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|  | **Sabrina Ewald: Unit 6 Plan with Lessons**  |
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| **Grade and Subject** | 10th, 11th, 12th Grades/AP Environmental Science | **Instructional Time**(min.) | 5 90-minutes class periods |
| **Unit Title (Topic)** | Energy Resources & Energy Production |
| **Curriculum Spark / Anchoring Phenomenon** |  1. Driving Question
2. Phenomena (list “Big Ideas”):

**Types of Energy Resources****Energy Use & Units****Environmental and Economic Impacts of Energy Use & Production** |
| **Learning Goals/ Lesson Topics**  | List main lesson concepts related to grade level NGSS PEs/ TEKS that support student learning goals. |
| **College Board****The AP Environmental Science Unit 6 examines human use of renewable and nonrenewable resources of energy and its impacts on the environment. Energy consumption differs throughout the world and the availability of natural energy resources depends on the region’s geologic history. Subsequent units will examine the impact of human activity on the atmosphere, land, and water.****In this unit, students practice identifying where natural energy resources occur (e.g., coal, crude oil, ores) on a global map. They can also practice describing other forms of energy and differentiating between nonrenewable and renewable forms of energy. Text analysis is also an important skill for students to build upon in this unit. When reading texts about topics in this unit, students can practice identifying the claims as well as describing the perspectives and assumptions of the author.** **NGSS**

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| **HS-ESS3-2.** | **Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.\***[Clarification Statement: Emphasis is on the conservation, recycling, and reuse of resources (such as minerals and metals) where possible, and on minimizing impacts where it is not. Examples include developing best practices for agricultural soil use, mining (for coal, tar sands, and oil shales), and pumping (for petroleum and natural gas). Science knowledge indicates what can happen in natural systems—not what should happen.] |

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| **Select grade level NGSS** [**Performance Expectations**](https://www.nextgenscience.org/search-standards?keys=&type%5B%5D=performance_expectation) **(PEs)** | **Select grade level NGSS** [**Performance Expectations**](https://www.nextgenscience.org/search-standards?keys=&type%5B%5D=performance_expectation) **(PEs) that support student learning goals.** For NGSS, PE color coding reflects its 3-dimensional learning components. Search the [Evidence Statements](https://www.nextgenscience.org/evidence-statements) for details on what students should know and do. |
| **Supported claims** 1. **Students describe\* the nature of the problem each design solution addresses.**
2. **Students identify the solution that has the most preferred cost-benefit ratios.**

**Identifying scientific evidence a Students identify evidence for the design solutions, including:** 1. **Societal needs for that energy or mineral resource;**
2. **The cost of extracting or developing the energy reserve or mineral resource;**
3. **The costs and benefits of the given design solutions; and**
4. **The feasibility, costs, and benefits of recycling or reusing the mineral resource, if applicable.**

**Evaluation and critique a Students evaluate the given design solutions, including:** 1. **The relative strengths of the given design solutions, based on associated economic, environmental, and geopolitical costs, risks, and benefits;**
2. **The reliability and validity of the evidence used to evaluate the design solutions; and**
3. **Constraints, including cost, safety, reliability, aesthetics, cultural effects environmental effects.**

