of **energy transfer, resulting in moving objects, sound, light, or heat.**

- **Using the lens of: Cause and Effect (CCC)**
- **Students will: Plan and carry out investigations (SEP)**
- **To make sense of: Why things move, light up, heat up, or make sound. (DCI)**

In Lesson 9: (Lesson 9, Teacher Guide) Lesson learning goal: **Obtain and combine information** about the **effects** that **getting and using renewable and nonrenewable resources (cause) have on the environment.**

- **Using the lens of: Cause and Effect (CCC)**
- **Students will: Obtain, evaluate, and communicate information (SEP)**
- **To make sense of: How getting and using various renewable and nonrenewable resources impacts land, water, animals, and people (DCI)**

The unit has pre-assessments, formative assessments, summative assessments, and self-assessments.

Pre-Assessment

- Lesson 1, Synthesize Section, Step 3, Assessment Opportunity: "Pre-assessment: Student's initial models and the Class Initial Consensus Model they will develop next provide an opportunity to gather evidence around Learning Goal 1 with the purpose of determining support that students may need in upcoming lessons around the practice of modeling, around ideas of cause and effect, and around energy and energy transfer. Students will continue to develop these ideas and practices throughout this unit." (Lesson 1, Teacher Guide)

Formative Assessment

- Formative assessments are included in each lesson. Each lesson also includes a section called Lesson Assessment Guidance, which includes the three-dimensional learning goal, where to check for understanding, what to look/listen for, and advice for teachers on how to use the assessment information. (See III B for a specific analysis of formative assessment).

Summative Assessment

Summative assessments are used in Lesson 8 and 14.

- Lesson 8, Synthesize Section, Step 3, “Individually identify evidence for energy transfer. Display slide D. Distribute Make Observations and Self-Reflection to students. Tell students they will be using their understanding of usable energy sources and how a plug-in clock turns on to identify evidence that could be used to explain energy transfer in a game console.” (Lesson 8, Teacher Guide)
- Lesson 14, Assessment Opportunity, “In this assessment moment for Learning Goals 14.A and 14.B, look for evidence that students can apply their understanding of the engineering design process, usable energy sources, and energy transfer to refine a design for a new Mars rover.” (Lesson 14, Teacher Guide)

Self Assessment

- Lesson 8, Synthesize Section, Step 3: “When they are finished, they will then self-reflect on their learning so far in the unit on *Self-Reflection*.” (Lesson 8, Teacher Guide)
- Lesson 8, Synthesize Section Step 3, Assessment Opportunity: “Summative and Self-Reflection: Make Observations provides an opportunity to gather evidence about Learning Goal 9. Use Scoring Guidance for Student Assessment and consider providing feedback to students to revise their work. Make Observations is an opportunity for students to self-assess and reflect on their progress towards Learning Goal 8, and to help them identify improvements they can make the next time they are asked to complete similar tasks. Consider using the self-assessment in combination with Scoring Guidance for Student Assessment to provide feedback to students on Self-Reflection.” (Lesson 8, Teacher Guide)

The unit describes a coherent three dimensional assessment system. The Assessment System Overview document gives a lesson by lesson description of the types of assessment and the three-dimensional learning goals for each assessment

- The Elementary Teacher Handbook gives a description of the desired assessment system in the unit. “The goal for assessment in OpenSciEd Elementary is to provide students with opportunities to share their ideas, experiences, and ways of making sense of the world and for these ideas, experiences, and sensemaking strategies to be welcomed, valued, and used to support ongoing learning. When this philosophy toward assessment is enacted in classroom communities that have built norms and routines to invite students to make their thinking visible and use this thinking to help make sense of science phenomena, students can see how their ideas drive science learning. All OpenSciEd Elementary curriculum units have assessment opportunities woven throughout the lessons to support teachers in being responsive to students’ ideas and to support students in building their science understandings. These assessment opportunities encourage multimodal communication such that students have many different ways of demonstrating their ongoing sensemaking. Teaching tips and other educative features include prompts and questions to increase participation for traditionally minoritized learners within the whole class and cooperative learning groupings.” (Elementary Teacher Handbook, p59)

Criterion-Based Suggestions for Improvement: N/A

III.F. Opportunity to Learn

ADEQUATE

Provides multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback

These pieces of evidence support the **adequate** rating because the unit materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of disciplinary core ideas and crosscutting concepts and receive feedback. As students move toward proficiency with the performance expectations identified for this unit, multiple student performances provide students with iterative opportunities to show their progress toward proficiency. In the first lesson set (Lessons 1–8), these performances occur across multiple lessons, while in the second lesson set, there are few opportunities to demonstrate progress toward proficiency. Students receive feedback on individual artifacts throughout this process and are given time to revise accordingly. In the second and third lesson sets (9–11 and 12–13), there is less guidance for feedback and fewer opportunities for students to improve their performance in preparation for the next assessment opportunity.

