Environmental Science
Grades 11 - 12
Unit 5: Energy and Sustainability

New Jersey Student Learning Standards - Science

Established 2016-2017
Revised 2018-2019
Revised 2019-2020
Revised 2020-2021
Revised 2021-2022
Revised 2022-2023

Marking Period	Unit Title	Recommended Instructional Days
4	**Energy and Sustainability**	**45 Days**

NJSLS - Science: ***TItle***	**NJSLS - Science:** ***Performance Expectations***	**Recommended Activities, Investigations, Interdisciplinary Connections, and/or Student Experiences to Explore NJSLS-S within Unit**
HS-LS2: Ecosystems: Interactions, Energy and Dynamics HS-ESS3: Earth and Human Activity HS-PS3 Energy	HS-LS2-1 Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales HS-LS2-2 Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions HS-LS2-4 Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem. HS-LS2-5 Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere,	

	atmosphere, hydrosphere, and geosphere HS-LS2-6 Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity. HS-LS2-8 Evaluate the evidence for the role of group behavior on individual and species' chances to survive and reproduce. HS-ESS3-1 Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. HS-ESS3-2 Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. HS-ESS3-3 Create a computational simulation to illustrate the relationships among management of	

	natural resources, the sustainability of human populations and biodiversity. HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems. HS-ESS3-5 Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth's systems. HS-ESS3-6 Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity. 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	
FOUNDATION Disciplinary: ***Core Idea***	**FOUNDATION Disciplinary:** ***Statement***	
LS2A – Interdependent Relationships in Ecosystems	Ecosystems have carrying capacities, which are limits to the numbers of organisms and populations they can support. These limits result from such factors as the availability of living and nonliving resources and from such challenges such as predation, competition, and disease. Organisms would have the capacity to produce populations of great size were it not	**Essential Question/s:** How do humans power their technology, and what are the ramifications of this energy production?

LS2B – Cycles of Matter and Energy Transfer in Ecosystems	for the fact that environments and resources are finite. This fundamental tension affects the abundance (number of individuals) of species in any given ecosystem. Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. Plants or algae form the lowest level of the food web. At each link upward in a food web, only a small fraction of the matter consumed at the lower level is transferred upward, to produce growth and release energy in cellular respiration at the higher level. Given this inefficiency, there are generally fewer organisms at higher levels of a food web. Some matter reacts to release energy for life functions, some matter is stored in newly made structures, and much is discarded. The chemical elements that make up the molecules of organisms pass through food webs and into and out of the atmosphere and soil, and they are combined and recombined in different ways. At each link in an ecosystem, matter and energy are conserved. Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged among the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.	**Lab Activities** **Activity Description**: "Building a Power Plant" Students will design a power plant that can mimic what happens in a traditional fossil fuel fired power plant. Extension How can this model be modified to support renewable energy? **Activity Description**: "Your Household Energy Consumption" Students will keep a record of their energy consumption and analyze their electricity bills. The intention of the activity is to determine where energy is being used, and find any wasteful behaviors. **Activity Description**: "Build a Solar Collector" Students will work in teams of three to design solar collectors. The students vote on their favorite designs based on cost, ease of use, and efficiency. Top designs can be constructed and evaluated for their effectiveness. **Activity Description**: "Repurposed Wind Turbines" Students will create a wind turbine from things found in the cafeteria. The turbine needs to be able to lift a small load to be considered a success. Extension: Students can write a proposal for the Board of Education to adopt their design for implementation on the campus of BHS. **Activity Description**: "Modifying Packaging to be Eco-Friendly" Students will observe many different types of packaging on processed products. They will then brainstorm ways to improve the packaging with several eco friendly criteria in mind. Extension Students will need to design and draw or create their own new type of eco friendly packaging.

