EQuIP RUBRIC FOR SCIENCE EVALUATION

Energy Transfer from Earth's Systems into our Communities

DEVELOPER: OpenSciEd

GRADE: High School | **DATE OF REVIEW:** January 2023

Educators Evaluating Quality Instructional Products

P1: Energy Transfer

EQuIP RUBRIC FOR SCIENCE EVALUATION

OVERALL RATING: E

TOTAL SCORE: 8

CATEGORY I: NGSS 3D Design Score	CATEGORY II: NGSS Instructional Supports Score	CATEGORY III: Monitoring NGSS Student Progress Score
2	3	3

Click here to see the scoring guidelines.

This review was conducted by NextGenScience using the EQuIP Rubric for Science.

CATEGORY I CRITERIA RATINGS			CATEGORY II CRITERIA RATINGS			CATEGORY III CRITERIA RATINGS		
A.	Explaining Phenomena/ Designing Solutions	**Extensive**	**A.**	Relevance and Authenticity	**Extensive**	**A.**	Monitoring 3D Student Performances	**Adequate**
B.	Three Dimensions	**Adequate**	**B.**	Student Ideas	**Extensive**	**B.**	Formative	**Extensive**
C.	Integrating the Three Dimensions	**Extensive**	**C.**	Building Progressions	**Adequate**	**C.**	Scoring Guidance	**Adequate**
D.	Unit Coherence	**Extensive**	**D.**	Scientific Accuracy	**Extensive**	**D.**	Unbiased Tasks/Items	**Extensive**
E.	Multiple Science Domains	**Adequate**	**E.**	Differentiated Instruction	**Extensive**	**E.**	Coherence Assessment System	**Extensive**
F.	Math and ELA	**Extensive**	**F.**	Teacher Support for Unit Coherence	**Extensive**	**F.**	Opportunity to Learn	**Extensive**
			G.	Scaffolded Differentiation Over Time	**Adequate**			

Summary Comments

Thank you for your commitment to students and their science education. NextGenScience is glad to partner with you in this continuous improvement process. It is obvious that this unit was thoughtfully crafted, and it has many strengths in several areas, including unit coherence, relevance and authenticity, and supporting students in developing and using the three dimensions. In addition, the materials use authentic data sets and focus on students trying to solve the design problem of improving the reliability of their own electric infrastructure to learn more about the power crisis in Texas. The unit incorporates Common Core State Standards (CCSS) for English language arts (ELA) and mathematics in authentic and meaningful ways that assist students in better understanding the unit phenomenon.

During revisions, the reviewers recommend paying close attention to the following areas:

- **Developing specific elements of Science and Engineering Practices (SEPs) and Crosscutting Concepts (CCCs).** Currently, some SEP and CCC claims don't match the evidence of student use in the unit. Consider clarifying and aligning claims throughout the unit so that all documents reflect the same claims about learning goals in the unit.
- **Incorporating Scoring Guidance.** Although scoring guidance is provided for all key assessments, specific guidance that can be used to drive future instruction is not always evident for teachers. Consider providing supports for teachers to not only use the scoring guidance to evaluate students' artifacts, but to also guide future instruction based on students' performances.

Note that in the feedback below, black text is used for either neutral comments or evidence the criterion was met and purple text is used as evidence that doesn't support a claim that the criterion was met. The purple text in these review reports is written directly related to criteria and is meant to point out details that could be possible areas where there is room for improvement. Not all purple text lowers a score; much of it is too minor to affect the score. For example, even criteria rated as Extensive could have purple text that is meant to be helpful for continuous improvement processes. In these cases, the criterion WAS met; the purple text is simply not part of the argument for that Extensive rating.

Unless otherwise specified, page numbers in this review refer to the PDF pages in the Teacher Edition (TE).

CATEGORY I

NGSS 3D DESIGN

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

I.B. THREE DIMENSIONS

I.C. INTEGRATING THE THREE DIMENSIONS

I.D. UNIT COHERENCE

I.E. MULTIPLE SCIENCE DOMAINS

I.F. MATH AND ELA

I.A. EXPLAINING PHENOMENA/DESIGNING SOLUTIONS

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.

Rating for Criterion I.A. Explaining Phenomena/Designing Solutions	*Extensive* *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that learning is driven by students making sense of phenomena because learning is driven by students figuring out an anchor phenomenon, investigative phenomena, and completing a design challenge related to a problem to solve.

The anchor phenomenon (the power crisis in Texas) and design problem (improving the reliability of our electric infrastructure) provide a consistent focus throughout the unit. Students return to the phenomenon throughout the learning sequence, adding new learning to their understanding of the nature of electrical energy transfer, stability and change of energy inputs and outputs, the impact of energy transfer on our everyday lives, and the social/environmental tradeoffs inherent in sourcing energy from Earth's systems. The engineering task of designing a reliable energy solution that meets the community's needs requires students to develop elements of the science and engineering Disciplinary Core Ideas (DCIs).

Related evidence includes:

- Lesson 1: The anchor phenomenon is presented to students, "Present slide A and read the slide aloud: In February 2021, over 11.8 million Texans lost access to electricity to heat and light their homes, store their food, and charge their devices. For many people, the power outages lasted for several days. Hundreds of people died as a result" (TE, page 32).
- Lesson 1: Students make initial models to show and explain their understanding of blackouts and how they occur (TE, page 37).
- Lesson 1: The unit design challenge is presented to students, "How could we design better electricity to meet our community's needs" (TE, page 44). This challenge is connected thematically to the anchor phenomenon/problem but is not directly stated as a solution to the problem (e.g., "how could we ensure that the problem with power in TX doesn't happen here?").

- Lesson 1: At the end of the lesson, the teacher is told, "introduce the design challenge. Say, 'Whether or not we live in Texas, power is a huge part of our lives. How do you think that answering some of these questions might help us make decisions in our own communities?'" (TE, page 44). The teacher is not prompted to help students focus on a specific problem to solve (e.g., "sometimes people have power outages, and their lives are affected").
- Lesson 2: Investigation B is not connected to the anchor phenomenon or to solving a problem. The only context is when the teacher is told, "Tell students that after you distribute supplies for the next investigation, you will hook up a single light bulb to a single battery with no power strip, to establish a control condition for the whole class….tell students that after you distribute supplies, their goal will be to light up multiple light bulbs as brightly as the one at the front of the room, but using the power strip as an intermediate energy transfer mechanism" (TE, page 58). Later, a connection is made back to topics related to the anchor phenomenon, "Purpose of this discussion: To come to consensus about which parts and connections in the electrical system of a building (larger scale) are analogous to parts and connections in the power strip (smaller scale)" (TE, page 67).
- Lesson 2: Students visit the Driving Question Board (DQB) to recap Lesson 2 before dissecting a power strip to better understand how it transfers energy to electricity powered objects that need it inside a building. This is to help students "work backward in the larger-scale system to figure out how these devices, buildings, neighborhoods get the electrical energy they need" (TE, page 56) before they power a circuit. They use this to then develop a model to explain how the power strip system works before investigating using the model to investigate electrical distribution in a city.
- Lesson 3: A problem related to the anchor phenomenon is introduced, "Read about a situation in which overgrown trees caused an energy crisis that affected more than 50 million people in North America" (TE, page 80).
- Lesson 4: Using informational cards to gain additional understanding of the sources of energy, students determine which source would be responsible for a drop in supply before ranking the sources by reliability, which is a criterion for a successful energy grid. Students use a decision matrix to track how well each source meets the criteria.
- Lesson 5: An investigative phenomenon is introduced, "As they click back together, draw attention to the magnet by saying, 'Wow, they really snapped back together quickly, did you hear that snapping noise? See whether you can figure out what is pulling them back together so quickly when I pass them around'" (TE, page 120). This is then connected back to the anchor phenomenon, "How could this help us understand the energy crisis in Texas in 2021?" (TE, page 121).
- Lesson 6: At the end of day 2, the teacher is told to "Reground students in our larger line of inquiry, related to what happened in Texas and how to reengineer and improve our electric grid." Students are asked whether their simulation result helps them explain the anchor phenomenon more or solve the anchor problem more (TE, page 152).
- Lesson 6: An Exit Ticket asks students, "Do we have all the pieces we need to model how insufficient supply could have affected energy transfer into certain communities in Texas when temperatures dropped during the storm?" (TE, page 157).

- Lesson 6: Returning to the Engineering Design Tracker students include ideas they discovered while running a simulation on modeling energy transfers inside a wire to better understand how they can improve the electric grid.
- Lesson 7: Students use energy transfer models created over the unit to determine how the reduced supply of energy could have affected energy transfer into certain communities in Texas when the temperature dropped.
- Lesson 8: After listening to a podcast featuring a scientist whose research group used satellite data to investigate patterns in who lost power in Texas, students reflect on what choices they would make if they had control of their community grid in a power crisis. This ties into the unit design challenge of providing energy for the local community.
- “In the second lesson set (Lessons 9–11), students consider engineering trade-offs, criteria, and constraints inherent in making decisions about our energy systems and apply them in a culminating task: design a reliable energy solution that meets our communities' needs, as articulated by interviews with friends and family members” (Unit Overview, page 1). The teacher is therefore told that students will complete a design task rather than being told that students will be trying to figure out a solution to problem(s).
- Lesson 10: Returning to the decision matrix, students are reminded of the focus of the engineering design challenge. “Remind students that we want to be able to advocate for decisions in the future of our own communities. Have students turn and talk while answering this question, what additional criteria might be missing from the Decision Matrices” (TE, page 204).
- Lesson 10: Before being introduced to part 1 of the Engineering Design Challenge, students are reminded of the importance of community and how it is embedded within the challenge. “Motivate reading about interested parties by telling students that you have quotes from real people that can give us a glimpse into how different people approach a design solution with different values” (TE, page 207).
- Lesson 11: “This lesson is a putting the pieces together routine, where students get the chance to evaluate where they have been, what resources they have collected, and how they can use those resources to make decisions. What is important is that they know how to justify their decisions using a combination of engineering ideas about criteria, constraints, and tradeoffs, and science ideas about energy loss to the environment, factors that affect energy transfer, and the components and interactions involved in energy transfer in the electricity grid” (TE, page 216).

Student questions and prior experiences are used to drive learning and make sense of the phenomenon and solve the engineering problem. Student questions arise at the beginning of the unit and are arranged in a DQB that is organized by the teacher and the class. The class returns to answer these questions in Lessons 2 and 11. Most, but not all, learning is driven by students.

Related evidence includes:

- Lesson 1: Students’ home learning encourages students to connect with family and friends about the phenomenon to drive their learning. “Texas is not the only place where blackouts occur causing people to lose access to heat and other essentials. How many of you have experience [sic] a blackout or something similar. What could we do to gather even more stories about related phenomena?" (TE, page 34).

- Lesson 1: The teacher is told to say, "We had a lot of agreement across our models. We also had some competing ideas. Before we move on, we need to come to consensus around what we know and what we want to figure out" (TE, page 38). The class creates an "Initial Consensus Energy Transfer Model" (TE, page 39). The teacher is told, "add question marks to the parts of the system where there was disagreement or where the class wasn't sure about something."
- Lesson 1: A DQB is developed collaboratively as a class. "Tell students, Let's use the initial consensus model that we made to organize our questions. We can place questions related to specific systems near or on top of those systems on the poster, and then cluster related questions nearby. Then explain that you would like students to take the lead on this process. You might want to choose the first volunteer to begin the process and then step back. Students should use the direction on the handout (also on the slide) to guide them. Step in when necessary to point students to some of the class norms to encourage equitable participation" (TE, page 43).
- Lesson 1: The teacher is told, "Tell students that after we figure out what happened in Texas, we will apply those ideas to articulate some solutions we want to advocate for in our own communities. Ask students to share their ideas about the questions on the slide: 1. What are some things you would want to learn about what happened in Texas to inform and refine your community solutions? 2. What sorts of investigations could we carry out within our own class to further advance our understanding, and answer more of our DQB questions?" (TE, page 44). Facilitation guidance is given to the teacher, "For example, if students are only talking about data from Texas, say, We definitely want to investigate the context around what happened in Texas to inform our ideas. Are there any investigations we could do here in the classroom to answer some of our questions that are about energy production more broadly?"
- Lesson 1: The teacher is told to say, "Let's see what we can learn just by noticing the stuff around us that we think is part of the systems that bring electricity into our homes. Maybe we will see some patterns that could help us understand how the systems work and identify important design constraints" (TE, page 45).
- Lesson 2: Patterns in images from students' homes and communities are used to connect naturally to the next activity (Investigation A). The teacher is told, "Identify outlets as a common structure for further investigation. Say, since these three-hole outlet structures seem to be everywhere, they must be an important part of how energy is transferred to all the electricity-powered objects that need it inside a building. So, let's start there, as it might help us work backward in the larger-scale system to figure out how all these devices, buildings, and neighborhoods get the electrical energy they need" (TE, page 56). However, Investigation B is not connected back to students' questions or observations. The only context is when the teacher is told, "Tell students that after you distribute supplies for the next investigation, you will hook up a single light bulb to a single battery with no power strip, to establish a control condition for the whole class….tell students that after you distribute supplies, their goal will be to light up multiple light bulbs as brightly as the one at the front of the room, but using the power strip as an intermediate energy transfer mechanism" (TE, page 58). Similarly, the model

of electrical wiring in buildings is driven by the teacher, who is told to say, "Let's develop a map of some of these basic structures in both systems—a power strip and a building—so we can better understand how these systems function" (TE, page 63). Students are not facilitated to think of mapping or modeling as a next step.

- Lesson 2: The lesson ends with the teacher soliciting questions. "Say, In this lesson we figured out how a circuit is needed to transfer energy from a source to electricity-powered devices. Have students turn and talk with a partner to answer the question, what new ideas or new questions does this raise for you about our Texas case study? Emphasize that we should plan to investigate these questions next time. Remind students if time permits, they can add these questions to the Driving Question Board before class is over" (TE, page 72).
- Lesson 3: "Distribute a piece of paper to each student and ask them to use it to write their ideas in response to the slide prompt: What part of the electric grid system do you want to investigate next to determine what might have happened to decrease supply in Texas in February 2021? Have students turn in their exit tickets before they leave" (TE, page 94). The Exit Tickets are revisited in Lesson 4 at the beginning of the lesson. "Remind students that at the end of last class we completed an exit ticket. Tell students that most people wanted to know more about the sources of energy in Texas" (TE, page 101).
- Lesson 4: The lesson navigation connects to students' ideas. "Remind students that at the end of the last class, we completed an exit ticket. Tell them that most people wanted to know more about the sources of energy in Texas, because we saw a big drop in energy supply in February 2021." Students' prior learning is then elicited when they are asked "What energy sources have you heard about? What energy sources do you expect to see being used in Texas? Why?" Student questions about Texas's power sources are also elicited (TE, page 101). Students are then asked, "What data could help us understand whether any of these sources might have been responsible for the 2021 crisis?" (TE, page 102). This connects to the next activity, examining Energy Source Cards.
- Lesson 4: Facilitation notes are provided to help students feel as if they are driving the learning. "If nobody comes up with that idea directly, that's OK. Use students' other ideas to consider creative ways to introduce that data; for example, if several students suggest that we look at 'more data about whether the sources are reliable,' you can motivate looking at the data next time by saying, A lot of people wanted to know more about whether these sources were reliable. I have supply [sic] graphs for each of the sources we have been investigating. How could data about how much supply each source contributed in February 2021 help us figure that out?" (TE, page 105).
- Lesson 4: At the end of the lesson, students are asked, "What information is missing from these diagrams that could help us understand why energy sources are more reliable (or efficient, powerful, dispatchable)?" (TE, page 108).
- Lesson 5: "Remind students that natural gas and wind were two of the sources we identified as very popular in Texas, but that we saw differences in how reliable and efficient they were, how much power they provided and so forth. Have students turn and talk about the prompts on the slide: What do we know about how wind and natural gas produce energy transfer in wires that would help us understand what makes each more or less reliable, efficient or powerful? How could we figure this out? Elicit a few student ideas. Accept all ideas for the first prompt. For the

second prompt, listen for students to suggest seeing inside power plants somehow, either through videos, diagrams, a field trip or something else. Say, It sounds like we want to know more about what is inside a power plant" (TE, page 115). At the end of the lesson Exit Tickets are collected and used to guide Lesson 6.

- Lesson 6: "Connect to the exit ticket from previous class. Ask students to share their responses to the prompt on the slide, Why do many power plants need to get something spinning in order to transfer electrical energy to wires?" (TE, page 143).
- Lesson 6: Students have the opportunity to write down new questions about how matter transfers inside a wire and how it contributes to energy transfer. These are collected and then used to start the lesson for the next day (TE, page 146).
- Lesson 9: "How can we figure out how much stored energy would have been needed to fill this gap? Look for students to suggest calculating the energy that was needed (demand) and subtracting the energy that was available (supply). It is okay if students don't come up with any ideas" (TE, page 193).
- Lesson 10: Students are asked, "What could we do to make sure we are representing the interests of people in our community before we make decisions for our design project? Walk around the classroom and listen in. Then bring the class back together and say, I heard a couple of ideas about asking interested parties what criteria they value, and taking that into account. Let's explore that idea" (TE, page 208).
- Lesson 11: At the end of the unit, the teacher is told, "Have students work in pairs to evaluate what questions the class has answered from the DQB" (TE, page 224).