Students have multiple opportunities to use the SEPs, DCIs, and CCCs when coming to an understanding of targeted learning. Evidence from the materials where the criterion was met,

4-PS3-2 Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (Assessment Boundary: Assessment does not include quantitative measurements of energy.)

- Lesson 2: **Make observations to gather evidence that energy transfer causes changes in motion, sound, and heat (effect)**.Lesson 2, Explore Section, Step 4: "Then, explain that we can take the back off a plug-in clock so we can see the parts inside it and make predictions about how they work together to turn the clock on and keep it on." (Lesson 2, Teacher Guide)
- Lesson 6: **Combine information** and **describe patterns** about **how different sources of energy can be used to generate electricity.** Lesson 6, Synthesize Section, Step 4: "Summarize what we figured out. Display slide G and ask students to turn and talk with a partner to summarize what they figured out when sorting the *Electricity Generation Cards.* Then, have students briefly share their responses. Emphasize the idea that there was something unique about how the sun is used to generate electricity and that we figured out two new scientific terms related to generating electricity." (Lesson 6, Teacher Guide)
- Lesson 7: **Plan and carry out a fair test investigation to gather evidence** about how **energy can transfer from place to place through light**. Lesson 7, Synthesize Section, Step 5: "Ask students to look at their class data display and remind themselves of the patterns they observed in Explore. Then, ask students where is the energy coming from to make the motor move?" (Lesson 7, Teacher Guide)
- Lesson 8: **Make observations to provide evidence** that **energy can be transferred from place to place by sound, light, heat, and electric currents.** Lesson 8, Synthesize Section, Step 3: "Distribute *Make Observations* and *Self-Reflection* to students. Tell students they will be using their understanding of usable energy sources and how a plug-in clock turns on to identify evidence that could be used to explain energy transfer in a game console." (Lesson 8, Teacher Guide)

4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound; and, a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.) (Assessment Boundary: Devices should be limited to those that convert motion energy to electric energy or use stored energy to cause motion or produce light or sound.)

- Lesson 1: **Develop a model to describe the causes** of **why a clock turns on and stays on** (**effects**). Lesson 1, Synthesize Section, Step 3: "Distribute the *Initial Model* handout and give students 8-10 minutes to draw their models. Encourage students to use arrows to show why the plug-in clock turns on and stays on, and to label what their arrows represent." (Lesson 1, Teacher Guide)
- Lesson 3: **Make observations of a simple circuit to gather evidence** that the **light bulb turns on** (**effect**) because **batteries transfer energy through electrical currents** (**cause**). Lesson 3, Explore Section, Step 3: "Display slide D. Distribute a single cylindrical battery to each pair of students. Remind students that we noticed batteries need to be facing a certain direction to work correctly. Suggest taking a closer look at the battery to see what we notice." and "Suggest that we try to make a single LED shine in order to further investigate how the parts of devices like clocks and lanterns are connected. Use wires to connect batteries to an LED. Organize students into groups of 3-4. Display slide G. Distribute the Make a Light Shine handout, LED, battery holders, and 2 alligator clip wires to each small group of students." (Lesson 3, Teacher Guide)
- Lesson 4: **Make observations of paths for electrical current** and **energy transfer to build ideas about how energy transfers from somewhere** to **our plug-in clock by electrical currents**. Lesson 4, Synthesize Section, Step 3: "Display slide J. Use the prompt on the slide to have students turn and tell a partner about how an observation on the class list helps tell the story of how energy gets to the plug-in clock. Have students share their ideas with the class." (Lesson 4, Teacher Guide)
- Lesson 5: **Make observations to gather evidence** for **how energy from moving objects can be transferred** to **electrical current.** Lesson 5, Synthesize Section, 5: "Give students 5-7 minutes to develop their model (question #2) explaining how a wind turbine generates electricity before sharing it with a partner. Remind them to use arrows to show how and where energy is being transferred." (Lesson 5, Teacher Guide)
- Lesson 8: **Make observations to provide evidence** that **energy can be transferred from place to place by sound, light, heat, and electric currents.** Lesson 8, Synthesize Section, Step 3: "Distribute *Make Observations* and *Self-Reflection* to students. Tell students they will be using their understanding of usable energy sources and how a plug-in clock turns on to identify evidence that could be used to explain energy transfer in a game console." (Lesson 8, Teacher Guide)
- Lesson 9: **Define a simple design problem** and **identify criteria and constraints** for **transferring information across a distance**. Lesson 9, Explore Section, Step 4: "Distribute *Defining Problems Exit Ticket* to each student. Have students review the problem on the Communication Design Ideas chart and the criteria and constraints the class has developed. Give students a few minutes to describe on their own what they think are the design problem and the including criteria and constraints." (Lesson 9, Teacher Guide)
- Lesson 10: **Plan and carry out a fair investigation to test design solutions based on criteria and constraints for transferring** information (**energy**) across a distance and to s**uggest improvements.** Lesson 10, Explore Section, Step 4: "Remind students that if their design did not work during the first trial, that they should retest at the same distance." "After students have completed their tests, direct students to answer the round 1 questions at the end of their *Round 1 Design Testing*." (Lesson 10, Teacher Guide)