LS2C – Ecosystems Dynamics, Functioning and Resilience LS4D – Biodiversity and Humans	A complex set of interactions within an ecosystem can keep its numbers and types of organisms relatively constant over long periods of time under stable conditions. If a modest biological or physical disturbance to an ecosystem occurs, it may return to its more or less original status (i.e., the ecosystem is resilient), as opposed to becoming a very different ecosystem. Extreme fluctuations in conditions or the size of any population, however, can challenge the functioning of ecosystems in terms of resources and habitat availability. Moreover, anthropogenic changes (induced by human activity) in the environment—including habitat destruction, pollution, introduction of invasive species, overexploitation, and climate change—can disrupt an ecosystem and threaten the survival of some species. Biodiversity is increased by the formation of new species (speciation) and decreased by the loss of species (extinction). Humans depend on the living world for the resources and other benefits provided by biodiversity. But human activity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution,	**Projects** **Activity Description**: "Sustainable House" (Engineering) Students will engineer a prototype of a better building design to deal with the energy needs of the future. Students will draw blueprints to their new homes that include plans for zero waste and off the grid energy production. **Activity Description**: "Compost Generator" (Engineering) Students will utilize the garden area to test multiple factors on the efficacy of generating compost. They will design, construct and maintain their own compost bins to produce a usable product. **Interdisciplinary Connections:** Content: ELA NJSLS#: RST 9-10.8/RST.11-12.1/12.2/12.7/12.8 / WHST.9-12.2/12.5/12.7 Content: Math NJSLS#: MP.2/MP.4/ HSN-Q.A.1/HSN-Q.A.2/HSN-Q.A.3/ HSS-ID.A.1/ HSS-IC.A.1/B.6

	introduction of invasive species, and climate change. Thus sustaining biodiversity so that ecosystem functioning and productivity are maintained is essential to supporting and enhancing life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value.	
LS2D – Social Interactions and Group Behavior	Group behavior has evolved because membership can increase the chances of survival for individuals and their genetic relatives.	
ETS1B – 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.	
PS3A – Definitions of Energy	Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system. There is a single quantity called energy 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. At the macroscopic scale, energy manifests itself in multiple ways, such as in motion, sound, light, and thermal energy.	

PS3D – Energy in Chemical Processes and Everyday Life ETS1A Defining and Delimiting Engineering Problems ESS3A Natural Resources	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. Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. Resource availability has guided the development of human society. 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.	
ESS3B Natural Hazards	Natural hazards and other geologic events have shaped the course of human history; [they] have significantly altered the sizes of human populations and have driven human migrations.	
ESS3C Human Impacts on Earth	The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.	
ESS3D Global Climate Change	Though the magnitudes of human impacts are greater than they have ever been, so too are human abilities to model, predict, and manage current and future impacts. Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities.	
ESS2D Weather and Climate	Current models predict that, although future regional climate changes will be complex and varied, average global temperatures will continue to	

	rise. The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and biosphere.	
FOUNDATION **Science and Engineering Practices:** ***Core Idea***	**FOUNDATION** **Science and Engineering Practices:** ***Statement***	
Using Mathematical and Computational Thinking	Create a computational model or simulation of a phenomenon, designed device, process, or system. Use a computational representation of phenomena or design solutions to describe and/or support claims and/or explanations.	
Constructing Explanations and Designing Solutions	Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	

Developing and Using Models	Develop a model based on evidence to illustrate the relationships between systems or between components of a system. Use a model to provide mechanistic accounts of phenomena. Analyze data using tools, technologies, and/or models (e.g., computational, mathematical) in order to make valid and reliable scientific claims or determine an optimal design solution.	
Engaging in Argument from Evidence	Construct an oral and written argument or counter-arguments based on data and evidence.	
Planning and Carrying out Investigations	Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.	
Analyzing and Interpreting Data	Design or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations.	