Many of the lessons support students in building understanding of the strong engineering components **(ETS1-A, ETS1-B)** which assist students in answering the overarching question, "How can we design more reliable systems to meet our communities' energy needs?" These engineering pieces are seamlessly integrated with the physical science DCIs to support students in making sense of the anchor phenomenon (the power crisis in Texas).

An Engineering Design Tracker is used frequently throughout the unit. It is "used to keep track of how engineers use science ideas to design solutions and allows students to identify constraints that may prevent those solutions from being implemented" (TE, page 79).

- Lesson 3: "Distribute the Engineering Design Tracker to each student. Ask, 'What strategies did you read about that engineers have tried to make the electric grid more reliable?'" (Page 81).
- Lesson 6: "Ask students to use the ideas they see on the poster to fill in another row of their engineering design tracker. Remind students that some of the new ideas are more relevant to engineering solutions than to others" (TE, page 154).
- Lesson 9: Students read Battery Construction Impacts and update their Engineering Design Tracker with ideas from the reading (TE, page 197).
- Lesson 11: After the student's complete part 2 of the engineering design challenge, they are asked to return to their Engineering Design Tracker and consider new science ideas that could be applied to suggest possible changes to their electric grid (TE, page 221).

Suggestions for Improvement

- Consider developing a routine for generating student questions that is used more regularly.
- Consider making the problem to solve more explicit early in the unit, rather than framing it as a classroom design challenge.

I.B. THREE DIMENSIONS

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.

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

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

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

Rating for Criterion I.B. Three Dimensions	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials give students opportunities to build understanding of grade-appropriate elements of the three dimensions. Throughout the unit, students have opportunities to use many of the grade-appropriate elements of the three dimensions. However, there's a mismatch between some of the elements claimed and those that students develop and use in the materials. For example, the SEP category **Engaging in Argument from Evidence** is claimed as a focal SEP in the unit, but no specific elements are claimed, and it is not called out as an assessment target.

Science and Engineering Practices (SEPs) | Rating: Adequate

The reviewers found adequate evidence that students have the opportunity to use the SEPs in this unit. However, many claims are confusing, and some claims don't match the evidence of student use in the unit.

Asking Questions and Defining Problems

- *Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables.*
  - Lesson 6: This element is claimed. Students are scaffolded to write a research question, including a sentence stem, "A research question can often be stated as, 'What is the effect of (independent variable) on (dependent variable)?' Write your research question using two variables below" (Simulation Investigation, page 2).
  - Lesson 7: This element is claimed. After creating a model to show Texas in February, students choose variables to run a correlational analysis. While students develop and

test their correlational hypotheses to determine relationships, they are not asking questions to determine the relationship between these variables.

- *Ask questions to clarify and refine a model, an explanation, or an engineering problem.*
    - Lesson 1: This element is claimed. As students create the DQB, the teacher is told, "look for/listen for…questions about specific systems, for example the power plant, the wires, the building" (TE, page 44).
    - Lesson 2: This element is claimed. During an investigation using a power strip to model electrical distribution in a city, students ask questions to "clarify the role of individual buildings and other system components" (TE, page 70).
    - Lesson 3: This element is claimed. While students are participating in the model energy transfer activity, they are encouraged to ask clarifying questions if they are unsure of the focus for each scenario. "Discuss scenarios and identify areas of uncertainty in the models. Present slide K and use the slide prompts to elicit student ideas in a brief whole class discussion" (TE, page 88).
    - Lesson 10: This element is claimed. As students create an interview script, they are told, "Create questions that would clarify which considerations are most important to interested parties and create questions that can help identify a wide range of considerations important to interested parties" (TE, page 208).
    - Lesson 11: This element is claimed. "Reflect on the design challenge process. Take a moment and jot in your science to notebook any questions you have about the presentation changing your thinking. Record your questions about the complex process of making decisions for a community" (TE, page 222).
- *Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of a design.*
    - This element is claimed as being intentionally developed across the unit on page 5 of the Unit Overview but is not listed in the Elements of NGSS Dimensions document.
    - Lesson 3: This element is claimed. After analyzing graphs of electricity production and demand students participate in a scientist circle and use a decisions matrix to determine which scenarios explain what happened in Texas. "Build understanding about supply and demand mismatch as a class. Present slide S and give student partners the questions on the slide. What do you think was happening in people's homes at this moment when the temperature dropped? What questions do you have about the data from the graph? How do you think this data is connected to our models from scenarios A–E?" (TE, page 92),
    - Lesson 4: This element is claimed. While analyzing energy source supply graphs, students inquire about the presented data sets. "Ask students what they notice and wonder about the way this data is presented in each graph" (TE, page 105).
- *Ask questions that can be investigated within the scope of the school laboratory, research facilities, or field (e.g., outdoor environment) with available resources and, when appropriate, frame a hypothesis based on a model or theory.*
    - Lesson 7: This element is claimed, but only a small portion of the element is used. Students develop and test a correlational hypothesis based on data analysis using

CODAP in their classroom. However, they are not asking questions based on the information gathered during the data analysis.

- *Define a design problem that involves the development of a process or system with interacting components and criteria and constraints that may include social, technical, and/or environmental considerations.*
  - Lesson 1: This element is claimed. As students create the DQB, the teacher is told, "look for/listen for…questions that define specific local or global challenges" (TE, page 44). However, an example of a question that would define a challenge is not provided to the teacher, and it is unclear what that would look like.
  - Lesson 10: This element is claimed. Students define the problem when developing a script for collecting interested party feedback.
  - Lesson 11: This element is claimed. Students make arguments for why the region's current grid solution has costs and risks associated to define a design problem they will propose a solution to.

Developing and Using Models

- *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
  - Lesson 1: This element is claimed. Students are prompted, "Choose any two buildings in your community that have electricity. They can be close to each other or far apart. Model the system that brings power to those buildings. Add to your model to explain why one building might get enough energy to power lights and devices while the other does not" (TE, page 37).
  - Lesson 2: This element is claimed. The students' Power Strip Model handout scaffolds modeling. It asks students to, "Draw and label a diagram to help explain how the structures and connections in the power strip enable it to transfer energy from 1 source to multiple devices. Label key structures in the power strip, as well as the energy source and the devices." The teacher is told, "Remind students that whenever we develop a model in science, it is made for explaining something, and it isn't just a model of what we see. In other words, it seeks to help explain how and/or why something happens" (TE, page 61).
  - Lesson 5: This element is claimed. Students develop a model of energy transfer for the wind and gas plants before modeling energy transfer in the homemade generator.
  - Lesson 7: This element is claimed. "Create groups of three for students to create a model showing how insufficient supply of energy could have affected energy transfer into certain communities in Texas when the temperatures dropped." Teacher guidance for this task includes "Students use the energy transfer conventions that we developed in Lesson 3 to represent systems, and energy transfer between systems. Which subsystems students choose to include may vary but look for students to label systems clearly. At the least, students should include a power plant (or energy source), a transport system (or substation), and at least two communities (or homes/buildings in a community). (SEP:2.3)" (TE, page 165).

- Lesson 9: This element is claimed. Students are asked to, "complete two models to show how adding a battery to a system affects its reliability." A teacher sidebar says, "In middle school, students had practice developing and revising models to show the relationships among the variables of a system. In this unit, students will extend the use of this practice by using models to predict the relationships between systems. Use this as an opportunity to discuss two of the goals of developing models in science: to make predictions about the behavior of a system and to make our ideas visible to others. Getting students to revise their models can be a challenge if they think the expectation with modeling is to show a 'right' answer. Similar to Lesson 3, ask students to develop their models using pencils. This will make it easier to add or erase ideas" (TE, page 191).

- *Develop and/or use a model (including mathematical and computational) to generate data to support explanations, predict phenomena, analyze systems, and/or solve problems.*
  - Lesson 3: This element is claimed. After determining what data is needed to proceed, students use the developed energy transfer model to identify the need to quantify how much energy goes into the various parts of the system.
  - Lesson 6: This element is claimed. Students use a simulation to predict electrical energy transfer to improve the electric grid.
  - Lesson 7: This element is claimed. After finding the variable of interest related to hospitals, students use the R2 value to estimate how well the line fits the data in order to predict how many people lost power in a given county.
  - Lesson 11: This element is claimed. Students are asked, "How could we test our models to see what actually happens to an electric grid when supply cannot keep up with demand? Accept all ideas, but highlight ideas about using physical tests (wires, etc.) to try these things out. Students might also suggest a simulation or modifying our diagrammatic models" (TE, page 166).

Planning and Carrying Out Investigations

- *Manipulate variables and collect data about a complex model of a proposed process or system to identify failure points or improve performance relative to criteria for success or other variables.*
  - Lesson 2: This element is claimed. Students are asked to light up light bulbs using wires and a power strip (TE, page 58). There is no evidence that students use this SEP, as they are not collecting data about a complex model.
  - Lesson 7: This element is not claimed, but students use a simulation to gather data and to try to improve outcomes for the simulated parts of the system. Students are asked, "How could we test our models to see what actually happens to an electric grid when supply cannot keep up with demand? Accept all ideas, but highlight ideas about using physical tests (wires, etc.) to try these things out. Students might also suggest a simulation or modifying our diagrammatic models" (TE, page 166). The teacher is then told to focus students on what we could do to keep the lights on in some places. "Pose the last prompt on the slide: What does your class need to do to keep the lights on in the hospital?" (TE, page 168).

- *Plan and conduct an investigation or test a design solution in a safe and ethical manner including considerations of environmental, social, and personal impacts.*
    - Lesson 2: This element is not claimed, but it is referred to in a teacher note. “An important element of planning and conducting an investigation or testing of a design solution at the high school level is to do so safely and in an ethical manner, including considerations of the personal, societal, and environmental impacts. Establishing this as an explicit principle and referring to it often will help students start to use it as a default lens to evaluate what they or others propose to do before doing it, such as when they outline or critique the protocols or proposed/alternate procedures for an investigation” (TE, page 56).

Analyzing and Interpreting Data

- *Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.*
    - Lesson 7: This element is claimed. The teacher is told, “Introduce R as a value to estimate how well the line fits the data. Then show them the R value. Ask students if they have ever used a value like this before. Tell students that the R value on the line of best fit is known as the correlation coefficient. If R is close to 1, the line is a very good fit, and that variable helps us predict how many people lost power in a given county. If R is close to 0, the line is not a good fit, and the variable you chose does not help us predict how many people lost power in a county….Help students interpret the complexity of the result. Point out that R is pretty low, closer to zero than to 1. Explain that this doesn’t mean that hospitals or acute-care beds doesn’t [sic] help us explain the pattern of power outages, but that if there is a correlation, it probably isn’t the most important variable. It is probably one of many, many variables that can help us understand what happened. Some other variable might have been much more important, and will thus be much more predictive” (TE, page 170).
- *Consider limitations of data analysis (e.g., measurement error, sample selection) when analyzing and interpreting data.*
    - Lesson 7: This element is claimed. Students consider limitations on their analysis in order to seek information about patterns at a smaller grain size. This lesson is the only time students briefly use this element.
- *Evaluate the impact of new data on a working explanation and/or model of a proposed process or system.*
    - Lesson 3: This element is claimed. Students are given new data in the Electricity Production handout. A suggested prompt is given: “How does this data connect to our models from Scenarios A–E?” However, the “What to look for/listen for” for this performance doesn’t include information related to this particular SEP target. Instead, the teacher is told to look for evidence of students just analyzing data.

- *Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.*
  - Lesson 4: This element is claimed. Students analyze multiple types of data to identify characteristics of energy sources that increase the reliability of the energy grid.
  - Lesson 10: This element is claimed. Students analyze data from the interviews of interested parties they carried out to identify criteria for success that can inform the development of a plant to improve electricity infrastructure in their community.

Using Mathematics and Computational Thinking

- *Use mathematical, computational, and/or algorithmic representations of phenomena or design solutions to describe and/or support claims and/or explanations.*
  - Lesson 9: This element is claimed. After calculating the cost of the design solution, students use the same mathematical calculations to "determine if another energy storage solution might be more feasible for mitigating a crisis like the one in Texas and then use their calculations to support claims made about the feasibility" (TE, page 195).
- *Apply ratios, rates, percentages, and unit conversions in the context of complicated measurement problems involving quantities with derived or compound units (such as mg/mL, kg/m3 , acre-feet, etc.).*
  - Lesson 9: This element is claimed in the lesson but not in the Elements of NGSS Dimensions document, which says, "Students will apply ratios and unit conversions in the context of energy, costs, area, and efficiency problems involving quantities with compound units" (TE, page 3). In the lesson, the teacher is told, "Look for students to show units in their calculations, and the conversions they make for costs, efficiency, and land area of use" and "Support their claims about feasibility using their calculations" (TE, page 196).

Constructing Explanations and Designing Solutions

- *Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.*
  - Lesson 3: This element is claimed. Students use empirical data about energy supply and demand to revise the design solutions they are building in the unit about how to build a more reliable electrical system.
  - Lesson 10: Students read about tradeoffs associated with various energy sources before they develop their plan for improving the electricity infrastructure in their community.
  - Lesson 11: This element is claimed. Students design a solution, evaluate their peers' solutions, and then refine their solution to improve the electrical grid reliability in their community based on results from a computational model.

Engaging in Argument from Evidence

- This SEP category is claimed as a focal SEP, but no specific elements are claimed in the unit.

Obtaining, Evaluating, and Communicating Information

- *Compare, integrate and evaluate sources of information presented in different media or formats (e.g., visually, quantitatively) as well as in words in order to address a scientific question or solve a problem.*
    - Lesson 6: This element is claimed. Students read about fields and integrate that information with what they already learned in class (TE, pages 143–144). However, they do not evaluate sources of information during the lesson.
    - Lesson 8: This element is claimed. Students integrate information from a podcast and case studies to define some of the challenges and tradeoffs associated with a drop in energy supply. However, they do not evaluate sources of information during the lesson.

Disciplinary Core Ideas (DCIs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the DCIs in this unit because students are supported to fully develop most of the claimed DCIs throughout the unit and students use these DCIs in service of making sense of unit phenomena and designing solutions to the design problem. There are sufficient DCI elements included in the unit. However, three of the DCIs are briefly used. Therefore, students are not given the full opportunity to develop these.

ETS1.A: Defining and Delimiting Engineering Problems

- *Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.*
    - Lesson 8: This element is claimed. Students examine different sources of energy and identify important factors and trade-offs related to social, technical, and environmental considerations including energy efficiency, reliability, and renewability of resources. Students use a decision matrix to rank different energy sources. After reading about impacts of energy production, students identify an important trade-off and explain how engineers could use technology to address this trade-off.
    - Lesson 9: This element is claimed. Students explore how batteries can help build a more reliable electric grid. After comparing chemical batteries, students identify which battery was the best storage solution for the community, then they watch a video describing how chemical batteries work. Students participate in a jigsaw to learn more about the impact of raw material extraction and identify the social and environmental costs that need to be used when evaluating energy storage solutions.
    - Lesson 10: This element is claimed. Students evaluate solutions for energy storage using ideas about mechanical, thermal, and energy processes. After using the comparative matrices for energy storage solutions and the decisions matrix from a previous lesson, students identify that the alternative to chemical batteries that store energy could be an option but there are environmental issues that could impact the surrounding ecosystems.
    - Lesson 11: This element is claimed. Students reflect on the resources they have collected and how they can use those resources to make decisions. They justify their decisions using a combination of engineering ideas about criteria, constraints, trade-

offs, science ideas about energy loss to the environment, factors that affect energy transfer, and the components and interactions involved in energy transfer in the electricity grid.
- Throughout the unit, students learn about energy sources, but do not discuss clean water and food. This portion of the DCI was stricken out in Lesson 11.

ETS1.B: Developing Possible Solutions

- *When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.*
    - Lesson 3: This element is claimed. The teacher defines constraints for students and students are expected to discuss cost as a constraint. This portion of the lesson somewhat addresses this element.
    - Lesson 8: This element is claimed. Students examine different sources of energy and identify important factors and trade-offs related to social, technical, and environmental considerations including energy efficiency, reliability, and renewability of resources. Students use a decision matrix to rank different energy sources. After reading about impacts of energy production, students identify an important trade-off and explain how engineers could use technology to address this trade-off.
    - Lesson 9: This element is claimed. Students explore how batteries can help build a more reliable electric grid. After comparing chemical batteries, students identify which battery was the best storage solution for the community, then they watch a video describing how chemical batteries work. Students participate in a jigsaw to learn more about the impact of raw material extraction and identify the social and environmental costs that need to be used when evaluating energy storage solutions.
    - Lesson 10: This element is claimed. “Remind students that we (as a class) have not always agreed on what are the most important factors to consider. The costs and benefits are complicated, and difficult to quantify in terms of simple ratios, because the costs aren’t always financial, and some costs and benefits affect people differently” (TE, page 205).

PS2.B: Types of Interactions

- *Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.*
    - Lesson 5: This element is claimed. Students model a generator and make observations of the effects of the magnet in their generators. Students then observe that the generator can create a changing magnetic field.
    - Lesson 6: This element is claimed. Students read about electric and magnetic fields and use a water analogy to compare the flow of water in a pipe with the electric current within a wire. They use a simulation to explore how the different characteristics of electric systems could influence the transfer of electric energy.

    - Lesson 11: This element is claimed. Students complete the end of unit transfer task to develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy.