- Lesson 14: **Define criteria and constraints for a device that can be powered and communicate with objects on Earth** using **energy transfer from a usable energy source**. Lesson 14, Synthesize Section, Step 3: "Individually identify criteria and constraints and refine solutions. Display slide F. Distribute (Sentence Frames) Powering a Mars Rover or Powering a Mars Rover." (Lesson 14, Teacher Guide)

4-PS4-3 Generate and compare multiple solutions that use patterns to transfer information. (Clarification Statement: Examples of solutions could include drums sending coded information through sound waves, using a grid of 1's and 0's representing black and white to send information about a picture, and using Morse code to send text.)

- Lesson 9: **Define a simple design problem** and **identify criteria and constraints** for **transferring information across a distance**. Lesson 9, Explore Section, Step 4: "Distribute *Defining Problems Exit Ticket* to each student. Have students review the problem on the Communication Design Ideas chart and the criteria and constraints the class has developed. Give students a few minutes to describe on their own what they think are the design problem and the including criteria and constraints." (Lesson 9, Teacher Guide)
- Lesson 11: **Obtain information to explain how devices use digitized patterns to communicate information (energy) across long distances.** Lesson 11, Explore Section, Step 2: "Divide students into groups and assign each group a starting station. Give students about 10-12 minutes to complete each station before rotating to the next one." "Tell students that it sounds like they obtained a lot of information about how devices communicate that can help us figure out how some clocks don't have to be set." (Lesson 11, Teacher Guide)

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. (Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fissile materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.)

- Lesson 12: **Obtain and combine information about the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.** Lesson 12, Explore Section, Step 2: "Tell students that they will be researching an energy source with their group to figure out the effects of obtaining and using that source and then evaluating it based on our criteria and constraints." (Lesson 12, Teacher Guide)
- Lesson 13: **Combine information to evaluate the effects that getting and using renewable and nonrenewable resources (cause) have on the environment.** Lesson 13, Synthesize Section, Step 4: "Point out to students that we started our investigation by wondering what are the effects of using usable energy sources to power our devices, like clocks. We took some time to think about criteria and constraints for what we would want for usable energy sources in our community. Suggest to students that they revisit their criteria and constraints now that they have more information about the effects and how to reduce electricity usage." (Lesson 13, Teacher Guide)
- Lesson 14: **Apply scientific ideas to refine a device that converts energy from one form to another**. Lesson 14, Synthesize Section, Step 3: "Individually identify criteria and constraints and refine solutions. Display slide F. Distribute (Sentence Frames) Powering a Mars Rover or Powering a Mars Rover." (Lesson 14, Teacher Guide)

3-5 ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

- Lesson 9: **Define a simple design problem** and **identify criteria and constraints** for **transferring information across a distance**. Lesson 9, Explore Section, Step 4: "Distribute *Defining Problems Exit Ticket* to each student. Have students review the problem on the Communication Design Ideas chart and the criteria and constraints the class has developed. Give students a few minutes to describe on their own what they think are the design problem and the including criteria and constraints." (Lesson 9, Teacher Guide)

- Lesson 10: **Use data to compare solutions to evaluate which design solution best meets the criteria and constraints for transferring** information (and **therefore energy**) across a distance. Lesson 10, Synthesize Section, Step 5: "Ask students what we should do now that we have collected our data, received feedback, and added some new criteria and constraints." "Tell students that improving their designs based on testing is something engineers call optimizing, or making something the best that it can be"(Lesson 10, Teacher Guide)
- Lesson 14: **Apply scientific ideas to refine a device that converts energy from one form to another**. Lesson 14, Synthesize Section, Step 3: "Individually identify criteria and constraints and refine solutions. Display slide F. Distribute (Sentence Frames) Powering a Mars Rover or Powering a Mars Rover." (Lesson 14, Teacher Guide)

3-5 ETS1-3 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.

- Lesson 10: **Use data to compare solutions to evaluate which design solution best meets the criteria and constraints for transferring** information (and **therefore energy**) across a distance. Lesson 10, Synthesize Section, Step 5: "Ask students what we should do now that we have collected our data, received feedback, and added some new criteria and constraints." "Tell students that improving their designs based on testing is something engineers call optimizing, or making something the best that it can be"(Lesson 10, Teacher Guide)

The unit supplies teachers with strategies for responding to student work, but there are few opportunities for students to receive feedback on their individual thinking.