**Reasoning/synthesis** 1. **Students use logical arguments based on their evaluation of the design solutions, costs and benefits, empirical evidence, and scientific ideas to support one design over the other(s) in their evaluation.**
2. **Students describe\* that a decision on the “best” solution may change over time as engineers and scientists work to increase the benefits of design solutions while decreasing costs and risks.**
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| **Unpack the** [**3-D learning components**](https://www.nextgenscience.org/three-dimensions) **of the NGSS Performance Expectations/TEKS in the table below.** For NGSS guidance, see the [NGSS Topic Arrangements](https://ngss.nsta.org/AccessStandardsByTopic.aspx) and [NGSS DCI Arrangements](https://ngss.nsta.org/AccessStandardsByDCI.aspx). Use tools to [unpack](https://ngss.nsta.org/ngss-tools.aspx) each PE separately. |
| [**Science and Engineering Practices**](https://www.nextgenscience.org/sites/default/files/resource/files/Appendix%20F%20%20Science%20and%20Engineering%20Practices%20in%20the%20NGSS%20-%20FINAL%20060513.pdf) **(SEP)**Engaging in Argument from Evidence Engaging in argument from evidence in 9– 12 builds on K–8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed world(s). Arguments may also come from current scientific or historical episodes in science. • Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).**College Board (Process)**6.1 Renewable and Nonrenewable ResourcesExplain environmental concepts, processes, or models in applied contexts.6.2 Global Energy ConsumptionCalculate an accurate numeric answer with appropriate units<https://www.nextgenscience.org/pe/hs-ess3-2-earth-and-human-activity> <https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-ESS3-2%20Evidence%20Statements%20June%202015%20asterisks.pdf>  | **Disciplinary Core Ideas (DCI)**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. 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. (secondary)**College Board (Concepts)**6.5 – 6.12 Fossil Fuels, Solar, Biomass, Hydroelectric, Geothermal, Hydrogen Fuel Cell, Wind Energy ResourcesExplain relationships between different characteristics of environmental concepts, processes, or models represented visually.6.13 Energy ConsumptionCalculate an accurate numeric answer with appropriate units. | **Cross cutting Concepts****Connections to Engineering, Technology, and Applications of Science** Influence of Science, Engineering, and Technology on Society and the Natural World• Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. • Analysis of costs and benefits is a critical aspect of decisions about technology. **Connections to Nature of Science** Science Addresses Questions About the Natural and Material World • Science and technology may raise ethical issues for which science, by itself, does not provide answers and solutions. • Science knowledge indicates what can happen in natural systems — not what should happen. The latter involves ethics, values, and human decisions about the use of knowledge. • Many decisions are not made using science alone, but rely on social and cultural contexts to resolve issues. |

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| **Complete each of the 5E Instructional Model section(s). Each will correspond to a lesson in your unit plan** |

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| **Engage: *Interest in a concept is generated and students’ current understanding is assessed.*** ACTIVATE interest: Introduce curriculum spark/ anchoring phenomenon and driving question. |
| * Creates equity in the classroom
* Engages students in the concepts through a short activity or relevant discussion
* Connects students’ past and present experiences
 | * Creates interest and generates curiosity
* Uncovers students’ current knowledge and misconceptions
* Initiates students’ investigation into the curriculum spark/ anchoring phenomenon based on an observation, problem, or question “puzzle through the problems”
 |
| **Curriculum Spark / Phenomenon-based Driving/ Essential Questions** **(questions students are likely to ask about the lesson topic)**. **Driving Questions are authentic and student-focused and relates to investigating the PEs/standards and phenomenon.** |
| TV show that had a man powering appliances using a stationary bike. |

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| **Lesson Resources Aligned with Standards** |
| **Lesson Resource** (sequenced with titles and links) |
| * **Peardeck**
* **Google Slides**
* **Canvas**
* **Switch Classroom**
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| **Lesson Activities:** Describe what you will do(experiment, demonstration, video, visualization, Virtual Field Experience (VFE), reading, etc.). The activities must be coherently sequenced to help build understanding of PE/TEKS). For each activity, please provide details of the procedure including timing, teacher guidance, student prompts, strategies for discussions and differentiation, etc.  |
| To introduce the energy unit, students engaged with a Peardeck presentation built in Google Slides. Students performed calculations, evaluated the concept of energy and how much it takes to power basic, daily needs, answered concept questions to spark discussions, and brainstorm ideas of how they use energy on a daily basis. Students virtually participated in a tactile activity to demonstrate energy is action and then calculate the amount of energy generated by picking up and dropping a 5lb bag of potatoes or rice. This sparked a lot of interest in understanding energy production and use.[**Energy Resources and Production Engage Activity**](https://docs.google.com/presentation/d/1SJpHQ9RQ7XSvSU4STol8LyqFSFSlhoDs9qZPL3W-GjI/edit?usp=sharing) |
| **Formative Assessment:** Provide an example of, or describe in detail, the assessment that you will carry outto check for understanding of lesson concepts**.** Examples include activity sheet, summary, exit ticket, think-pair-share, etc.). Informs how the lesson is going. Looking for EVIDENCE that students are learning.  |
| Describe the Assessment that you will use.**I used Peardeck to embed interactive slides for students to respond to prompts and questions.**What **evidence** will indicate that students understand the concepts and key SEPs?**The evidence will be their responses that I can evaluate using the reports generated by Peardeck. From there I can determine which concepts students are understanding best and those that students need more guidance and practice.** |