PS3.A: Definitions of Energy

- *"Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.*
    - Lesson 2: This element is claimed. Students create models of circuits and system diagrams to show how each part is connected and how the structure of the materials inside work together to generate electrical energy.
    - Lesson 3: This element is claimed. Students illustrate and model energy flow between components of the electric grid and energy loss from the system.
    - Lesson 5: This element is claimed. Students dissect a generator to better understand what is happening in the space between the magnet and wire to cause energy transfers without anything touching.
- *At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.*
    - Lesson 5: This element is claimed. Students build a generator system to transfer motion energy to light.
    - Lesson 6: This element is claimed. Students use a simulation to model electron flow inside a wire before answering questions to determine electrical energy transfer.
- *Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. That there is a single quantity called energy is due to the fact that a system's total energy is conserved, even as, within the system, energy is continually transferred from one object to another and between its various possible forms.*
    - Lesson 6: This element is claimed. Students use a simulation to model electron flow inside a wire before answering questions to determine electrical energy transfer.
    - Lesson 8: This element is claimed. Students analyze different energy sources to determine that most of the sources used in electricity generation are a part of different earth's systems.
- *These relationships are better understood at the microscopic scale, at which all of the different manifestations of energy can be modeled as a combination of energy associated with the motion of particles and energy associated with the configuration (relative position of the particles). In some cases the relative position energy can be thought of as stored in fields (which mediate interactions between particles). This last concept includes radiation, a phenomenon in which energy stored in fields moves across space.*
    - Lesson 5: This element is claimed. Students are introduced to the field's energy transfer model to keep track of energy inputs, outputs, and transfers between subsystems.
    - Lesson 6: This element is claimed. Students use a simulation to model electron flow inside a wire before answering questions to determine electrical energy transfer.
    - Lesson 8: This element is not claimed, but students use part of it in the expected student response, "Listen for students to recognize that if energy going into a grid is spread too

thin there will not be sufficient energy in the system to keep electrons in the wires moving fast enough" (TE, page 181).

PS3.B: Conservation of Energy and Energy Transfer

- *The availability of energy limits what can occur in any system.*
    - Lesson 3: This element is claimed. Students analyze an electricity demand forecast and evaluate the impact of energy supply and demand in Texas in February 2021.
    - Lesson 4: This element is claimed. Students identify characteristics of energy sources derived from Earth's systems and determine that, for the grid to remain stable, it must be designed for energy supply to meet energy demand.
    - Lesson 7: This element is claimed. After developing a model showing how insufficient supply entering a system could lead to a building losing power, students discover patterns in decision making in Texas during the February 2021 power outage.
    - Lesson 9: This element is claimed. Students evaluate different energy storage systems by calculating their costs based on energy storage capabilities.
- *Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.*
    - Lesson 5: This element is claimed. Students look at energy transfer at the particle level by generating data to explore how factors that affect energy transfer inside a wire could account for what happened in Texas in 2021.
    - Lesson 6: This element is claimed. Students develop a model that includes three bounded systems made up of subsystems to illustrate the energy transfer relationships between the systems.
- *Conservation of energy means that the total change of energy in any system is always equal to the total energy transferred into or out of the system.*
    - Lesson 9: This element is claimed. Students evaluate different energy storage systems by calculating their costs based on energy storage capabilities. This is the only time students interact with this element. Therefore, they are not likely to develop an understanding of it.

PS3.C: Relationship Between Energy and Forces

- *Although energy cannot be destroyed, it can be converted to less useful forms — for example, to thermal energy in the surrounding environment.*
    - Lesson 6: This element is claimed. The teacher prompts the students, "Call on students' previous knowledge of 'energy cannot be created or destroyed' as they try to add numbers to their models. Say, *I see that __ energy goes into the substation, but only __ comes out. Where did that extra __ energy go?* Encourage students to explore the limitations of their models. Say, *Are you certain of the exact amount of energy that transfers in your models? What are you certain of? Where can you use a question mark to show you're less certain?"* (TE, page 88). This is the only time students interact with this element. Therefore, they are not likely to develop an understanding of it.

ESS3.A: Natural Resources

- *All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.*
    - Lesson 4: This element is claimed. Students look at energy sources used in Texas and rank them by reliability using the decision matrix. This is the only time students interact with this element. Therefore, they are not likely to develop an understanding of it.
    - Lesson 11: A student handout says, “All forms of energy production and other resource extraction have associated costs and risks as well as benefits. Use evidence from our readings, data analysis, and the Energy Grid Calculator to make an argument for why our region’s current grid solution has costs and risks associated with it, as well as benefits.” However, this is the only time this element is referred to in this lesson. Therefore, students are not likely to develop an understanding of it.

Crosscutting Concepts (CCCs) | **Rating: Adequate**

The reviewers found adequate evidence that students have the opportunity to use or develop the CCCs in this unit. However, there are frequent mismatches between claims and what CCC understanding is evident in student performances.

The Teacher Handbook lists example prompts to support student use of the CCCs to ask questions. However, the specific examples that are given currently relate to CCC elements at an elementary level (**Systems and System Models**) and a middle school level (**Structure and Function**), even though they are included in the high school-level Teacher Handbook.

Patterns

- *Empirical evidence is needed to identify patterns.*
    - Lesson 3: This element is claimed. However, the idea of empirical evidence is not explicit in the lesson. Students identify patterns in data and the teacher is told to look for, “Reasonable inferences about patterns that emerge from the data” (TE, page 93). There is no discussion or associated teacher “look fors” related to the need for empirical evidence.
- *Patterns of performance of designed systems can be analyzed and interpreted to reengineer and improve the system.*
    - Lesson 6: This element is claimed. Students fill in their Engineering Design Trackers and are asked to, “choose a conclusion that clearly connects to re-engineering and improving our grid” (TE, page 154). Students then use the scientific ideas they learned in class to propose re-engineered design solutions. The teacher is told to look for ideas like “Larger diameter wire means less energy loss, more electric current → Large diameter wires should be used instead of smaller wires” (TE, page 155). The idea of patterns of performance is not explicit in the lesson, but students likely build toward this idea implicitly.
    - Lesson 11: This element is claimed. Question 3 of the Design Challenge handout says, “The Energy Grid Calculator is a computational model that can be used to aid in the

engineering design process. Refine an engineering solution in your copy of the Energy Grid Calculator to reflect their priorities, then summarize in words and diagrams, a) the changes you've made to our region's current grid solution, and b) the predicted impact those changes will have" (TE, page 221).

Cause and Effect

- *Cause and effect relationships can be suggested and predicted for complex natural and human designed systems by examining what is known about smaller scale mechanisms within the system.*
    - Lesson 6: This element is claimed. Students model energy transfer, and the teacher is told to look for student discussion that includes the idea, "We can use particle-scale mechanisms for interactions between particles and fields to identify cause-effect relationships for larger systems like a wire" (TE, page 144). Later in the lesson students discuss their experimental results and the teacher is told to look for the idea that, "Electrons move inside the wire, pushed by the electric field. This causes energy to transfer to devices like the light bulb" (TE, page 151), indicating that students are able to connect causal mechanisms at different scales.
- *Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.*
    - Lesson 7: This element is claimed. Students are asked, "Is there a correlation between the two variables we chose to look at? What conclusions can we make about our hypothesis from this analysis? Does this analysis tell us anything about what caused the crisis?" (TE, page 170). Students compare datasets and discuss the limitations of different datasets, but this discussion does not include differentiating what kind of data could come from empirical evidence or the need for empirical evidence.

Scale, Proportion and Quantity

- *Patterns observable at one scale may not be observable or exist at other scales.*
    - Lesson 5: This element is not claimed but some guidance is provided to help students begin building toward it. The teacher is told, "Some students may know that electrons are moving in the wires. Tell them this is an interesting idea, and ask them what evidence we see in the diagram for that matter change. Then say, It's not in the diagram, but let's keep that idea on the table and come back to it, because it could help explain what's happening if we zoomed in on those wires. Let's think at a larger scale for now, and then we'll zoom to a particle scale afterward" (TE, page 116).
    - Lesson 7: This element is claimed. Students are asked, "What patterns do you predict we will see if we could zoom in to the counties where some, but not all people lost power?" (TE, page 171).

- *The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs.*
    - Lesson 9: This element is claimed. Students compare quantities to determine the most feasible energy solution (TE, page 196). The "quantity" part of this element is therefore implicitly built toward.

Systems and Systems Models

- *Systems can be designed to do specific tasks.*
    - Lesson 1: This element is claimed. In the lesson students model their initial ideas of electrical systems, but there is no evidence that students consider this element. At the end of the lesson the teacher tells students, "we also have a lot of questions that are more general and could help us design solutions for our own communities and other communities around the world." The teacher is then told, "Pick out 2–3 questions on the DQB that are related to local and/or global systems and point to them now" (TE, page 44). Students might therefore build toward this element, but there is no evidence that student questions will include mention of systems.
    - Lesson 5: This element is claimed. After examining the generator component in a wind turbine system and natural gas plant, students examine a dissected generator before designing their own generator to light up multiple LEDs or light up an LED for a longer period of time.
- *Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions — including energy, matter, and information flows — within and between systems at different scales.*
    - Lesson 2: This element is claimed. Students diagram a power strip and then discuss how the power strip can be used as a model of a building's electrical system. However, the class is more likely to represent systems rather than to simulate systems, and therefore more likely to use the Grade 6–8 element, *Models can be used to represent systems and their interactions — such as inputs, processes and outputs — and energy, matter, and information flows within systems* than to use the claimed high school-level element. Later, the teacher demonstrates a simulation of energy flows between systems, helping students build toward this element. After the demonstration, the teacher is told, "Have students turn and talk to discuss how this model shows how multiple buildings in a neighborhood could get electricity from one energy source. Explain that a typical substation has a similar function as the power strip in this system, serving as a common junction point for distributing energy to multiple customers" (TE, page 70).
    - Lesson 3: This element is claimed. Students develop and compare models of energy transfer, and are asked, "How did you clearly show how much energy goes to which subsystems?" (TE, page 87). The teacher is told to look for, "Modeling energy transfer across more than one system (e.g., the power plant, substation, and buildings) and using question marks to indicate areas of uncertainty" (TE, page 88).
    - Lesson 6: This element is not claimed, but students use a simulation that models electrons and current. The teacher is told, "Say, We know that this simulation is a

model, and that this model is only useful if the predictions it makes actually match results in real life. What do you think the 'ammeter' is measuring? Why? What does the 'energy loss to the surroundings' percentage tell us?" (TE, page 148).

- *When investigating or describing a system, the boundaries and initial conditions of the system need to be defined and their inputs and outputs analyzed and described using models.*
    - Lesson 1: This element is not claimed, but it is developed. The teacher facilitates development of a consensus class model and is told to point out, "that we are bounding our subsystems based on the role they play in getting energy to buildings as part of the system as a whole" (TE, page 40).
    - Lesson 3: This element is not claimed, but a teacher prompt could help students develop it. "One of the main challenges students face when using systems thinking is defining what belongs to the system under investigation and what belongs to the surroundings. To support development of systems thinking throughout this unit, we suggest using similar prompts whenever we analyze a system. By using similar prompts across contexts, students will understand that defining the boundaries of any system depends on the question being answered" (TE, page 83).
    - Lesson 7: This element is not claimed, but a student prompt supports student development of this element, "How will we bound our system to show energy loss?" (TE, page 164).
- *Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems* (Grade 6–8 element)
    - Lesson 1: This element is not claimed but is used. The teacher tells the students, "'Sometimes scientists and engineering calls systems that make up other systems subsystems'…Spend some time helping students simplify into systems with subsystems" (TE, page 39). The teacher is then told, "point out that systems can have multiple subsystems or components" (TE, page 40).

Energy and Matter

- *The total amount of energy and matter in closed systems is conserved.*
    - This element is claimed as being intentionally developed across the unit on page 5 of the Unit Overview but is not listed in the Elements of NGSS Dimensions document.
    - Lesson 11: Students are asked, "How did our investigations over the course of this unit help us build a foundation for understanding energy conservation and energy transfer that we can take forward into the rest of the year?" (TE, page 224).
- *Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.*
    - Lesson 1: This element is not claimed but is used. Suggested teacher prompts include, "How is energy being transferred in the next system?" (Sample student responses include, "electricity moving or flowing…movement of charged particles…particles moving through the wire in some systems").
    - Lesson 5: This element is claimed. In the beginning of the lesson, students are asked, "How does matter move and change in the wind turbine system? What components and interactions represented in the diagram show this?" (TE, page 116).

  - Lesson 7: This element is claimed. Students show how an insufficient energy supply could lead to reduced energy transfer into certain communities in Texas when the temperatures dropped.
  - Lesson 8: This element is claimed. Students define challenges and tradeoffs associated with a drop in energy supply driven by cold weather describing changes in terms of energy flows into and out of the system.
  - Lesson 9: This element is not claimed, but a teacher side bar describes supports for helping students use it, “One of the advantages of the energy transfer model is that it allows students to draw connections between energy flow and energy conservation. By using quantitative thinking to illustrate the amount of energy that flows across the different systems, the energy that is lost to the surroundings, and the matter interactions behind the flow of energy, students can make sense of reliability and energy conservation through a mechanistic lens. Use this energy transfer model to elicit student ideas about interactions in the system and energy flow. Use prompts such as: how do we know there is energy in the system? Does all the energy transfer from this component to the next? Where does the energy go?” (TE, page 192).
- *Energy cannot be created or destroyed — only moves between one place and another place, between objects and/or fields, or between systems.*
  - Lesson 1: This element is not claimed, but is used when students are asked to respond to the prompts, “Where does the energy come from to power the electrical devices in each of those buildings? What happens to the energy in this system that would have been used to power the electrical devices in each building during a blackout?” (TE, page 37).
  - Lesson 3: This element is not claimed but is referenced in the lesson. “Call on students’ previous knowledge of ‘energy cannot be created or destroyed’ as they try to add numbers to their models. Say, I see that __ energy goes into the substation, but only __ comes out. Where did that extra __ energy go?” (TE, page 88).
  - Lesson 7: This element is claimed. Students model energy transfer, and the teacher is given the following “look for”, “Students use numbers, dots, or some other quantitative representation to show that the amount of energy entering the system is equal to the amount of energy available to homes, minus any energy lost to the surroundings” (TE, page 165). Students therefore use part of this element in the lesson.
  - Lesson 8: This element is claimed. Students are asked to discuss after they listen to a podcast. The teacher is told, “Listen for students to recognize that if energy going into the grid is spread too thin there will not be sufficient energy in the system to keep electrons in the wires moving fast enough” (TE, page 181). This indicates that students are supposed to know that energy in a system is finite.

Structure and Function

- *Investigating or designing new systems or structures requires a detailed examination of the properties of different materials, the structures of different components, and connections of components to reveal its function and/or solve a problem.*
    - Lesson 2: This element is claimed. Students are asked to closely examine and model a circuit in order to help figure out which parts need to be connected to light bulbs. Students might therefore implicitly begin building toward this idea but are more likely to use the middle school-level element *Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.*

Stability and Change

- *Much of science deals with constructing explanations of how things change and how they remain stable.*
    - Lesson 1: This element is claimed. Students are asked to describe a change in a system (TE, page 37), but are not asked to use an understanding of this high school-level CCC element. They might instead use one of the corresponding middle school-level elements, such as "*small changes in one part of a system might cause large changes in another part*."
- *Systems can be designed for greater or lesser stability.*
    - Lesson 1: This element is not claimed in learning goal charts, but a teacher note on page 40 of the Teacher Edition says, "This model is an opportunity for students to start thinking about how systems can be designed for greater or lesser stability."
    - Lesson 4: This element is claimed. The teacher is told, "Listen for them to point out that power outages are dangerous, and that providing power in a predictable, stable way is the fundamental purpose of the electric grid" (TE, page 104).
    - Lesson 9: This element is claimed. Students consider the conditions that can make a system more reliable by modeling how a battery can affect the behavior of a grid during a supply drop. An example student answer says, "Even if the supply drops a small percentage, the energy stored in the batteries would allow power companies to fill the gap between energy supply and demand" (Modeling Reliability Key, page 3). Students therefore implicitly build toward this element, although the notion of stability is not explicitly discussed.
    - Lesson 10: This element is claimed. As the class discusses their interview protocols, the teacher is told, "Tell them that we are considering solutions to improve the reliability of our power systems, and meet the needs of our local and global community. Make sure they understand what reliability is, and provide a definition if necessary" (TE, page 208). Students therefore implicitly build toward this element, although the notion of stability is not explicitly discussed.
    - Lesson 11: This element is claimed. Students are asked, "How did our investigations over the course of this unit help us understand what structures can function to make our energy systems stable, even when conditions change?" (TE, page 224).

Suggestions for Improvement

General

- Consider clarifying and aligning claims throughout the unit.

Science and Engineering Practices

- Consider having students analyze and interpret data in Lessons 5–7. This would give students more opportunities to build understanding of the **Analyzing and Interpreting Data** elements.

Disciplinary Core Ideas

- Consider clarifying DCI claims or providing additional explicit learning supports to ensure students have opportunities to develop all claimed DCI elements.

Crosscutting Concepts

- Consider making use of the CCC elements explicit for students such that they could recognize their use and employ the elements again in other contexts independently.
- Think about increasing the opportunities for students to discuss CCC ideas explicitly to help them build awareness of the usefulness of these concepts for sense-making and problem solving.

I.C. INTEGRATING THE THREE DIMENSIONS

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

Rating for Criterion I.C. Integrating the Three Dimensions	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that student performances integrate elements of the three dimensions in service of figuring out phenomena and designing solutions to problems. Students have several opportunities to engage in multi-dimensional learning in service of problem solving or sense-making. The section titled “What Students Will Do” at the beginning of each lesson highlights the three-dimensional learning goals and the specific elements of the dimensions that will be used in the lesson.