- Lesson 3, Lesson Assessment Guidance, "You can use this formative assessment to see if students need more support in understanding that electricity has to follow a specific path to flow. Refer to Lessons 2- 7 Following Student Sensemaking for examining students' understanding based on their current sensemaking. The tool can be used as a guide for assessing either group or individual progress, depending on your assessment needs. (Lesson 3, Teacher Guide) There is no guidance on how feedback can be given to students.
- Lesson 5, Synthesize Section, Step 5, "Have students write an explanation (question #3) using evidence from their observations to describe how the wind turbine generates electricity. If needed, students can revisit the videos, book, and model turbine to help craft their model. (Lesson 5, Teacher Guide)
- Lesson 7, Assessment Opportunity, "Use the Light Investigation handout to look for evidence that students are making progress towards Learning Goal 7. Use the Lessons 2- 7 Following Student Sensemaking teacher assessment tool to record evidence of students' developing sensemaking. See the Assessment Guidance for more information on how to support students who are not yet making important connections between (sun)light and energy transfer. " (Lesson 7, Teacher Guide) There is no guidance on how feedback can be given to students.
- Lesson 8, Assessment Opportunity, "Summative and Self-Reflection: Make Observations provides an opportunity to gather evidence about Learning Goal 9. Use Scoring Guidance for Student Assessment and consider providing feedback to students to revise their work." (Lesson 8, Teacher Guide)
- Lesson 10, Connect Section, Step 4, "Engage in a gallery tour to compare designs. Display slide G. Describe the feedback process to students: two students from each group will stay to demonstrate their design solution to others, even if it did not work, and the rest of the group will rotate to see the other designs and provide peer feedback." (Lesson 10, Teacher Guide)
- Lesson 11, Assessment Opportunity, "Key Formative: Use the Stations Activity Sheet to look for evidence that students are making progress towards Learning Goal 11. Use the Key Formative Instructional Guidance for guidance on example student responses and a way to support students who have not yet met the learning goal." There is not an established time within the lesson for students to improve their performance in preparation for the next assessment opportunity.

- Lesson 12, Synthesize Section Step 5, "Students can use the answers to questions 1 and 2 on their Energy Sources Research handout to help them with creating their sentences on their first slide and creating their criteria and constraints summary on their second slide. For the picture, students can use images from Effects of Useable Energy Sources Website." (Lesson 12, Teacher Guide) There is not an established time within the lesson for students to improve their performance in preparation for the next assessment opportunity.
- Lesson 13, Synthesize Section, Step 4, "Give students a few minutes to complete part 3. As students work on their individual arguments, walk around and ask students questions such as: What is your evidence? Where did you obtain the evidence that supports your claim? What effects will your choice have on our community (people, animals, plants, lands, and water)?" (Lesson 13, Teacher Guide)
- Lesson 14, Lesson Assessment Guidance, "Use the Scoring Guidance for Student Assessment teacher assessment tool to support your evaluation of students' assessments and to provide them with feedback. If you would like to extend your students' learning, consider allowing them to revise their assessments using the provided feedback." (Lesson 14, Teacher Guide)

Criterion-Based Suggestions for Improvement

- Consider collecting student work in Lessons 3, 5, and 7 and providing individual student feedback.
- Ensure that "[s]tudents have opportunities to use their feedback to construct new learning and improve their performance in preparation for the next assessment opportunity." In Lessons 11 and 12, consider how to be more explicit about the feedback that can be provided to students as they obtain information and when students can have the opportunity to improve their performance in preparation for the next assessment opportunity.

Category Ratings

CATEGORY I	**NGSS 3D Design**	0 1 2 (3)
CATEGORY II	**NGSS Instructional Supports**	0 1 2 (3)
CATEGORY III	**Monitoring NGSS Student Progress**	0 1 2 (3)
TOTAL SCORE		**9**

Overall Ratings

Overall ratings:		**Overall rating below:**
The score total is an approximate guide for the rating. Reviewers should use the evidence of quality across categories to guide the final rating. In other words, the rating could differ from the total score recommendations if the reviewer has evidence to support this variation.	**E: Example of high quality NGSS design—** High quality design for the NGSS across all three categories of the rubric; a lesson or unit with this rating will still need adjustments for a specific classroom, but the support is there to make this possible; exemplifies most criteria across Categories I, II, & III of the rubric. (total score ~8–9) **E/I: Example of high quality NGSS design if Improved—**Adequate design for the NGSS, but would benefit from some improvement in one or more categories; most criteria have at least adequate evidence (total score ~6–7) **R: Revision needed—**Partially designed for the NGSS, but needs significant revision in one or more categories (total ~3–5) **N: Not ready to review—**Not designed for the NGSS; does not meet criteria (total 0–2)	**E**