**AND/OR**

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| **Explore: *Students participate in activities to explore questions related to a concept****.* BUILD Knowledge: Learn the science behind concepts. |
| * Students explore the concepts with others to develop a common set of experiences
* Provides students with one or more actual experiences
* Offers opportunities for creative thinking and skills development
* Students make and record observations and ideas, make connections, and ask questions
* Students usually work in groups
* Teacher acts as coach or facilitator in student-led investigations
 |
| **Curriculum Spark/ Questions that students are likely to ask about the lesson topic** |
| **You are off to college and have a wonderful apartment and living on your own for the first time! What would your personal electric bill be at the end of the month?** |
| **Lesson Activities** (experiment, demonstration, video, visualization, reading, etc., coherently sequenced to help build understanding of PE/standard)For each activity, provide details of the procedure including timing, teacher guidance, student prompts, strategies for discussions and differentiation, etc.  |
| [**From Ground to Electricity – Energy Analysis Lab**](https://docs.google.com/spreadsheets/d/1e9PGi94k0f4K7C98uEraY29QlviTmDoRAGj--KhZnig/edit?usp=sharing)Students have 45-50 minutes to complete this assignment to examine and calculate their personal energy use. They will learn more about kW, kWh, and MW.Students will next calculate the quantity of coal, natural gas, and renewable resources that would be required to generate the amount of energy they use. From here, students will then extrapolate to calculate the energy consumption for their city and the world, using their personal energy use as a baseline.Finally, students will investigate the land requirements for implementing renewable energy resources for local electricity generation. Students then must formalize strategies to reduce energy use.The results of the assignment will be used to drive our discussion about nonrenewable vs renewable energy resources and the capability of renewables meeting our energy needs. |
| **Formative Assessment** (activity sheet, Venn diagram, summary, **exit ticket**, think-pair-share, etc. to check for understanding of lesson concepts). Informs how the lesson is going. Looking for EVIDENCE that students are learning. |
| The reflection and analysis questions in the assignment provides a snapshot of their comprehension and understanding of energy calculations, and energy resources. |

 **Exit ticket.** Evidence that student has mastered skills and content.

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| **Explain: *Students construct their understanding of a concept and develop evidence-based explanations.*** DEVELOP Concepts: Research information using real-world data. |
| * Develops students’ explanation for the concepts they have been exploring with teacher providing supporting guidance
* Students describe their observations and come up with explanations
* Students listen critically to each other’s explanations
* Students learn to apply and interpret evidence
* Develops students’ academic vocabulary by applying scientific terms once students have figured out the lesson concepts
* Teacher guides students’ reasoning, asks appropriate questions, and directs students to additional supporting resources
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| **Curriculum spark/ Questions that students are likely to ask about the lesson topic** |
| Is there a renewable that could feasibly produce all the electricity for Frisco? |
| **Lesson Activities** (experiment, demonstration, video, visualization, reading, etc., coherently sequenced to help build understanding of PE/standard)For each activity, provide details of the procedure including timing, teacher guidance, student prompts, strategies for discussions and differentiation, etc.  |
| [**Energy Resources & Consumption Assignment**](https://www.youtube.com/watch?v=DiNaJAk20hw&feature=emb_logo)Students have approximately 60 minutes to complete this assignment, during which they complete this structured activity to learn about fossil fuel formation, the resources used to generate electricity in the U.S., evaluate GHG’s associated with burning fossil fuels. Students end the assignment by creating hand-drawn diagrams to illustrate how electricity is generated using coal and natural gas and how a dam generates electricity.[**Global Energy Consumption Class Activity & Intro to Fossil Fuel Extraction Assignment**](https://docs.google.com/presentation/d/1qpKNmxEy0vE19n-xpnsjJvhUe0dBUq7An7Qzqsf3Xx8/edit?usp=sharing)[**Video**](https://www.youtube.com/watch?v=hwDTYywgXbs&feature=emb_logo) **explain the activity and assignment in Canvas.**This assignment was designed using Switch Classroom resources. Students have approximately 50-60 minutes to complete this assignment where they explore the environmental, economic, and societal implications of using coal and natural gas to generate electricity. Students do a deeper dive into oil extraction and the environmental and economic impacts of these methods. At the end of the assignment, students learn more about the Deepwater Horizon disaster and the impacts it had on aquatic ecosystems. |
| **Formative Assessment** (activity sheet, diagram, summary, exit ticket, think-pair-share, etc. to check for understanding of lesson concepts). Informs how the lesson is going. Looking for EVIDENCE that students are learning. |
| Analysis of the student’s work provides evidence of their learning. Students will be creating hand-drawn, original info graphics and diagrams where they apply their knowledge. Their knowledge will also be used to successfully complete their next class activity and assignment over Global Energy Consumption and Methods of Oil Extraction. |