The following student sense-making tasks of the phenomenon included elements of all three dimensions:

- Lesson 2: Students dissect a power strip to better understand analogous structures that show how systems (CCC: **Systems and System Models**) transfer electrical energy (DCI: **PS3.B**) before developing a model (SEP: **Developing and Using Models**) to showcase their understanding.

- Lesson 3: Students use previous knowledge of energy (DCI: **PS3.B)** to revise their models (SEP: **Developing and Using Models**) in order to determine the amount of energy (CCC: **Energy and Matter**) coming into the substation is equal to the total amount of energy leaving the substation.
- Lesson 4: Students gather information about Texas energy sources that are derived from Earth's systems by analyzing data (SEP: **Analyzing and Interpreting Data**) before ranking them by reliability to determine that the system (CCC: **System and System Models**) must remain stable by keeping the energy supply equal to the energy demand (DCI: **PS3.B**).
- Lesson 7: Students develop a model (SEP: **Developing and Using Models)** to show the effect of insufficient energy supply (CCC: **Energy and Matter**) and how it can lead to reduced energy transfer which results in buildings losing power (DCI: **PS3.B**).
- Lesson 9: Students develop an energy transfer model (SEP: **Developing and Using Models**) to predict the stability (CCC: **Stability and Change**) in the distribution of electric energy (DCI: **PS3.B**).
- Lesson 10: Students define the problem and ask questions (SEP: **Asking Questions and Defining Problems**) of interested parties in their community to make decisions about making the electrical infrastructure more stable (CCC: **Stability and Change**) while considering social, cultural, and environmental impacts (DCI: **ETA1.B**).

Suggestions for Improvement

- Consider providing additional opportunities for students to clearly use high school-level CCC elements in their sense-making and problem solving for students to have more three-dimensional learning opportunities in the unit.

I.D. UNIT COHERENCE

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.

Rating for Criterion I.D. Unit Coherence	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that lessons fit together coherently to target a set of performance expectations (PEs) because most lessons build on prior lessons and many times this is apparent to students. Across lessons, there is evidence that students should refer to prior lessons to figure out what caused the power crisis in Texas. Students work toward developing proficiency in most, but not all, targeted PEs in most lessons.

Most lessons build on prior lessons in a way that makes sense from students' perspectives by engaging students in asking questions based on what they've learned so far or pursuing relevant questions unanswered in the previous lesson.

Related evidence includes:

- The unit uses a DQB to cultivate student questions. The DQB is used in Lessons 1, 2, and 11.
- Lesson 1 concludes with home learning where students have to capture images of electricity infrastructure in their community. Lesson 2 begins with introducing the navigation routine and students sharing their images from the previous lesson (TE, page 55). Lesson 3 begins with the navigation routine and recapping the investigation from Lesson 2 (TE, page 80).
- Lesson 2: The teacher is told to say, "Last time, we kicked off the start of a new unit by building a Driving Question Board to keep a record of what we are wondering. Now we will work together to make progress on those questions over the next several weeks. At the beginning of the day, or of a new lesson, we will use navigation to help us make connections between what we figured out the last time and what we want to do next… Start by recapping the first two bullets of questions on the slide to remind students why we wanted to capture images of electricity infrastructure in our community" (TE, page 55).
- Lesson 2: Investigation B may not seem coherently linked to the rest of the unit from the students' perspective, as they are not supported to see why they are trying to make light bulbs match a certain level of brightness.

- Lesson 2: The class diagrams a power strip and then diagrams the electrical system in a building. However, the teacher is told to introduce both activities in the same way. “Say, Let’s develop a map of some of those basic structures in both systems—a power strip and a building--so we can better understand how these systems function” (TE, page 63). “Say, Let’s develop a map of what some of those basic structures are in both systems--a power strip and a building--so we can better understand how these systems function” (TE, page 67). This repetition — rather than connecting the two different steps — might be confusing to students.
- Lesson 2: The teacher is prompted to summarize the lesson and connect it to the previous lesson. “Say, In this lesson, we figured out how a circuit is needed to transfer energy from a source to electricity-powered devices. Have students talk with a partner for 1–2 minutes about the question below and then discuss it as a class. Suggested Prompt: What new ideas or new questions does this raise for you about our Texas case study?” (TE, page 72).
- Lesson 3: The teacher is told, “Orient the class to where we left off…. What did we see last class when there was a short circuit in our city?” (TE, page 80).
- Lesson 3 introduces the Engineering Design Tracker (TE, page 81) and students return to it in Lessons 6, 9, 10, and 11.
- Lessons 3, 5, and 6 end with an Exit Ticket. Lessons 4, 5, and 6 begin with the Exit Ticket from the previous lessons during the navigation routine.
- Lesson 4: The lesson begins with a reflection on the prior lesson. “Remind students that at the end of the last class, we completed an exit ticket. Tell them that most people wanted to know more about the sources of energy in Texas, because we saw a big drop in energy supply in February 2021” (TE, page 101).
- Lesson 4: As students look at graphs, the teacher is told, “Remind students that we looked at this graph in Lesson 3, and that we were concerned about the gap between how much energy was being supplied and how much energy people wanted to use” (TE, page 105). This helps students make connections between the current and prior activities.
- Lesson 4: Students are supported to see the usefulness of their prior activities for their current work. “Ask students whether we might want to include any other criteria that came up in our investigations over the past few days. Suggest that they look back at the factors they recorded in their notebooks during the gallery walk, the Factors that May Impact Reliability poster, and/or the Source Cards Full Page” (TE, page 107).
- Lesson 5: As students work on design challenges, the teacher is told, “Move around the classroom with the dissecting generator and ask probing questions to make sure that students are making connections between what they are doing and our questions about how generators work” (TE, page 123).
- Lesson 7: “Give students time to add to their progress trackers. Students may sketch an energy transfer model or a representation of the Electric City Demo” (TE, page 172).
- Lesson 8 ends with the teacher prompting students to consider additional solutions for a crisis. “Could we apply a similar solution to prevent a crisis in real life, and avoid having to make inequitable tradeoffs? We will explore this more next time” (TE, page 185). Lesson 9 begins with students returning to their answers from this question in Lesson 8. This is a missed opportunity to return to the DQB.

- Lesson 9 concludes with home learning reading, and it is briefly referenced in the navigation routine to begin Lesson 10. This is a missed opportunity to have students make the connections between Lessons 9 and 10.

In the Unit Overview, the following NGSS PEs are listed as targets that the unit is "building towards." The following notes are provided about the superscript notation in the PE claims listing:

- "*This performance expectation is developed across multiple units. This unit reinforces or works toward these NGSS PEs that students will develop more fully in future units.
- †This performance expectation is developed across multiple courses. This unit reinforces or works toward these NGSS PEs that students will have previously developed in the OpenSciEd chemistry and/or biology courses" (Unit Overview, page 12).

However, the extent to which the claimed PEs are developed in the unit is not described (see Criterion I.B for evidence related to each element):

- **HS-PS2-5*** *Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.* Note that this PE is listed on page 14 but not page 1.
- **HS-PS3-1*** *Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.* Note that this PE is designated with a * on page 1 but with a † on page 14.
- **HS-PS3-2** *Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects).* Note that this PE is designated with a † on page 14 but not on page 1.
- **HS-PS3-3** *Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.* This PE is mostly developed; evidence for one of the DCIs could not be located in the unit.
- **HS-PS3-5*** *Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the changes in energy of the objects due to the interaction.* Note that this PE is designated with a * on page 1 but with a † on page 14.
- **HS-ESS3-2†** *Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* This PE is only addressed in Lesson 4.
- **HS-ETS1-3** *Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.* Note that this PE is designated with a † on page 14 but not on page 1.
- **HS-ETS1-4†** *Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.* Note that this PE is listed on page 14 but not page 1.

Suggestions for Improvement

- Consider clarifying the PE claims in the unit to describe the degree to which they are intended to be developed in this unit.
- Consider providing additional opportunities to cover PE **HS-PS3-1** and/or **HS-PS3-2**. These two PEs are partially developed and could be easily fully developed if additional lessons were added. Think about removing additional secondary PEs to clarify the focus of the unit.

I.E. MULTIPLE SCIENCE DOMAINS

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.

Rating for Criterion I.E. Multiple Science Domains	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that links are made across the science domains when appropriate because the phenomenon of the power crisis in Texas and design problem (improving the reliability of our elective infrastructure) can be fully addressed with the targeted physical science (PS) domain. However, the CCCs are not used explicitly to make connections across science domains.

Related evidence includes:

- The anchoring phenomenon is mostly explained using the DCIs **PS3.A: Definitions of Energy** and **PS3.B: Conservation of Energy and Energy Transfer**. Most of the lessons (6 of 11) are explained through these DCIs.
  - Lesson 6: Students use a simulation to model electron flow inside a wire before answering questions to determine electrical energy transfer.
  - Lesson 7: After developing a model showing how insufficient supply entering a system could lead to a building losing power, students discover patterns in decision making in Texas during the February 2021 power outage.
  - Lesson 8: Students analyze different energy sources to determine that most of the sources used in electricity generation are a part of different earth systems.
  - Lesson 9: Students evaluate different energy storage systems by calculating their costs based on energy storage capabilities.

- The DCIs **PS2.B: Types of Interactions** and **PS3.C: Relationship Between Energy and Forces** are partially explained in Lessons 5 and 6.
    - Lesson 5: Students model a generator and make observations of the effects of the magnet in their generators. Students then observe that the generator can create a changing magnetic field.
    - Lesson 6: Students read about electric and magnetic fields and use a water analogy to compare the flow of water in a pipe with the electric current within a wire. They use a simulation to explore how the different characteristics of electric systems could influence the transfer of electric energy.
- The DCI **ESS3.A: Natural Resources** is identified as prerequisite learning from previous units and is only addressed in Lesson 4. Evidence to support connections between Earth and space science (ESS) and PS domains using CCCs was not located.
    - Lesson 4: The teacher is told, "Listen for them to point out that power outages are dangerous, and that providing power in a predictable, stable way is the fundamental purpose of the electric grid. Remind students that in Lesson 3, they saw that energy supply and demand matched before the energy crisis and that the gap between supply and demand was the largest during the blackout" (TE, page 104). This is a missed opportunity for teachers to support students in making the connection between stability and energy sources derived from earth's systems. The CCC of **Energy and Matter** could also be tied to this lesson.

Suggestions for Improvement

Consider supporting student use of CCC elements and their understanding of the utility of CCC elements to help explain phenomena related to different domains.

I.F. MATH AND ELA

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.

Rating for Criterion I.F. Math and ELA	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide grade-appropriate connections to the Common Core State Standards (CCSS) in mathematics, English language arts (ELA), history, social studies, or technical standards. Specific standards for both ELA and mathematics are noted at the end of the lessons. Mathematics topics are used at appropriate times when needed and writing experiences are used for students to show their understanding. Varied grade-appropriate reading materials are used throughout the unit and students have multiple opportunities to meaningfully engage in speaking and listening practices.

Students have many opportunities to use ELA/Literacy standards to express their science understanding. For example:

- Tools, such as the DQB and Scientist Circle, are used throughout the unit to support students in practicing their speaking and listening skills.
- Throughout the unit students are engaged in multiple discussion types to support students in communication through productive science talk.
  - The OpenSciEd High School (HS) Teacher Handbook states, "OpenSciEd units use specific types of discussions to help draw out student ideas, negotiate and refine them, and support students in communicating with one another in scientific ways: Initial Ideas Discussions, Building Understandings Discussions, Consensus Discussions" (page 40).
  - Class discussions include strategies such as Think-Pair-Share, Turn and Talk, and Gallery Walks.

The CCSS are listed at the end of the appropriate lessons where they are used or developed, and a short description of what students are doing in support of the standard is included. Some examples include:

- **CCSS.ELA-Literacy.RST.11-12.2**: *Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.*
  - Lesson 1: Students read a series of articles about the blackout in Texas in February 2021. They use a jigsaw structure to summarize their articles for their peers by paraphrasing them.
  - Lesson 2: Students contribute ideas identified from Electricity Related Parts to develop and identify analogous structures in a model for circuits in a building.
  - Lesson 4: Students synthesize information from the Source Cards Full Page to develop the energy transfer model for each energy source.
- **CCSS.ELA-Literacy.RST.11-12.5**: *Analyze how the text structures information or ideas into categories or hierarchies, demonstrating understanding of the information or ideas.*
  - Lesson 4: Students sort the Source Cards Full Page into different categories using the information presented in the text.
- **CCSS.ELA-Literacy.RST.11-12.3**: *Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.*
  - Lesson 5: Students test the effect of the configuration of the magnets and the rotation of a generator on the transfer of energy in a wire. They use their results to consider the constraints of building a generator.
- **CCSS.ELA-Literacy.RST.11-12.4**: *Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11–12 texts and topics.*
  - Lesson 6: Students identify the main ideas from a reading about charged particles to determine the model that best reflects the interactions between electrons in a wire.

- **CCSS.ELA-Literacy.RST.11-12.7**: *Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address or solve a problem.*
    - Lesson 8: Students read a transcript and listen to an interview with an energy professional and use details from the interview to help answer the question of why some people lost power in Texas and why others did not.
- **CCSS.ELA-Literacy.RST.11-12.9**: *Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.*
    - Lesson 10: Students weigh the values and priorities from the different interested parties they interview and decide the ranking of the criteria represented in the consensus decisions matrix.
- **CCSS.MATH.CONTENT.HS. S-ID.9**: *Interpreting Categorical and Quantitative data: Distinguish between correlation and causation.*
    - Lesson 8: Students listen to a podcast where a scientist explains why it is hard to find a correlation with the type of data students used and the distinction between correlation and causation.
- **CCSS.MATH.CONTENT.HSS.ID.8**: *Compute (using technology) and interpret the correlation coefficient of a linear fit.*
    - Lesson 7: Students use the data visualization and analysis tool to identify the correlation coefficient of a linear fit between different demographic variables and the percentage of people who lost power.
- **CCSS.MATH.CONTENT.HSS.ID. B.6c**: *Represent data on two quantitative variables on a scatter plot and describe how the variables are related. Fit a linear function for a scatter plot that suggests a linear association.*
    - Lesson 7: Students explore issues with the scale of the data used to explain lack of correlation and reasons for why causal relationships cannot be drawn from a correlation in this context.
- **CCSS.MATH.CONTENT.HS. N-Q.2**: *Quantities: Define appropriate quantities for the purpose of descriptive modeling.*
    - Lesson 3: Students use the energy transfer model which uses a quantitative approach to make sense of energy transfer and to determine whether the amount of energy increases or decreases as the energy flows across.
    - Lesson 9: Students continue using quantitative reasoning to consider how to model the role of a battery in the flow of energy in a system.
- **CCSS.MATH.CONTENT.HS. N-Q.1**: *Quantities: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
    - Lesson 9: Students will apply rations and unit conversions to calculate the costs and land area of use of different energy storage systems.
    - Lesson 11: Students complete the Sands and Mirrors assessment which includes units and multiple processes.

- **CCSS.MATH.CONTENT.HS. N-Q.1:** *Quantities: Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.*
    - Lesson 11: Students complete the Sands and Mirrors assessment which includes units and multiple processes.

Suggestions for Improvement

None

OVERALL CATEGORY I SCORE: **2** (0, 1, 2, 3)	
Unit Scoring Guide – Category I	
Criteria A-F	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

CATEGORY II

NGSS INSTRUCTIONAL SUPPORTS

II.A. RELEVANCE AND AUTHENTICITY

II.B. STUDENT IDEAS

II.C. BUILDING PROGRESSIONS

II.D. SCIENTIFIC ACCURACY

II.E. DIFFERENTIATED INSTRUCTION

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

II.A. RELEVANCE AND AUTHENTICITY

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.

Rating for Criterion II.A. Relevance and Authenticity	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials engage students in authentic and meaningful scenarios that reflect the real world because students are provided with experiences to engage in the phenomenon of the February 2021 Texas power outage as firsthand as possible while making numerous connections to their own lives and communities. The phenomenon is authentic to students when they read firsthand accounts of the blackouts and then consider the needs of stakeholders in their communication plans. Guidance for teachers on how to support students in their social emotional learning throughout the unit is provided.

Students experience the phenomenon through photographs, reading selections, and podcasts. Related evidence includes:

- Lesson 1: Students participate in a jigsaw activity and read articles about the Texas blackouts.
- Lesson 7: Students examine satellite images that capture three of the four largest cities in Texas the night of the power outages.
- Lesson 8: Students listen to a podcast from a scientist whose research group used satellite data to investigate patterns in who lost power in Texas.

The phenomena and problems are relevant to students and students have opportunities to connect the activities and phenomena to their lives. For example:

- Page 11 of the Teacher Edition provides multiple reasons for why the anchoring phenomenon was chosen. “The Texas blackouts phenomenon was chosen from a group of phenomena aligned with the target expectations based on the results from a survey administered to almost 10,000 students from across the country.”
- The anchor phenomenon is a real-world phenomenon and students are shown how it affects real people, making the phenomenon more relevant. “Present slide A and read the slide aloud: In February 2021, over 11.8 million Texans lost access to electricity to heat and light their

homes, store their food, and charge their devices. For many people, the power outages lasted for several days. Hundreds of people died as a result. Then move to slide B. Ask students if they heard about this or knew anybody who was impacted. Give students a minute or two to share their ideas with the person next to them. Acknowledge that this story can be upsetting, and that people lost their lives as a result of these power outages" (TE, page 34). Students are also asked to reflect on the effects of the storm personally. "What do you think it was like to experience a power outage like this?" (TE, page 32).