FOUNDATION **Crosscutting Concepts:** ***Core Idea***	**FOUNDATION** **Crosscutting Concepts:** ***Statement***	
Systems and System Models	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.	
Stability and Change	Change and rates of change can be quantified and modeled over very short or very long periods of time. Some system changes are irreversible. Feedback (negative or positive) can stabilize or destabilize a system.	
Scale, Proportion and Quantity	The significance of a phenomenon is dependent on the scale, proportion, and quantity at which it occurs. Using the concept of orders of magnitude allows one to understand how a model at one scale relates to a model at another scale.	
Cause and Effect	Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.	
Energy and Matter	Energy drives the cycling of matter within and between systems.	
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. Energy cannot be created or destroyed—it only moves between one place and another place, between objects and/or fields, or between systems.	
Social and Emotional Learning: ***Competencies***	**Social and Emotional Learning:** ***Sub-Competencies***	
Self-awareness	Recognize one's feelings and thoughts and how they impact one's own behavior.	
Self-Management	Identify and apply ways to persevere.	
Social Awareness	Recognize and identify the thoughts, feelings, and perspectives of others. Demonstrate an awareness of the differences among individuals, groups, and others' cultural backgrounds. Demonstrate an understanding of the need for mutual respect when viewpoints differ.	
Responsible Decision Making	Demonstrate an awareness of the expectations for social interactions in a variety of settings. Develop, implement, and model effective problem-solving and critical thinking skills.	

Relationship Skills	Identify the consequences associated with one's actions in order to make constructive choices. Evaluate personal, ethical, safety, and civic impact of decisions. Establish and maintain healthy relationships.	

Assessments (Formative) ***To show evidence of meeting the standard/s, students will successfully engage within:***	**Assessments (Summative)** ***To show evidence of meeting the standard/s, students will successfully complete:***
Formative Assessments: ● Do Now questions ● Exit Polls ● Kahoot ● Current Event Essays	**Benchmarks:** ● District generated diagnostic test and four district assessments. **Summative Assessments:** ● Exams based on multiple choice, true/false, short answer responses ● Summative essays based on performance tasks ● Summative presentations

Differentiated Student Access to Content:
Teaching and Learning *Resources/Materials*

Core Resources	**Alternate Core Resources** *IEP/504/At-Risk/ESL*	**ELL Core Resources**	**Gifted & Talented Core Resources**
● Holt Environmental Science ● Basic Lab Equipment ● Chromebooks ● Newsela ● Smartboard ● biointeractive.org ● nasa.gov ● Kahoot	● modified tests ● supplemental study guides	● modified tests ● supplemental study guides ● multilingual assignments ● multilingual dictionary	● modified assignments ● supplemental assignments

Supplemental Resources

Technology:
- Chromebooks
- Smartboard

Other:

- NA

Differentiated Student Access to Content: Recommended *Strategies & Techniques*			
Core Resources	**Alternate Core Resources** ***IEP/504/At-Risk/ESL***	**ELL Core Resources**	**Gifted & Talented Core**
• Holt Environmental Science • Basic Lab Equipment • Chromebooks • Smartboard • biointeractive.org • nasa.gov • Crash Course video series	• Utilize a multi-sensory (VAKT) approach during instruction, provide alternate presentations of skills by varying the method (repetition, simple explanations, additional examples, modeling, etc.), modify test content and/or format, allow students to retake tests for additional credit, provide additional times and preferential seating as needed, review, restate and repeat directions, provide study guides, and/or break assignments into segments of shorter tasks	• Extend time requirements, preferred seating, positive reinforcement, check often for understanding/review, oral/visual directions/prompts when necessary, supplemental materials including use of an online bilingual dictionary, and modified assessment and/or rubric.	• Create an enhanced set of introductory activities, integrate active teaching/learning opportunities, incorporate authentic components, propose interest-based extension activities, and connect students to related talent development opportunities.

New Jersey Legislative Statutes and Administrative Code (place an "X" before each law/statute if/when present within the curriculum map)									
	Amistad Law: *N.J.S.A. 18A 52:16A-88*		Holocaust Law: *N.J.S.A. 18A:35-28*		LGBT and Disabilities Law: *N.J.S.A. 18A:35-4.35*	x	Standards in Action: *Climate Change*	x	Diversity and Inclusion *N.J.S.A. 18A:35-4.36a*