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| **Elaborate: *Students deepen and expand their understanding by applying their understanding in new contexts.***APPLY Learning: Utilize information in new ways.  |
| * Extends students’ understanding or applies what they have learned in a new setting
* Students use the information they have gained to propose solutions and extend their learning to new situations
* Teacher supports students in broadening their understanding and extend ideas to other situations so they can draw broader conclusions beyond their experiment or investigation
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| **Phenomenon-based Driving Questions** **Extended/Applied in a New Context** (questions students are likely to ask about the lesson topic) |
| How did the dish soap brand Dawn become associated with fossil fuels? |
| **Lesson Activities** (experiment, demonstration, video, visualization, reading, etc., coherently sequenced to help build understanding of PE/standard)For each activity, provide details of the procedure including timing, teacher guidance, student prompts, strategies for discussions and differentiation, etc.  |
| [**Coal and Oil Recap and Intro to Methods of Oil Extraction Assignment**](https://docs.google.com/presentation/d/1f7MNMntKg0MJCYs17VgTrUJ3I4BA6ib8kyFab-rwICs/edit?usp=sharing)[**Methods of Oil Extraction Assignment**](https://docs.google.com/presentation/d/16GljEtikxdoL8ZG9nREUrMIc5XAP7QWhfbbr8FOHhHs/edit?usp=sharing)This elaboration activity allows students to become more familiar with advanced technologies used to extract oil and how these innovations can minimize environmental impacts. Students are given the opportunity to reflect on the knowledge they have gained over the course of the unit and provide well-informed responses as to whether fossil fuels will continue to be used the possibilities of integrating renewable energy resources. |
| **Formative Assessment** (activity sheet, Venn diagram, summary, exit ticket, think-pair-share, etc. to check for understanding of lesson concepts). Informs how the lesson is going. Looking for EVIDENCE that students are learning. |
| There is a free response question at the conclusion of the Methods of Oil Extraction Assignment where students will be given the chance to demonstrate their knowledge and understanding. The free response question requires students to provide comprehensive responses concerning the use of nonrenewable and renewable energy resources. |

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| **Evaluate: *Students and teachers have opportunities to assess students’ understanding of a concept.*** DEMONSTRATE Ability: Write, illustrate, create, etc. artifacts that accurately describe knowledge gained. |
| * Students have the opportunity to demonstrate understanding of skills and concepts, and evaluate their own progress
* Teacher evaluates students’ understanding and progress, as well as their own instructional practice, and may implement alternative assessment strategies
 | * Enables adjustment of misconceptions, reinforces students’ understanding of the PE concepts in greater depth
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| **Phenomena-based Driving Question (and** questions about the unit topics) |
| How did students answer the driving question? **Students answered the driving questions by being active participants in class discussions and activities and by completing their individual and group assignments.** How do their answers align with their hypotheses, results of the assignment (.e.g., lab activity) scientific evidence? **Most of the work provided from students aligned with the goals and objectives of each task. Their data collection, analysis, original products, and reflective analysis throughout the course of the unit could be used to assess their understanding and comprehension.** |
| **Skills Learning Performance (SEPs) Goals** (assess student skills related to the lesson).  |
| Evaluate competing design solutions to a real-world problem based on scientific ideas and principles, empirical evidence, and logical arguments regarding relevant factors (e.g., economic, societal, environmental, ethical considerations).Each assignment provided an opportunity to evaluate energy resources and their environmental, economic, and societal implications using data and resources provided to them. |
| **Content Learning Performance (DCIs, CCCs, TEKS) Goals** (assess student mastery of lesson content).  |
| 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. (secondary)Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. Analysis of costs and benefits is a critical aspect of decisions about technology. Students demonstrated their skills by calculating their personal energy use (From Ground to Electricity), analyzing data related to energy resources used by countries throughout the world (Global Energy Consumption), and learning about the reliability, cost, safety, and aesthetics of renewable energy resources (Renewable Energy Plan Assignment). Students expressed their knowledge and understanding engineering innovations when completing the Fossil Fuels Extraction Assignment and Methods of Oil Production Assignment.  |
| **Summative Assessment:** How will students demonstrate that they have achieved the objectives of the unit lessons? EVIDENCE.(quiz, test, report, presentation, poster, video, model, etc. to demonstrate students’ understanding about the PEs/standards) |
| [**Renewable Energy Plan Assignment**](https://www.youtube.com/watch?v=CExKqst1CPQ&feature=emb_logo)[**Group Research Document**](https://docs.google.com/presentation/d/1MNiyZDNLOH8tV8N94_qr8j_D5uCILvVGjSQwYraQOSQ/edit?usp=sharing) What are the observable features will you look for to assess student performance by the end of the unit? * What evidence will you look for to determine that students learned the skills that relate to the SEPs associated with the PE(s) for the unit lessons.