- Lesson 1: Students' homes and communities are framed as a fund of knowledge. "Look for students to suggest asking friends and family. Say, I bet there is a lot we can learn from your stories, and the stories of those in your families and communities. Let's gather some of these stories for next time" (TE, page 34). "Each student will have two minutes to share one of the stories they recorded when they spoke to their friends and family…When each person has gotten a chance to share, students should discuss the questions they responded to as an exit ticket last time on the second part of the slide, informed now by the additional funds of knowledge from their families and communities: How do you think your community gets power? How is this different or the same as Texas?" (TE, page 34).
- Lesson 1: Students are told, "Observe the electricity infrastructure that you see at school, at home, and on your way to and from school. Make a record of what you see, either by taking photos, or if you would prefer, making a sketch. This may include wires, outlets, or anything else you see that might be related" (TE, page 45).
- Lesson 2: When sharing pictures from home learning students are asked, "What are some of the things you noticed across the photos you took of the structures that you found inside and outside of buildings? Alost of us noticed outlets of many kinds. What patterns did you notice across the outlets that we find in this room and our homes?" (TE, page 56).
- Lesson 3: The teacher is told, "If time allows, show your class an example of the live forecast for your own community during the class" (TE, page 89).
- Lesson 4: "Explain that eventually, we want to be able to advocate for systems in our own community that are reliable, using lessons learned from Texas; so, we should keep track of what we figure out about how well these sources meet the criteria we set" (TE, page 107).
- Lesson 7: "Consider finding data about the local county where your school is located and looking at the distribution of communities in a map of that county in Lesson 8, after listening to the interview. What detail is lost about these communities when those variables are reported only about the county?" (TE, page 172).
- Lesson 10: Students are asked to interview interested parties in their communities. The teacher is told, "Do not require that students complete this home learning and do not score it; the goal of this guide is to promote conversation between students and others in their family and/or community about their values and decision making" (TE, page 209). In the interview, students ask questions of their community members about their experiences.
- Unit Overview: An option for extending or enhancing the unit is given. "Lesson 11: Give students additional time and resources to complete the culminating task. Consider planning an assembly, or inviting friends, family, and community members into the classroom to see the presentations" (TE, page 21).

Support is provided for dealing with potentially emotional issues. For example:

- Lesson 1: "The Texas power outages resulted in hundreds of lives lost, and for some students, their lives and families may have been (or may still be) greatly affected. For more support around teaching at the nature-cultural divide, and specifically around framing decision making related to these kinds of phenomena, visit http://learninginplaces.org/frameworks/ethical-deliberation-and-decision-making-in-socio-ecological-systems-framework/" (TE, page 32).
- Lesson 7: "If students are upset because they believe these decisions to be unfair (or perfectly fair), make space for those students to voice their opinions right now, and forecast that we will spend more time thinking about how fairness is a part of engineering decision-making. Make it clear that the concerns of students over ethics and decision-making have a rightful presence in the science classroom, even if we do not have the time to dig deep today" (TE, page 169).
- Lesson 7: "It is important to be sensitive to students in the classroom from low-income neighborhoods, or neighborhoods with a high percentage of people of color, who may not feel comfortable talking about disparities in a personal way. Never ask students to reveal where they live or what kind of neighborhood they live in, but if students want to share details about their neighborhood, listen, and validate their contributions as valuable to the discussion. Make it clear that while students do not have to engage in these conversations, or speak for their communities, students' ideas about social disparities, and what is fair or unfair are welcome in the science classroom when they move our thinking forward about a design problem or phenomenon" (TE, page 171).
- Lesson 8: "Some students may want to discuss the ethical implications of what they heard in the podcast, as in the example in the first row of the table above. Do not discourage them. Make it clear that the concerns of students over ethics and decision-making have a rightful presence in the science classroom. Check in with students about how they feel about what they learned in the podcast and validate their feelings if they are frustrated or angry after hearing Juan Pablo's findings" (TE, page 180).

Suggestions for Improvement

None

II.B. 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.

Rating for Criterion II.B. Student Ideas	*Extensive* *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide students with opportunities to both share their ideas and thinking and respond to feedback on their ideas. The unit offers multiple instances where students can express their ideas, clarify and justify their thinking, and revise their thinking based on input from the teacher and peers.

Opportunities for students to express their thinking occur throughout the unit. For example:

- Lesson 1: After viewing maps of Texas blackouts, students are encouraged to share their notices and wonders with the class. A T-chart is made displaying their initial ideas about the cause of the blackouts (TE, page 34).
- Lesson 1: Students participate in an initial ideas discussion where they respond to the questions: “Was a storm responsible for the blackouts you or your family experienced? What other phenomena could cause a blackout?” (TE, page 36). A public record of students’ suggestions is created and displayed at the front of the room.
- Lesson 3: Students complete the Engineering Design Tracker before they are encouraged to share their ideas with a partner. The teacher is guided to tell students that the tool is used to “keep track of our ideas so we can use them to inform solutions we might consider in our own community” (TE, page 81).
- Lesson 4: The unit materials provide teachers with many prompts to elicit students’ thinking when making sense of what contributed to the Texas blackouts. Sample student responses are given, along with ideas for follow-up questions (TE, page 104).
- Lesson 5: After examining diagrams from two types of power plants students model energy transfer in a wind turbine. “Suggest that we start with the wind turbine together before asking the suggested prompts below” (TE, page 116).

Students have opportunities to clarify and justify their thinking and extensive teacher guidance is provided in order for students to do so. Related evidence includes:

- The Teacher Handbook provides guidance for different kinds of classroom discussions (pages 38–46) and states that “students’ cultural and linguistic practices should be viewed as assets essential to the classroom community’s efforts to make sense of natural phenomena, never as deficits or barriers to student learning” (TE, page 28).
- Lesson 1: “Keeping a science notebook allows students a space in which to reflect and communicate their developing understandings about science ideas and to track changes in those

understandings. Each student should have a binder that will serve as their science notebook for the course" (TE, page 33).

- Lesson 1: The teacher is told, "Encourage student-to-student talk with a focus on raising questions, clarifying, or adding onto what someone has said rather than a focus on debating or arguing. Students might also use head nods or hand signals to show they had a similar idea to a classmate's" (TE, page 36).
- Lesson 1: "The purpose of introducing the consensus task before talking about Community Agreements is to get students thinking about how difficult it will be to get all members of the learning community to agree, and how we want to make sure everyone is included and all voices are heard" (TE, page 38).
- Lesson 1: A teacher sidebar says, "Norming is a powerful tool for equity in the classroom when done collaboratively and thoughtfully. But be aware that ideas such as safe, respectful, polite, nice, and kind are culturally embedded, and thus can mean different things in different communities" (TE, page 38).
- Lesson 1: "Distribute Progress Tracker. Explain that throughout this course, we will be keeping track of our thinking using a Progress Tracker. Explain that the tracker is not intended to be a record of the 'right' answers--it is a record of our changing thinking over the course of a unit, and should be a place where students feel comfortable reflecting on what they do not know or do not yet understand" (TE, page 41).
- Lesson 2: Students are asked, "What can you do to make sure everyone gets a chance to contribute their ideas? Give students just a moment to think individually about this question" (TE, page 57).
- Lesson 2: The teacher is told, "ask students for examples of a set of nonverbal signals (e.g., ASL signs) to adopt as a class for signaling agreement, disagreement, and wondering/questioning, as a way to ensure equitable participation in ideas that others are proposing" (TE, page 63).
- Lesson 2: The teacher is told to say, "Tell them, My role in this discussion is to press for evidence, regardless of whether the ideas are right or wrong. So you might hear me ask, 'Where did you see that?' It is my job to push us as a class to articulate the evidence we have to support our ideas" (TE, page 63).
- Lesson 3: Students make connections between Lesson 2's circuit diagram and the directionality of energy transfer in the grid before they are asked to clarify their thinking. "Use probing questions to clarify the difference between a circuit diagram and an energy transfer diagram" (TE, page 84).
- Lesson 4: Students justify their reasoning about data and its reliability. "Motivate a second look at reliability. There is no need to come to consensus on which sources performed the best, use this conversation to expose that complexity and encourage students to justify patterns in the data and explain what they mean, relating their ideas back to reliability" (TE, page 107).
- Lesson 5: Students build and test a generator and teachers are encouraged to, "ask students to explain why they constructed the generator in a particular way. Use probing questions to help them clarify their thinking about energy for each challenge" (TE, page 124).

- Lesson 6: Connecting the Exit Ticket from Lesson 5, students are encouraged to share their ideas about their answers to the first prompt. “Ask 2–3 students to share their responses, listen for students to suggest that movement can cause a change in the magnetic fields” (TE, page 143).
- Lesson 7: Students create a consensus model and are encouraged to justify their reasoning when choosing which systems to model and how energy transfers through them (TE, page 166).
- Lesson 7: Students stop and make a note about human decision making. “Remind students that last time we used Electric City to model Texas in February 2021 by reducing supply and decreasing demand, what did we need to do to keep the lights on in the hospital electric city? Have students stop and jot then share out” (TE, page 169).
- Lesson 10: When creating their class consensus decisions matrix, students are asked to use their progress trackers to justify their suggestions to decide how well a source matches each criterion (TE, page 205).

Throughout the learning sequence, multiple activities exist which allow students to demonstrate their change in thinking. For example:

- Throughout the unit students use a science notebook to record their thinking. This is introduced to students in Lesson 1. “Keeping a science notebook allows students a space in which to reflect and communicate their developing understandings about science ideas and to track changes in those understandings. Each student should have a binder that will serve as their science notebook for the course. Students can use large dividers to indicate the start of a new unit. They can use smaller dividers or sticky notes to create three sections within the unit: 1. The main science notebook, 2. The Progress Tracker, and 3. The Engineering Design Tracker” (TE, page 33).
- The Engineering Design Tracker is introduced in Lesson 3 and is a way to keep track of student’s new understandings about the engineering design process. They return to this tracker in Lessons 4, 5, 6, 9, and 11 to document the new science ideas learned, how engineers could apply these new ideas and what constraints they could have when implementing these new ideas.
- The Progress Tracker is introduced in Lesson 1 and is a way for students to keep track of their thinking and how it changes throughout the unit. Clarification on when students should be utilizing this resource is needed because there are two other resources (science notebook and Engineering Design Tracker) with which students are intended to keep track of their learning. Therefore, it may be confusing to students as to when they’re intended to use this tracker without further guidance. Students return to the Progress Tracker in Lessons 6, 7, and 10.

Students have opportunities to receive teacher feedback, to give and receive peer feedback, and to reflect on the feedback they are given. For example:

- The Teacher Handbook provides some general guidance for facilitating peer review (pages 66–68).
- The Unit Overview provides guidance about peer feedback. “This resource is available in the front matter. There will be times in your classroom when facilitating students to give each other feedback will be very valuable for their three-dimensional learning and for learning to give and receive feedback from others. We suggest that peer review happen at least two times per unit…..Peer feedback is most useful when there are complex and diverse ideas visible in student

work and not all work is the same. Student models or explanations are good times to use a peer feedback protocol. They do not need to be final pieces of student work, rather, peer feedback will be more valuable to students if they have time to revise after receiving peer feedback" (TE, page 28).

- Throughout the unit there are several places where the teacher is provided prompts to elicit student ideas. There are many charts with the headings, "suggested prompts", "sample student response", and "follow up questions."
- Each Assessment Opportunity tells the teacher what to look and listen for in student responses. The section called, "What to do" gives ideas about how to give feedback to the class.
- Lesson 2: The teacher is told, "if students' models do not show connections clearly enough to determine whether devices would receive energy, leave a sticky note on their model, prompting: What structures are connected to what? How does your model help us see which devices receive energy?" (TE, page 62).
- Lesson 3: "Instruct students to switch models (handouts) with another student pair and follow the slide's instructions to annotate similarities, differences, and uncertainties in their peers' models. Give students about 5 minutes to complete their annotations. After students get their own handouts back, give them an additional five minutes to process and incorporate feedback into their own models" (TE, page 87).
- Lesson 6: "When a pair of students is finished with their model, ask them to trade work with another pair of students. Give each pair of students a copy of Rubric for Modeling and instruct them to use the rubric to evaluate the others students' work. When both pairs have gone through the rubric, they should talk through and revise their work, then prepare to hand in this work at the end of class" (TE, page 144).
- Lesson 7: The teacher is told, "You will collect Texas County Data Analysis at the end of the day to provide even more focused feedback." (TE, page 171).
- Lesson 9: "Compare energy transfer models with a partner and give feedback. Present slide C. Ask students to switch models with a partner. Distribute Peer Rubric for Modeling and give students 5 minutes to give feedback to their peer's model. Then give them a couple more minutes to revise their own model based on the feedback they received" (TE, page 191). At the end of the class day, students are asked to self-reflect on how well they gave and received feedback (TE, page 194).
- Lesson 11: "Invite two students from each group of four to stay while two students stray. Display slide H and pass out two copies of the Peer Interactions Support handout to each group, one for the stayers and one for the strayers. Ask each group to nominate half of their group to be the first 'strayers.' Stayers need to be ready to share their ideas about their design solution with the visiting strayers" (TE, page 222). The Peer Interactions Support handout includes prompts such as, "I notice that your solution seems to be missing ___. It would be more complete if you added ___." After students receive feedback, the next step for the class is "Review and incorporate peer feedback into community plans. Tell groups to go back to their original groups and process the feedback that the stayers received from other groups and ideas that the strayers got from the other presentations. Display slide I to suggest a structure for reviewing and incorporating feedback. Explain, We use peer feedback to improve our work,

making it more clear, more accurate, and better supported by evidence. When you receive feedback, you should take these steps" (TE, page 222). The teacher is also told, "Some students might not feel comfortable highlighting the changes they made to their design solutions based on peer feedback because they might get a lower score. Make sure they understand that what matters in this step of the design process is their response to the feedback and to justify the changes they make" (TE, page 223).

Suggestions for Improvement

Consider consolidating the tracking devices to ensure students are focusing on one document.

II.C. BUILDING PROGRESSIONS

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.

Rating for Criterion II.C. Building Progressions	Adequate *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials identify and build on students' prior learning because evidence of the materials referencing students' prior proficiency regarding two of the three dimensions was clearly identified. Extensive support is provided to help the teacher understand DCI progressions, but this kind of support is rare for CCCs and SEPs, and when provided, it is generally limited to the CCC and SEP category levels (e.g., "Patterns") and not for individual elements.

Information about how the learning in this unit connects to other units is provided. For example:

- A draft document is linked in the Teacher Handbook, showing planned use for all SEP and CCC elements across the high school program ("HS Program Level SEP/CCC Planning"). This table can provide information about when and in what contexts students will encounter these elements again.
- "This unit is the first in the OpenSciEd High School Physics course sequence, and is designed to transition students into high school level physics ideas and practices in a relevant context grounded in real-world decision making....This unit builds a foundation for energy transfer and conservation in a physics context that students will carry forward into the rest of the course, but does not yet focus on forces as a way to model interactions" (Unit Overview, page 11). A

description is also provided of how student understanding of forces will progress in the other physics units in the course.

- In the Unit Overview, a section titled "How does the unit build three-dimensional progressions across the course, and the program?" lists specific ideas related to DCIs that "students should have previously developed in the OpenSciEd High School Biology and Chemistry courses" (TE, page 18). Prior DCI-related middle school ideas are also listed. This section also references SEPs and CCCs that "students should have previously developed in OpenSciEd High School Biology and Chemistry," but these ideas are only listed at the category level (e.g., "Questions," "Patterns") even though there are quite disparate ideas under each category at the high school level. It is therefore unclear which specific elements of SEPs and CCCs are meant as foundations for this unit. Note also that the way this page is set up, it seems as if additional physics units are listed as part of what students should have previously learned, although elsewhere the unit materials state that this is the first unit in the physics course. This could be confusing to teachers and administrators.
- Common ideas that students might have when starting the unit are listed in the Unit Overview document (TE, page 20). The teacher is told, "It is valuable to think of ideas like these not as misconceptions that need to be erased but as productive ideas that we can use to build understanding." They are also told "building explicitly from these ideas about distinct forms to draw connections is a productive pedagogical tool that will help students construct a new, more accurate conceptual model for energy transfer."
    - Lesson 1: The term subsystem is referenced as a first-time introduction without reference to possible prior learning, even though the term is included in a middle school-level CCC learning goal. "Sometimes scientists and engineering call systems that make up other systems subsystems" (TE, page 39). The concept of subsystems is also included in the lesson's list of "What students will figure out" (TE, page 27).
- A section of the Unit Overview is titled "What modifications will I need to make if this unit is taught out of sequence?" (TE, page 20). The suggestions describe supplemental teaching of DCI material, but do not include suggestions for supplemental teaching of SEPs or CCCs, even though page 18 of the Unit Overview indicates that this unit builds on the foundation of SEPs and CCCs in many prior units.

Detailed information about prior learning and learning progression is provided in the section called "Where are we going and Not going" at the beginning of each lesson in the Teacher Edition. However, these sections primarily describe only DCI-related information instead of regularly including information about all three dimensions. In only two of the lessons does this section describe expectations related to CCCs or SEPs. Related evidence includes:

- Lesson 1: The teacher is told, "Students should already have worked with the idea of energy in the context of chemistry and/or biology and should understand that electricity is one macroscopic manifestation of energy" (TE, page 31).
- Lesson 2: "This lesson builds a foundation for the rest of the unit, using several elementary and middle school grade band ideas that are established quickly, and also using high school crosscutting concepts. This lesson reinforces and builds on the elementary grade band idea that energy can be transferred through circuits, and that a circuit is a structure that provides a

continuous loop for a current to flow. This lesson is designed to coherently build on ideas related to the following disciplinary core ideas: PS3.A.4 and PS3.B.2" (TE, page 54).

- Lesson 3: "Students will not discuss trade-offs until the second lesson set in this unit. At that point, they will learn about trade-offs between criteria and constraints and consider how interested parties can inform decision making when making trade-offs are involved" (TE, page 79).
- Lesson 6: "Thus, this lesson contributes to students' understanding that the scale at which a problem is investigated can help us identify additional causes for the problem" (TE, page 142). This teacher note relates to a CCC.
- Lesson 7: "In this lesson, students will determine that even though at some scales it appears that county-level variables might determine who lost power in Texas in February 2021, this relationship is not supported statistically. It is important to emphasize that there are limitations on our analysis, so we should not draw conclusions too quickly. In the next lesson (Lesson 8), students will listen to a podcast and obtain information about what this same analysis can tell us when performed at a different scale (CCC 3.3 Patterns: Patterns observable at one scale may not be observable or exist at other scales.)" (TE, page 163).

Suggestions for Improvement

Consider including information to explicitly state the expected level of prior proficiency students should have with individual elements of all three dimensions as well as how students will build on those understandings throughout the unit.

II.D. SCIENTIFIC ACCURACY

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

Rating for Criterion II.D. Scientific Accuracy	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials use scientifically accurate and grade-appropriate scientific information because all science ideas and representations in the materials are accurate.

Teacher guidance is provided to ensure scientific ideas are accurate. For example, the "Where we are going and not going" sections at the beginning of each lesson outline key scientific concepts from each unit and possible misconceptions which may arise:

- Lesson 2: In the "Where We Are NOT Going" section, the teacher is told, "Going too deep into energy transfer is not the goal of Lesson 2. Avoid dwelling on this aspect of the system for now, as it will likely reinforce in students an incorrect mental model of matter transferring from battery to bulbs through two wires" (TE, page 54).
- Lesson 5: "Students may not yet understand the distinction between electrical and magnetic energy, and that's fine. Try not to distinguish these as fundamentally different forms of energy" (TE, page 129).
- Lesson 6: The main concept of the lesson is described. "After investigating the simulation, we discovered that a shorter, larger diameter wire would give us less energy loss with more electric current. This will help us model electron flow inside the wire so we can identify patterns to determine relationships between variables involving electrical energy transfer" (TE, page 155).
- Lesson 9: "The purpose for this lesson is to have students evaluate different energy storage solutions by calculating their costs based on their energy storage capabilities. These calculations will help students consider more complex design solutions and their associated tradeoffs in the next lessons" (TE, page 190).

Suggestions for Improvement

None

II.E. DIFFERENTIATED INSTRUCTION

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.

Rating for Criterion II.E. Differentiated Instruction	*Extensive* *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide guidance for teachers to support differentiated instruction because the unit offers support for some student groups including multilingual learners, struggling students, and students with disabilities. However, few supports are provided to support students who have already met the performance expectations.

Various supports are provided for building vocabulary throughout the unit to support many student groups including multilingual learners and struggling students. For example:

- Lesson 1: “Students should be encouraged to record their ideas using linguistic (e.g., written) words and nonlinguistic modes (e.g., photographs, drawings, tables, graphs, mathematical equations, measurements). This is especially important for emergent multilingual students because making connections between written words and nonlinguistic representations helps students generate richer explanations of scientific phenomena” (TE, page 33).
- Lesson 1: “The Texas Articles are written at different reading levels and vary in length. Texas Article 2 and Texas Article 6 are most accessible while Texas Article 3 and Texas Article 4 are most challenging. At your discretion, either count students into random groups or assign them into intentional mixed- ability reading groups with students who need more reading support in groups 2 and 6” (TE, page 33).
- Lesson 2: “You might need to spend a moment reminding students what it means to provide a control condition, particularly if your students are multilingual. A control provides a standard against which other conditions can be compared in a scientific investigation, but it means something completely different in everyday language. Highlighting how words can have different meanings in different context gives emergent multilingual students the opportunity and space to discuss any preconceptions about the meaning of the words and to draw upon their personal experiences” (TE, page 58).
- Lesson 3: “Before students engage in whole class discussions, it can be helpful to first provide them with the opportunity to work with others - either in pairs, triads, or small groups - on ideas related to their reasoning. These smaller group structures can be especially helpful for emerging multilingual students because they offer students a chance to engage in sensemaking with their peers, and also offers them the space to use their linguistic and nonlinguistic resources to express their ideas (and learn from other students’ uses of these resources too)” (TE, page 81).
- Lesson 5: “If students don’t bring up fields themselves, don’t bring it up. The term field will be defined later in this lesson. If students do bring it up, validate this idea, and then continue to reference the space around the magnet until the end of the lesson so students who do not know what a field is have the opportunity to construct a conceptual understanding” (TE, page 126).
- Lesson 10: “At your discretion, either count students into random groups or assign them into intentional, mixed ability reading groups. Biomass Impacts Gas Impacts and Wind Impacts are similar in reading level but are shorter therefore most accessible. Hydropower Impacts and Nuclear Impacts are most challenging due to potentially less familiar vocabulary and content” (TE, page 204).

Guidance is provided for teachers to create and use a Word Wall to increase retention of grade-level appropriate scientific vocabulary. For example:

- “After students have developed a deep understanding of a science idea through these experiences, and sometimes because they are looking for a more efficient way to express that idea, they have ‘earned’ that word and can add the specific term to the class Word Wall. These ‘words we earn’ should be recorded on the Word Wall using the students’ own definition whenever possible” (TE, page 25).

- "The words we earn and words we encounter in this unit are listed in this document and in each lesson to help prepare and also to avoid introducing a word before students have earned it. They are not intended as a vocabulary list for students to study before a lesson, as that would undermine the authentic and lasting connection students can make with these words when they are allowed to experience them first as ideas that they're trying to figure out" (TE, page 25).

Some scaffolds and supports are suggested using Universal Design for Learning (TE, page 30), which may aid students with disabilities. These supports are often found in the "Attending to Equity" sections in the margins of lessons. For example:

- Lesson 1: "Use representations like color coding and/or letter or number coding to foreground different parts of the system. Though color coding is useful for quick reference, letter or number coding helps ensure accessibility for any student who may be color-blind" (TE, page 39).
- Lesson 6: "This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far. Some students may benefit from using multiple modalities to express their thinking for any or all of the questions on this assessment. You may consider allowing some students to verbally explain their answers with you or another student acting as a scribe to record their thinking on paper. Some students may benefit from using gestures, images or manipulatives to support their explanations as opposed to written text. In each case, encourage students to use multiple modalities to show their thinking creates a clear, accessible, equitable pathway for all students to demonstrate proficiency" (TE, page 156).
- Lesson 11: "This project offers students the chance to express their ideas using a diverse set of modalities. Allowing students to express their ideas using multiple modalities supports student ownership of their learning by giving students choice, access and control in navigating their own understanding around science ideas" (TE, page 222).

Two optional extensions are provided. However, these extensions are not designed specifically for students who have met the performance expectations or learning goals.

- Lesson 2: "This step in the lesson sequence is another opportunity for creative input from students outside of what is described here. They may want to make a sign or spend more time decorating or labeling their buildings of the city itself" (TE, page 71). This is not an extension opportunity that is tied to the lesson level performance expectation.
- Lesson 6: "In the extension, students get more first-hand experience with concepts of voltage, and algebraic relationship related to circuits such as Ohms Law and an operational definition of resistance" (TE, page 142). However, evidence of this activity was not located.
- Lesson 6: "If students are ready, encourage students to try modeling a 'spicy' passage from the second page of the reading" (TE, page 145). This is not an extension opportunity that is tied to the lesson level performance expectation.
- Lesson 7: "Students will determine the statistic of correlation and use it to make inferences about whether or not there is a correlation between two variables, but they will not determine the statistical significance of that correlation….But you may decide to take this exercise a step further and discuss statistical significance" (TE, page 163).

Guidance is provided for supporting students who may be struggling. For example:

- Lesson 2: “Students may think of a model of the power strip system as only a diagram of the power strip and may focus on capturing as much visual detail as possible. Help them realize that in science, modeling does not always mean drawing a representative picture. Instead, we are trying to capture the key parts and interactions that help explain something about a phenomenon” (TE, page 61).
- Lesson 3: “The graph of energy demand forecast is less complex than the others, because it only shows one line. Use this first graph as a chance to spot students who may have trouble as the graphs become more complex” (TE, page 93).
- Lesson 5: “Even though students should recognize the energy transfer from the generator to the wires, they may not identify that matter is changing inside of the wires as well. If they have questions about this, note those as excellent questions or lines of inquiry, but try to shift focus to the visible parts of the generator itself” (TE, page 134).
- Lesson 6: “Students may get hung up on the idea that the temperature of the wire doesn’t increase as the % of energy lost to the surroundings increases. As they just saw a demonstration equating the temperature of the wire to emerge loss, this is a very reasonable question. Acknowledge their questions as valid and point to this as a limitation of the computer models” (TE, page 149).
- Lesson 9: “In middle school, students had practice developing and revising models to show the relationships among the variables of a system. In this unit, students will extend the use of this practice by using models to predict relationships between systems. Use this as an opportunity to discuss two of the goals of developing models in science to make a prediction about the behavior of a system and to make our ideas visible to others” (TE, page 191).

Suggestions for Improvement

Consider providing extensions that will extend the learning of students who have already met the performance expectation.

II.F. TEACHER SUPPORT FOR UNIT COHERENCE

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.

Rating for Criterion II.F. Teacher Support for Unit Coherence	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials support teachers in facilitating coherent student learning experiences over time. Teacher support and strategies are provided for linking student engagement across lessons and for helping students see connections between their DCI learning and their sense-making and problem solving.

Teacher support is provided for linking engagement across lessons. Related evidence includes:

- A unit storyline is provided for teachers to show a summary of each lesson, including lesson questions, phenomena or problems, and student models or representations (Unit Overview, pages 3–9).
- In the beginning of each lesson, the teacher is given a short summary of the outcomes of the previous lesson, a description of what students do in the current lesson, and a summary of what students will do in the following lesson (e.g., TE, page 47).
- Unit materials (including answer keys) are provided mostly together in a PDF or separated by lesson.
- At the start of each lesson, teachers are provided a Navigation Routine to facilitate unit coherence. The three elements of the Navigation Routine are described in the Teacher Handbook (TE, pages 15–16). The first part of the routine is "Look Back: How did we get here?" which occurs at the beginning of the lesson and reviews the previous lesson. The second part is "Take Stock: Where are we now?" which occurs in the middle of a lesson to strengthen connections between the activities and the storyline. Finally, the third part is "Looking Forward: Where are we going?". At the end of a lesson, the class looks back over what has been done and decides where they need to go next.

Students are supported to connect their learning in all three dimensions to their sense-making and problem solving. For example:

- Lesson 3: The sidenote states, "One of the main challenges students face when using systems thinking is defining what belongs to the system under investigation and what belongs to the surroundings. To support development of systems thinking throughout this unit we suggest using similar prompts whenever we analyze a system" (TE, page 83).

- Lesson 4: Students analyze data, and are then asked, "How does this help us understand how each energy source may have contributed to the crisis?" (TE, page 106).
- Lesson 4: The Assessment Opportunity call out box states, "Use the crosscutting concept of stability and change to support student sensemaking. Remind students that in Lesson 3, they saw that energy supply and demand matched before the energy crisis(stability) and the gap between supply and demand was the largest during the blackout (change). Use this framing to help students draw connections between the stability of an electric grid system and its reliability".
- Lesson 5: The sidenote states, "We have begun to consider the interplay between matter and energy, but the wires don't obviously fit the pattern we've seen so far. Even though students should recognize the energy transfer from the generator to the wires, they may not identify that matter is changing inside the wires as well. If they have questions about this, note those as excellent questions or lines of inquiry but try to shift focus to the visible parts of the generator itself" (TE, page 132).

Suggestions for Improvement

None

II.G. SCAFFOLDED DIFFERENTIATION OVER TIME

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.

Rating for Criterion II.G. Scaffolded Differentiation Over Time	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials support teachers in helping students engage in the practices as needed and gradually adjust supports over time because teacher supports are not explicitly provided to help students build understanding and proficiency in the SEPs during the unit. Scaffolding is not clear for all the focus SEP elements, and they aren't consistently reduced over time.

Related Evidence includes:

The Teacher Guide (pages 14–16) clearly states where the focus SEP and their elements are used through specific lessons in the unit. The three-dimensional ideas in context of the unit (TE, page 14) states which lessons are targeted for specific SEPs and how students are developing and using them over time. However, this explanation could use clarification.

Scaffolding is claimed to be provided to students to build proficiency in the SEP element of **Asking Questions and Defining Problems,** *Ask questions to clarify and refine a model, an explanation, or an engineering problem.* However, supports are not clearly reduced over time and are inconsistent. For example:

- Lesson 1: Students are encouraged to ask questions of one another when they are participating in a group discussion about the related phenomena. In this lesson, teachers accept all questions created by students. "Encourage student-to-student talk with a focus on raising questions, clarifying or adding onto what someone has said rather than a focus on debate or arguing. It is important to encourage students to draw from their own ideas and not worry about whether their ideas or questions are right or wrong. All questions are welcome" (TE, page 36).
- Lesson 3: While students are participating in the Model Energy Transfer activity, they are encouraged to ask clarifying questions if they are unsure of the focus for each scenario. However, students are not given any assistance to guide the creation of these questions. Teachers are not given any guidance on how to scaffold the creation of these types of questions. Therefore, scaffolding is not present for this activity at all.
- Lesson 6: Students carry out an investigation using the simulation and choose their own independent and dependent variables. In this activity students are asked to develop research questions. Teacher support is provided for understanding variables on page 139, but not related specifically to developing questions.
- Lesson 6: After using a simulation to explore different characteristics of an electrical system students ask questions to refine their Engineering Design Trackers. The materials do not support teachers in scaffolding students in the creation of these questions.
- Lesson 10: Students participate in a peer feedback activity where they ask questions after given feedback that can be used to refine their designs. Support for teachers is provided. "Circulate among the groups to support students as they work on their interview protocols. Focus on the types of questions students generate. If the opportunity presents itself, model for students how to turn a question from a closed question answered with a 'yes' or 'no' to an open question that could provide richer information from the interviewee. For example, a closed question might be: 'Do you care about the environment?' This could be answered with yes or no. The question could be modified to: 'What environmental impacts related to energy generation are you more concerned about?' which is an open-ended question" (TE, page 208). However, this scaffolding is added late in the unit after students are expected to use the element independently earlier in the unit.

Scaffolding is claimed to be provided to students to build proficiency in the SEP element of **Developing and Using Models**, *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.* For example:

- Lesson 1: Students develop an initial model to explain blackouts and energy transfer in a system. This model may serve as a pre-assessment of students' modeling. No scaffolds are provided here as a follow up to students' modeling.
- Lesson 2: The students' Power Strip Model handout scaffolds modeling. It asks students to "Draw and label a diagram to help explain how the structures and connections in the power strip enable it to transfer energy from 1 source to multiple devices. Label key structures in the

power strip, as well as the energy source and the devices." The teacher is told, "Remind students that whenever we develop a model in science, it is made for explaining something, and it isn't just a model of what we see. In other words, it seeks to help explain how and/or why something happens" (TE, page 61). This guidance is the first time teachers are provided support to assist students with modeling in the unit and focuses on the nature of models.

- Lesson 5: Students develop models of energy transfer for the wind and gas plants before modeling energy transfer in the homemade generator. Scaffolding guidance for the teacher or student is not provided, indicating that students are expected to be more responsible for the element during this lesson in comparison with Lesson 2.
- Lesson 6: Students carry out an investigation using the simulation to model electron flow inside of a wire. Teacher support is provided. "Students may get hung up on the idea that the temperature of the wire doesn't increase as the % of energy lost to the surroundings increases. As they just saw a demonstration equating the temperature of the wire to energy loss, this is a very reasonable question. Acknowledge their questions as very valid, and point to this as a 'limitation of the computer model.' Say, Like all models, this model has limitations. We can change the temperature of the wire using the slider, but the energy lost to the surroundings doesn't affect the temperature of the wire itself. If you want to, you can think through what might happen as the % energy loss goes up, and the temperature goes up, which then in turn changes the % energy loss again, and so on, but this gets really complicated. I recommend that we use the values given in the simulation, and acknowledge that this limitation doesn't match up perfectly" (TE, page 149).
- Lesson 7: Students create models in groups of three. "What to do: Students have modeled all these systems before. Remind them to look back at their progress trackers to see examples of energy transfer diagrams and of the systems they will need to model now" (TE, page 165).
- Lesson 9: Students are asked to, "complete two models to show how adding a battery to a system affects its reliability" A teacher sidebar says, "In middle school, students had practice developing and revising models to show the relationships among the variables of a system. In this unit, students will extend the use of this practice by using models to predict the relationships between systems. Use this as an opportunity to discuss two of the goals of developing models in science: to make predictions about the behavior of a system and to make our ideas visible to others. Getting students to revise their models can be a challenge if they think the expectation with modeling is to show a 'right' answer" (TE, page 191). Another teacher sidebar states, "Models are generative tools for identifying a gap in our understanding. Identifying the limitations of a model is usually a good opportunity to discuss new questions about the behavior of a system that we cannot explain with our current ideas. Evidence that suggests students are starting to grasp the usefulness of models as generative tools include the spontaneous use of models to support their own thinking. You might hear students raising new questions, revising an idea, or making predictions when using models for moving their thinking forward" (TE, page 192). In this lesson, teacher-provided scaffolding related to modeling focuses on a different aspect of modeling than does the scaffolding from Lesson 2, so it may deepen students' understanding of modeling.