**The Renewable Energy Plan Assignment provided evidence of student learning as they were required to apply their knowledge of energy production for creating an energy plan for their city. Students were required to demonstrate their knowledge of economic and environmental implications of all energy resources and determine which renewables were best suited for meeting the energy needs of their city.*** What evidence will you look for to determine that students learned the content that relates to the DCIs associated with the PE(s) for the unit lessons.

**Evidence will be determined by the thoroughness of their Renewable Energy Plan and how well it was organized and presented for the city council. It will be clear that students had a firm grasp of the content if they plan clearly illustrated the understanding of the pros and cons of each renewable energy resources. Their justifications as to WHY they chose the resources in their presentation.****Students did complete a Unit 6 Summative Test**Other example questions: * How have students used reasoning to connect the evidence?

**Many of the assignments required students to individually or in small groups to process information and formulate solutions, reflections, and explanations as they make connections to the real world. The students must conduct a lot of self-reflection as they connect the concepts of energy and energy production to their daily activities and current events.*** How have students organized data (e.g., with graphs) from models (e.g., computational simulations) and observations over time. How have students used their analysis of the data?

**Students analyzed data using EIA and Our World in Data to receive a real world perspective of energy resources and consumption throughout the years. Students also collected personal data of their energy use as a way to kick off the energy unit and use as a baseline for all their assignments.** |

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| **Teacher Preparation**  |
| **Student Misconceptions**(potential student ideas that are problematic when engaging in the lesson) | **Scientific Terminology** (vocabulary named once students “figure out” concepts of lesson) |
| **Fossil fuels have no positive impact on the environment.****Hydraulic Fracturing very detrimental to the environment.****Renewable energy resources can easily and quickly replace fossil fuels to meet energy needs.** | **Hydraulic Fracturing****Petroleum, Oil Shale, Tar Sands****GHG’s** |
| **Supporting Information**  |
| **References**(links to cite sources of data, images, websites, etc.) | **Background Reading**(for teachers and/or students) |
| [**Switch Classroom**](https://classroom.switchon.org/)[**EIA**](https://www.eia.gov/)[**Our World in Data**](https://ourworldindata.org/grapher/share-of-primary-energy-consumption-by-source?time=earliest..latest&country=~SWE)**PTSI Resources** |  |

 **Resources/ References (Examples of how to cite your sources)**

* + BBC Four: Ancient Apocalypse: The Maya Collapse, <https://www.youtube.com/watch?v=fuFL5ETw6oQ>
	+ Brenner, M., Rosenmeier, M., Hodell, D., & Curtis, J. (2002). PALEOLIMNOLOGY OF THE MAYA LOWLANDS: Long–term perspectives on interactions among climate, environment, and humans. *Ancient Mesoamerica,* *13*(1), 141-157. Retrieved November 6, 2020, from http://www.jstor.org/stable/26308050
	+ Gill, Richardson (2018). The Great Maya Droughts: Water, Life, and Death, University of New Mexico Press.
	+ Hodell, D., Curtis, J. & Brenner, M. (1995). Possible role of climate in the collapse of Classic Maya civilization. *Nature* **375,**391–394. https://doi.org/10.1038/375391a0
	+ Marx, W., Housnchild, R. and Bornmann, L. (2017). The Role of Climate in the Collapse of the Maya Civilization: A Bibliometric Analysis of the Scientific Discourse, Climate 5(4):88**.** DOI: [10.3390/cli5040088](https://www.researchgate.net/deref/http%3A//dx.doi.org/10.3390/cli5040088)