Scaffolding is claimed to be provided to students to build proficiency in the SEP element of **Analyzing and Interpreting Data,** *Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.* However, supports are not clearly reduced over time and students are not given the opportunity to use this element frequently enough to use it independently. For example:

- Lesson 3: "Present Slide M. Tell students we will look at the energy demand forecast first. Say, we are going to use a strategy for analyzing this data, first as a class, and then with a partner. As a class discuss the x and y axes, making sure students understand what the graph is representing. Ask a volunteer to read step 1 from the handout" (TE, page 89).
- Lesson 5: After building a generator, students analyze data collected and decide if they were successful in their design. Support for teachers to guide students in this analysis was not located. Therefore, this is a missed opportunity for scaffolds from Lesson 3 to be reduced.
- Lesson 7: "Discuss a hypothesis and make a prediction as a class. Orient to CODAP and run a correlational analysis between hospitals and percent out. Turn and talk about what might be different about different counties" (TE, page 170). Because this portion of the lesson is very teacher-guided, it is difficult for students to build independence in using the element. However, in the second part of this activity, students analyze data in small groups and unlike the first part of the activity, teachers are provided no scaffolding guidance to support students in the data analysis.
- Lesson 10: Students analyze the decision matrix to determine if they have met the criteria for success. This lesson is the first time students are introduced to the decision matrix and scaffolds are not present. This is a missed opportunity for teachers to support students in analyzing data using this tool.
- Lesson 11: Students analyze the energy grid calculator to determine if they have met the success criteria for the challenge. This lesson is the second time students are introduced to the decision matrix and scaffolds are not present. This is a missed opportunity for teachers to support students in analyzing data using this tool.

Suggestions for Improvement

- Consider providing clear guidance for teachers around where and how scaffolding is reduced for all focus SEP elements identified by the unit.
- Consider limiting the number of individual SEP elements, or choosing to focus on a few selected elements, so that teachers can build in scaffolds to ensure that students can become more proficient over time in focus elements.

OVERALL CATEGORY II SCORE: 3 (0, 1, 2, 3)	
Unit Scoring Guide – Category II	
Criteria A-G	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

CATEGORY III

MONITORING NGSS STUDENT PROGRESS

III.A. MONITORING 3D STUDENT PERFORMANCES

III.B. FORMATIVE

III.C. SCORING GUIDANCE

III.D. UNBIASED TASK/ITEMS

III.E. COHERENT ASSESSMENT SYSTEM

III.F. OPPORTUNITY TO LEARN

III.A. MONITORING 3D STUDENT PERFORMANCES

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.

Rating for Criterion III.A. Monitoring 3D Student Performances	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials elicit direct, observable evidence of students using practices with DCIs and CCCs to make sense of phenomena or design solutions. The unit provides opportunities for students to show the use of all three dimensions to further their understanding of the phenomenon and to derive a solution to a problem. Artifacts showing understanding of the targeted learning are created through both group and individual efforts in the unit. Students use grade-appropriate elements of the DCIs, SEPs, and CCCs to respond to prompts designed to further understanding of the phenomenon. Formal tasks are based on real-world scenarios and require students to extend their understanding to a new scenario. However, there is some mismatch between some claimed focal elements and those assessed in the unit.

The materials elicit evidence of students integrating the three dimensions in service of sense-making and solving problems. Related evidence includes:

- Lesson 2: Students dissect a power strip to determine how it works in a system when connected to a battery to power multiple devices. They identify what interactions are needed to transfer electrical energy. Students use the following elements of the three dimensions in this task:
    - DCI: **PS3.A**: *"Electrical energy" may mean energy stored in a battery or energy transmitted by electric currents.*
    - CCC: **Systems and System Models:** *Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions — including energy, matter, and information flows — within and between systems at different scales.*
    - SEP: **Developing and Using Models:** *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
- Lesson 5: After dissecting a generator, students build their own and model energy transfer through fields. Students integrate the following dimensions in the task:
    - DCI: **PS3.A**: *At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy*.
    - CCC: **Energy and Matter**: *Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.*
    - SEP: **Analyzing and Interpreting Data:** *Analyze data to identify design features or characteristics of the components of a proposed process or system to optimize it relative to criteria for success.*

- Lesson 7: Students develop a model to show how an insufficient supply of energy could lead to less energy transferring to certain communities in Texas. Students integrate the following dimensions in the task:
  - DCI: **PS3.B:** *The availability of energy limits what can occur in any system.*
  - CCC: **Energy and Matter**: *Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.*
  - SEP: **Developing and Using Models:** *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*

Formal assessment tasks in the materials are driven by phenomena and require students to use three dimensions. For example:

- There are two transfer tasks featured in the materials, after Lessons 6 and 11.
  - Lesson 6, Mid Unit Transfer Task: Students use what they've discovered about generators to model and explain energy transfer in a motor. Students integrate the following dimensions in the task:
    - DCI:
      - **PS3.A:** *At the macroscopic scale, energy manifests itself in multiple ways such as sound, light, and thermal energy.*
      - **PS3.A:** *Electrical energy may mean energy stored in a battery or energy transmitted by electric currents.*
      - **PS3.D**: *Although energy cannot be destroyed, it can be converted into less useful forms — for example, to thermal energy in the surrounding environment.*
    - CCC: **Energy and Matter:** *Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system.*
    - SEP: **Developing and Using Models:** *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*
  - Lesson 11, Sand and Mirrors Final Transfer Task: Students integrate the following dimensions in the task:
    - DCI:
      - **PS3.A:** *At the macroscopic scale, energy manifests itself in multiple ways such as sound, light, and thermal energy.*
      - **PS3.A:** *Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system.*
    - CCC: **Energy and Matter***: Energy cannot be created or destroyed, only moves between one place and another place, between objects and/or fields or between systems.*
    - SEP: **Developing and Using Models:** *Develop, revise, and/or use a model based on evidence to illustrate and/or predict the relationships between systems or between components of a system.*

Suggestions for Improvement

Consider ensuring that assessment targets are aligned with claimed learning goals throughout the unit.

III.B. FORMATIVE

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

Rating for Criterion III.B. Formative	Extensive *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials embed formative assessment processes throughout that evaluate student learning and inform instruction because each lesson provides identified formative assessment opportunities for the named lesson level objectives. Formative assessments occur throughout the unit and are accompanied by guidance to the teacher on how to evaluate student responses and how to modify instruction based on the results.

The Teacher Handbook includes general guidelines for how to proceed instructionally if 75% or more, between half and 75%, or less than half of students provide expected responses during an Assessment Opportunity (TE, page 70).

- Lesson 1: When the teacher checks for students' understanding of the Texas Outages Map, the prompt could be misleading. The teacher is told to ask, "How were the people in this county affected by the power outages?" (TE, page 34). However, the map only shows that people had power outages — not how they were affected by the power outages (e.g., whether it was traumatic, whether they lost their food). Therefore, student responses (e.g., "I don't know how they were affected") might not provide a window into their understanding of the map.
- Lesson 5: "As students work, circulate and look closely at their progress, using their diagrams as a formative assessment. If students are having trouble getting started, prompt them to think first about matter in the system" (TE, page 117).
- Lesson 5: "Collect the exit tickets as students leave class. If students are unclear on the difference between energy transfer through direct contact and energy transfer at a distance, plan to review this briefly at the start of their next class period" (TE, page 125).
- Lesson 5: "Use this exit ticket to gauge how ready students are for the reading. If most answers show little grasp of fields, plan to do a close reading of the home learning in the next class period. If most answers show some basic understanding of fields, you may be able to skip some steps of the close reading" (TE, page 135).

- Lesson 6: The transfer task includes a "Feedback / What to Do" section that is differentiated for three different levels of student performance and that has some relationship to all three dimensions.
- Lesson 7: The Answer Key for the Texas County Data sheet says, "Support students who are not yet making connections in seeing how their hypothesis will map onto this trend by writing, You mentioned that you thought this would make people more likely to lose power. Is this what your graph shows?" (page 3).

During assessment opportunities in the lessons, teachers are guided to follow up with students who do not perform as expected. Related evidence includes:

- Lesson 1: "Use the language of stability and change by saying, It looks like you modeled a stable system here. What changed in this second model to disrupt that stability?" This prompt relates to CCCs, but only at the middle school level. However, a high school-level element (CCC **7.1**) is claimed.
- Lesson 2: "What to do: If students do not connect structures from the reading to the power strip say, How does that structure relate to our model of the power strip? If students do not explicitly emphasize structure and function, ask for more with a targeted question such as, How does the structure of the wires in the building function to help us get electricity safely?" (TE, page 67). This prompt is meant to help students in relation to CCC element **HS.6.1**, but only shows evidence of helping students use the corresponding middle school-level element: *Complex and microscopic structures and systems can be visualized, modeled, and used to describe how their function depends on the shapes, composition, and relationships among its parts; therefore, complex natural and designed structures/systems can be analyzed to determine how they function.*
- Lesson 4: "What to do: Use questions about specific systems to support students in making those connections. As students discuss the second question, listen for ideas about which factors might contribute to reliability/unreliability, including efficiency, dispatchability, power and specific mechanisms related to the sources production of energy; accept these ideas without judgement" (TE, page 102).
- Lesson 5: "If students have trouble getting started, direct them to the key components in the diagram of the generator. Write these components with arrows between them, leaving enough space to label each arrow with a verb to describe the interaction that transfers energy. If students have trouble suggesting verbs to describe energy transfer through contact of moving matter, ask, How would you describe what the [hand, nail] is doing to the [nail, magnets]? If students have trouble suggesting a verb to describe energy transfer at a distance through the field, ask, How did the compasses respond when the magnets moved? What does this mean for the field? What do the magnets do to the field?" (TE, page 133).
- Lesson 6: "What to do: As students are modeling passages from the reading, if they are deeply struggling try to coach them with useful ideas. Say, what does the reading say is happening to the field? What action word does the reading use? If students' models don't 100% make perfect sense that's not a bad thing, as some confusion will be cleared up in the partner conversations, using the rubric. However, it will be helpful to ensure that all students have the passage they are modeling clearly labeled" (TE, page 145).

- Lesson 9: "What to do: Encourage students to solve the problems step by step. This might help students avoid technical errors and make sure they are tracing the units that are eliminated along the solution. If students are having difficulties deciding which design solution is more feasible, suggest they rank each solution for cost, land area of use, and efficiency and decide which one performs better overall" (TE, page 196).

Suggestions for Improvement

Consider providing teacher guidance for modifying instruction based upon a variety of responses reflecting different levels of student proficiency for each of the three dimensions.

III.C. SCORING GUIDANCE

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.

Rating for Criterion III.C. Scoring Guidance	*Adequate* *(None, Inadequate, Adequate, Extensive)*

The reviewers found adequate evidence that the materials include aligned rubrics and scoring guidelines that help the teacher interpret student performance for all three dimensions. Scoring guidance is provided with clear learning outcomes along with sample student responses and some guidance for teachers on how to provide feedback and modify instruction. However, element level guidance is not consistently provided, and guidance provided is typically only for a single, exemplary response. The reviewers found evidence of lesson-level PEs with number codes for the elements of each dimension. However, it is not clear as to which numbering system is being used and there are discrepancies between what is contained on each PE and what is listed in the front matter.

Scoring guidance is provided for the assessments in Lessons 6 and 11.

- Lesson 6: The Motors Transfer Task Key document contains a chart that outlines each question and their alignment with each dimension. The short answer questions contain a rubric that is separated into three sections. Each section contains what to look for and an example of the level of understanding.
  - "Foundational Pieces: Students suggest a way to refine the generator but make no connections to evidence from the device or to energy transfer. (SEP: 6.5)."
  - "Linked Understanding: Students suggest an evidence-based way to refine the generator and relate it to energy transfer, but do not point to mechanisms for how energy transfers through the system. (SEP: 6.5; CCC: 5)."

    - "Organized Understanding: Students use evidence that the student collected from the broken motor and from their energy transfer models to describe how energy transfers between systems from their energy and/or out of the system. (SEP: 6.5, 2.3; CCC: 5.2; PS3.A.2, PS3.B.4) and Students connect these ideas to suggest an evidence-based way to refine the generator so that sufficient energy will transfer to the shaft. (SEP: 6.5, 2.3; CCC: 5.2) (Some students may describe energy leaving the system through the hot wires, and why this is inefficient.)" (TE, page 5).
- Lesson 11: The Sand and Mirrors Task Key document contains a chart that outlines each question and their alignment with each dimension. Although the key contains responses, a range of student responses is not included.

Scoring guidance is often present. However, only exemplar features of student responses are shown (rather than a range of responses). Related evidence incudes:

- Lesson 1: As students create the DQB, the teacher is told, "look for/listen for…questions that define specific local or global challenges" (TE, page 44). However, an example of a question that would define a challenge is not provided to the teacher, and it is unclear what that would look like. This Assessment Opportunity is positioned as building toward LLPE **1.B** "Ask questions to clarify and define the problem of how our community can generate energy…" This LLPE has <u>two separate</u> SEP elements whereas the assessment look-for combines these into one desired performance without an example of what such a performance would look like.
- Lesson 2: "What to look for/listen for: Students' models of the power strip system should be a circuit diagram, showing which parts in the system need to be connected in order for the system to work as designed for energy to transfer from the source to multiple devices. Models should be clear enough to serve as a tool for identifying whether those connections exist. (SEP: 2.3, CCC 6.1, DCI: PS3.B.2)" (TE, page 62). Sample student models are not shown, but sample class consensus models are provided.
- Lesson 3: The "What to look for/listen for" for this performance doesn't include information related to the claimed SEP and CCC targets (SEP: *Evaluate the impact of new data on a working explanation and/or model of a proposed process or system,* CCC: *Empirical evidence is needed to identify patterns)*. Related to the SEP, the teacher is told to look for evidence of students just analyzing data. Teachers are told to look for/listen for, "Concise descriptions of patterns (similarities, trends, or changes) presented in the graphs." Related to the CCC, the teacher is told to look for students describing patterns emerging from data (TE, page 93). However, recognizing patterns in data is not the same thing as understanding that empirical evidence is required to identify patterns.
- Lesson 4: "What to look for/listen for: Students can explain that in order for the system to remain stable, it must be designed for supply to meet demand. (CCC: 7.4; DCI: PS3.B.4)" (TE, page 104). Only guidance for the CCC and DCI are shown.
- Lesson 5: The teacher is told to look for/listen for, "Students identify design criteria relevant to the generator's performance, transferring motion energy to light (i.e., lighting multiple bulbs, lighting a bulb for an extended time). (SEP: 3.7, DCI: PS3.A.2)" (TE, page 124).
- Lesson 6:

- "What to look for/listen for in the moment: Fields store and transfer energy. In their energy transfer diagram, students should label the energy transfer arrow into a field with the word CHANGE, or the like. Energy transfer arrows from a field to a particle, such as an electron, should be labeled PUSH or the like. (DCI: PS3.A.3) Students should connect passages from the reading to evidence from class or their personal experience, including: electrical energy transfers in wires, changing magnetic fields can generate electricity, a buildup of electric energy can cause a spark, and others. We can incorporate information from the reading with our own evidence to model energy transfer in wires. (SEP: 8.2; DCI: PS3.A.3) We can use particle-scale mechanisms for interactions between particles and fields to identify cause-effect relationships for larger systems like a wire, and explain evidence of energy transfer we've seen in class, such as moving compasses and wires heating up. (CCC: 2.2; DCI: PS3.A.3)"
- "What to do: As students are modeling passages from the reading, if they are deeply struggling try to coach them with useful ideas. Say, *What does the reading say is happening to the field? What action word does the reading use?* If students' models don't 100% make perfect sense that's not a bad thing, as some confusion will be cleared up in the partner conversation using the rubric. However, it will be helpful to ensure that all students have the passage they are modeling clearly labeled. If students are ready, encourage students to try modeling a 'spicy' passage from the second page of the reading."
- "Building toward: 6.A.1 Integrate information from a reading alongside student-generated models and a computer simulation to examine smaller scale mechanisms within the system and develop cause and effect relationships about motions of particles or energy stored in fields. (SEP: 8.2; CCC: 2.2; DCI: PS3.A.3)" (TE, page 145).

- Lesson 7: In the Texas County Data Analysis, a rubric is provided. The CCC target for the assignment is *Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects*. However, the expected student response for the "organized understanding" level of performance does not include any evidence that students understand this high school-level CCC element. The suggested teacher feedback colored in green (indicating a CCC connection) only seems to explicitly relate to the middle school level of this CCC: *Relationships can be classified as causal or correlational, and correlation does not necessarily imply causation*. "Remind students that correlation is not causality, but that it can suggest interesting relationships that can be investigated in different ways" (P.1 Lesson 7 Answer Key Texas County Data).

In the Assessment System Overview document, the Lesson-by-Lesson Assessment Opportunities section includes a table that showcases formative assessment guidance for each lesson. The Lesson-Level PE(s) which contain the focus elements for each dimension are included. The elements for each dimension are included by number. For example:

- Lesson 3:
  - "3.A. Develop and use a model based on evidence from our investigation in. Lesson 2 to illustrate the energy flow between components of the electric grid system and energy loss from the system as a possible cause of the crisis in Texas. (SEP: 2.3; CCC: 4.3; DCI:

PS3.B.2, 3PS3.D.1)" This DCI is not included in the front matter of the unit. While it is contained in the performance expectation **HS-PS3-3,** the content is explicitly covered in the unit.
    - "When to check for understanding: On day 1, when students develop Energy Transfer models for Scenarios A–E on Energy Transfer Scenarios."
    - "What to look for/listen for: Modeling energy transfer across more than one system and using. Question marks to indicate areas of uncertainty. (SEP:2.3); Using numbers or symbols to quantify energy coming in and out of various parts of the system. (CCC: 4.3); Indicating that the energy coming into the substation from the power plant is equal to the total energy leaving the substation to buildings and surroundings. (DCI: PS3.B.2, PS3.D.1)" (TE, page 232).
- Lesson 6:
    - "6.A. Integrate information from a reading alongside student-generated models and a computer simulation to examine smaller scale mechanisms within the system and develop cause and effect relationships about motions of particles or energy stored in fields. (SEP: 8.2; CCC: 2.2; DCI: PS3.A.3)".
    - "When to check for understanding: On day 1, when students model passages from *Magnetic and Electric Fields*, and then later model the inside of a wire; and on day 2, when students share conclusions from the simulation with each other, and connect these conclusions to in-class experiments."
    - "What to look for/listen for in the moment: Fields store and transfer energy. In energy transfer diagrams, students should label the energy transfer arrow into a field with the word CHANGE, or the like. Energy transfer arrows from a field to a particle, such as an electron, should be labeled PUSH or the like. (DCI: PS3.A.3); Information about fields obtained from a reading is consistent with evidence we have in class. We can incorporate both together to model energy transfer in wires. (SEP: 8.2; DCI: PS3.A.3); We can use particle-scale mechanisms for interactions between particles and fields to identify cause-effect relationships for larger systems like a wire, and explain evidence of energy transfer we've seen in class, such as moving compasses and wires heating up. (CCC: 2.2; DCI: PS3.A.3)" (TE, page 234).

Suggestions for Improvement

- Consider including scoring guides or rubrics with at least three levels of student performance related to each of the three dimensions for all short answer questions on assessment tasks.
- Consider consistently providing sample student models and diagrams, such as the system diagram in Lesson 2 (page 62).
- Consider numbering the elements in the front matter to align with the Assessment System Overview.

III.D. UNBIASED TASK/ITEMS

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

Rating for Criterion III.D. Unbiased Task/Items	*Extensive* *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials assess student proficiency using accessible and unbiased methods, vocabulary, representations, and examples. Tasks in the unit use vocabulary and text that are grade-level appropriate, and students are provided with a variety of ways to respond to assessment tasks, such as drawing, writing, and discussing with peers, along with an opportunity to choose their own modality. Scenarios used in tasks are unbiased and accessible to all students.

Vocabulary and text volume in student assessments are grade-level appropriate and usually accompanied by visual representations. For example:

- The amount and level of texts are varied and grade-level appropriate and include Lexile range and Flesch-Kincaid Grade Level.
  - Lesson 1: "The Texas Articles are written at different reading levels and vary in length. Texas Article 2 and Texas Article 6 are most accessible, while Texas Article 3 and Texas Article 4 are most challenging. At your discretion, either count students into random groups 1–6, or assign them into intentional, mixed ability reading groups, with the students who need more reading support in groups 2 and 6 along with students who do not need the extra support" (TE, page 33).
  - Lesson 10: "At your discretion, either count students into random groups 1–7, or assign them into intentional, mixed ability reading groups. Biomass Impacts, Gas Impacts, and Wind Impacts are similar in reading level, but are shorter and therefore most accessible. Hydropower Impacts and Nuclear Impacts are most challenging due to potentially less familiar vocabulary and content" (TE, page 204).
- All major assessment handouts include visual support such as diagrams or photos along with the assessment text prompts.
  - Lesson 6: In this assessment, students are given a diagram to explain energy transfer in a motor.
  - Lesson 8: Students are given a model used in a previous lesson to complete an Electronic Exit Ticket.
  - Lesson 11: The Sand and Mirrors Task includes a graphic organizer for students to use when completing the task.

Representations, phenomenon, and scenarios are fair and unbiased and support teachers in ensuring all students can engage with the phenomena. Attending to Equity side boxes provide potential scaffolds for students who may not have the background or abilities to be successful with an assessment or learning task. For example:

- Lesson 3: Teachers are encouraged to reflect with students on a discussion map. The call-out box says, "The goal of this reflection is to notice whole-class patterns and decide how to move discussions forward as a community. Avoid addressing the contributions or behaviors of specific students. If they are brought up, prompt students to return to the class-level patterns we observed, saying, Let's look at the whole map. What suggestions would support our whole class community? This is also an opportunity to remind students that Discussion Mapping Tool captures only spoken contributions, and to explicitly state that nonverbal participation and listening closely are also valued contributions" (TE, page 94).
- Lesson 6: Teachers are given guidance on the assessment task. "This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far. Some students may benefit from using multiple modalities to *express* their thinking for any or all of the questions on this assessment. You may consider allowing some students to verbally explain their answers with you or with another student acting as a scribe to record their thinking on paper. Some students may benefit from using gestures, images, or manipulatives to support their explanations as opposed to written text. In each case, encouraging students to use multiple modalities to show their thinking creates a clear, accessible, equitable pathway for all students to demonstrate proficiency" (TE, page 156).

Students have choices when engaging in an assessment task. For example:

- Lesson 5: "Alternatively, students can respond to the prompts with written sentences, or even by talking through their answers out loud. If they do not draw a model, clarify that we'll use these ideas to build an energy transfer model as a class" (TE, page 132).
- Lesson 6: "Universal Design for Learning: This assessment encourages students to demonstrate their understanding of key skills and concepts from the unit so far. Some students may benefit from using multiple modalities to *express* their thinking for any or all of the questions on this assessment. You may consider allowing some students to verbally explain their answers with you or with another student acting as a scribe to record their thinking on paper. Some students may benefit from using gestures, images, or manipulatives to support their explanations as opposed to written text. In each case, encouraging students to use multiple modalities to show their thinking creates a clear, accessible, equitable pathway for all students to demonstrate proficiency" (TE, page 156).
- Lesson 6: "Some students may benefit from using multiple modalities to express their thinking for any or all of the questions on this assessment. You may consider allowing some students to verbally explain their answers with you or with another student acting as a scribe to record their thinking on paper. Some students may benefit from using gestures, images, or manipulatives to support their explanations as opposed to written text. In each case, encouraging students to use multiple modalities to show their thinking creates a clear, accessible, equitable pathway for all students to demonstrate proficiency" (TE, page 156).

- Lesson 11: "Universal Design for Learning: This project offers students the chance to express their ideas using a diverse set of modalities. Allowing students to *express* their ideas using multiple modalities supports student ownership of their learning by giving students choice, access, and control in navigating their own understanding around the science ideas. Encourage students to choose a modality that works for their group" (TE, page 222).
- Lesson 11: Students have a choice in modality for the final project. "Make a slide deck, poster, infographic, or video with your group" (TE, page 222).

Suggestions for Improvement

None

III.E. COHERENT ASSESSMENT SYSTEM

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

Rating for Criterion III.E. Coherent Assessment System	*Extensive* *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials include pre-, formative, summative, and self-assessment measures that assess three-dimensional learning. Assessments match the stated learning goals and fit together into a system that allows the teacher to gain information about individual student learning.

The Assessment System Overview (beginning on TE, page 228) provides information to the teacher about how to use different assessment opportunities in the unit.

Pre-assessment:

- The Assessment System Overview says, "The student work in Lesson 1 available for assessment should be considered a pre-assessment. It is an opportunity to learn more about the ideas your students bring to this unit. Revealing these ideas early on can help you be more strategic in how to build from and leverage student ideas across the unit" (TE, page 228). However, specific pre-assessment goals (e.g., specific elements of any one of the three dimensions) are not mentioned and the narrative does not clarify which elements would be assessed.
- Lesson 1: "The initial model developed on day 2 of Lesson 1 is a good opportunity to pre-assess student understanding of which parts of the system are important for explaining what happened in Texas" (TE, page 228).

Formative assessment:

- Lesson 5*:* "In Lesson 5, students get a chance to make a claim about the relationship between two variables in a simulation of electricity moving through a wire, and then plan and conduct an investigation, and analyze the data to use as evidence to either support or refute their claim" (TE, page 228).
- Lesson 9: "Students make a complex energy transfer model to show how adding a battery could improve the reliability of the electric grid. They incorporate many of the conventions and ideas we have developed across the unit" (TE, page 229).
- Lesson 10: "This electronic Exit Ticket addresses 3-D elements associated with the lesson-level performance expectations from Lessons 9 and 10. This assessment is designed to be easy to gather information about where your students are still struggling to apply certain practices in the context of engineering" (TE, page 229).
- See additional evidence under Criterion III.B.

Self-Assessment:

- The Teacher Handbook includes student self-assessment charts related to their performance giving and receiving feedback.
- Lesson 1: "The Progress Tracker is a formative self-assessment tool that is designed to help students keep track of important discoveries that the class makes while investigating phenomena, and to help them figure out how to prioritize and use those discoveries to explain the phenomenon they're working on. The Progress Tracker is a metacognitive tool requiring students to (1) look back at what we have done, (2) make decisions about where we are going next, and (3) consider what we don't know" (TE, page 42).
- Lesson 6: After the transfer task, the teacher is told to say, "Let's reflect for a moment on how we got there. Do you think you could have shown mastery on this Transfer Task before we began this unit? Encourage students to be honest. If they don't think that they've been making much progress, this is a time to say so…. If assessment at your school allows for students to get multiple attempts at mastery, emphasize the third question. Say, If you haven't shown mastery yet, what can you do next to change that? What are some resources you can use to master energy transfer models, and energy transfer through particles and fields?" (TE, page 157).

Summative:

- Lesson 6: In this assessment, students get a chance to use what they have figured out about generators to model and explain energy transfer in a motor.
- Lesson 8: This Electronic Exit Ticket addresses elements of the three dimensions associated with the lesson-level PEs from Lessons 7 and 8, which function together as a problematize/putting the pieces together routine for the first lesson set of the unit. This assessment is designed to be easy to gather information about where your students are still struggling to put the pieces together. Two of the five questions are not aligned to the DCIs.
- Lesson 11: The Design Challenge Key document contains a chart that outlines each question and their alignment with each dimension. The short answer questions contain a rubric that is

separated into three sections. Each section contains what to look for and an example of the level of understanding.

- Lesson 11: The Sand and Mirrors Task Key document contains a chart that outlines each question and their alignment with each dimension. Although the key contains responses, a range of student responses is not included.

Suggestions for Improvement

None

III.F. OPPORTUNITY TO LEARN

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

Rating for Criterion III.F. Opportunity to Learn	*Extensive* *(None, Inadequate, Adequate, Extensive)*

The reviewers found extensive evidence that the materials provide multiple opportunities for students to demonstrate performance of practices connected with their understanding of DCIs and CCCs because students are provided with many opportunities to demonstrate their learning in all three dimensions in the unit for some of the claimed learning.

For some of the claimed learning in the unit, there are multiple opportunities for students to demonstrate their growth over time. For example, students have iterative opportunities to demonstrate their learning for key claimed learning in the DCI of **PS3.B: Conservation of Energy and Energy Transfer**, SEP of **Developing and using Models**, and CCC of **Systems and System Models:**

- Lesson 1: Students develop a model that helps show and explain the blackouts. “Look for students modeling more than one system, for example, the power plant, the wires and the houses; an indication of energy transfer between system, for example, arrows connect systems or the systems are drawn in a line; the second model indicates a clear change to the system and the repercussions of that change in terms of energy transfer” (TE, page 37).
- Lesson 2: Students dissect a power strip to better understand analogous structures that show how systems transfer electrical energy before developing a model to showcase understanding. “Develop a model for explaining how the power strip works. Show slide H. Emphasize that you are going to ask students to use their observations to develop a model for explaining how the structure of the objects they just observed enables the system to function” (TE, page 61).
- Lesson 5: Students develop a model based on evidence to illustrate the energy and matter changes in a generator, including energy transfer between moving parts to explain how the system functions. “Make connections between matter changes, energy transfer and fields.

Present slide X and direct students to return to their table to work in groups to consider the prompts: Can we track how matter changes or moves through a system? What does matter tell us about how energy transfers? Encourage students to begin sketching an energy transfer diagram to help them think through the prompts, using key components on the diagram of a motor as the starting point" (TE, page 132).

- Lesson 7: Students develop a model to show the effect of insufficient energy supply and how it can lead to reduced energy transfer which results in buildings losing power. "Ask students to model in small groups. Present slide B. create groups of three for students to create a model showing how insufficient supply of energy could have affected energy transfer into certain communities in Texas when the temperature dropped. We recommend modeling at the macro scale, including more than one power plant, a transport system and at least two communities. Begin by deciding which systems to model and how energy transfers through them. Project slide C which presents a series of decisions the class will need to make as a part of modeling" (TE, page 165).
- Lesson 9: Students develop an energy transfer model to predict the stability in the distribution of electric energy. "Represent a reliable system using an energy transfer model. Present slide B. Distribute Modeling Reliability. Ask students to complete two models to show how adding a battery to a system affects its reliability. Give students 8 minutes. Compare energy transfer models with a partner and give feedback" (TE, page 189).

Students receive feedback from the teacher and peers and apply them to improve their performance:

- Lesson 2: The teacher is told, "if students' models do not show connections clearly enough to determine whether devices would receive energy, leave a sticky note on their model, prompting: What structures are connected to what? How does your model help us see which devices receive energy?" (TE, page 62).
- Lesson 3: "Instruct students to switch models (handouts) with another student pair and follow the slide's instructions to annotate similarities, differences, and uncertainties in their peers' models. Give students about 5 minutes to complete their annotations. After students get their own handouts back, give them an additional five minutes to process and incorporate feedback into their own models" (TE, page 87).
- Lesson 6: "When a pair of students is finished with their model, ask them to trade work with another pair of students. Give each pair of students a copy of Rubric for Modeling and instruct them to use the rubric to evaluate the others students' work. When both pairs have gone through the rubric, they should talk through and revise their work, then prepare to hand in this work at the end of class" (TE, page 144).
- Lesson 7: The teacher is told, "You will collect Texas County Data Analysis at the end of the day to provide even more focused feedback." (TE, page 171).
- Lesson 9: "Compare energy transfer models with a partner and give feedback. Present slide C. Ask students to switch models with a partner. Distribute Peer Rubric for Modeling and give students 5 minutes to give feedback to their peer's model. Then give them a couple more minutes to revise their own model based on the feedback they received" (TE, page 191). At the end of the class day, students are asked to self-reflect on how well they gave and received feedback (TE, page 194).

- Lesson 11: “Invite two students from each group of four to stay while two students stray. Display slide H and pass out two copies of the Peer Interactions Support handout to each group, one for the stayers and one for the strayers. Ask each group to nominate half of their group to be the first ‘strayers.’ Stayers need to be ready to share their ideas about their design solution with the visiting strayers” (TE, page 222). The Peer Interactions Support handout includes prompts such as “I notice that your solution seems to be missing ___. It would be more complete if you added ___.” After students receive feedback, the next step for the class is “Review and incorporate peer feedback into community plans. Tell groups to go back to their original groups and process the feedback that the stayers received from other groups and ideas that the strayers got from the other presentations. Display slide I to suggest a structure for reviewing and incorporating feedback. Explain, We use peer feedback to improve our work, making it more clear, more accurate, and better supported by evidence. When you receive feedback, you should take these steps” (TE, page 222). The teacher is also told, “Some students might not feel comfortable highlighting the changes they made to their design solutions based on peer feedback because they might get a lower score. Make sure they understand that what matters in this step of the design process is their response to the feedback and to justify the changes they make” (TE, page 223).

Suggestions for Improvement

None

OVERALL CATEGORY III SCORE: **3** (0, 1, 2, 3)	
Unit Scoring Guide – Category III	
Criteria A-F	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

SCORING GUIDES

SCORING GUIDES FOR EACH CATEGORY

UNIT SCORING GUIDE – CATEGORY I (CRITERIA A-F)

UNIT SCORING GUIDE – CATEGORY II (CRITERIA A-G)

UNIT SCORING GUIDE – CATEGORY III (CRITERIA A-F)

OVERALL SCORING GUIDE

Scoring Guides for Each Category

Unit Scoring Guide – Category I (Criteria A-F)	
3	At least adequate evidence for all of the unit criteria in the category; extensive evidence for criteria A–C
2	At least some evidence for all unit criteria in Category I (A–F); adequate evidence for criteria A–C
1	Adequate evidence for some criteria in Category I, but inadequate/no evidence for at least one criterion A–C
0	Inadequate (or no) evidence to meet any criteria in Category I (A–F)

Unit Scoring Guide – Category II (Criteria A-G)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least two criteria
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

Unit Scoring Guide – Category III (Criteria A-F)	
3	At least adequate evidence for all criteria in the category; extensive evidence for at least one criterion
2	Some evidence for all criteria in the category and adequate evidence for at least five criteria, including A
1	Adequate evidence for at least three criteria in the category
0	Adequate evidence for no more than two criteria in the category

OVERALL SCORING GUIDE	
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)