Unit 6: Energy- Renewable and Nonrenewable

Content Area: **Science**
Course(s):
Time Period: **MP3**
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NJSLS - Science

9-12.HS-ESS3-3	Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
9-12.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.
9-12.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.
9-12.HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
9-12.HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
9-12.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.
9-12.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.
9-12.HS-LS4-6	Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

Science and Engineering Practices

Using Mathematics and Computational Thinking

Create a computational model or simulation of a phenomenon, designed device, process, or system. (HS-ESS3-3)

Use a computational representation of phenomena or design soluons to describe and/or support claims and/or explanations. (HS-ESS3-6)

Create or revise a simulation of a phenomenon, designed device, process, or system. (HS-LS4-6)

Analyzing and Interpreting Data

Analyze data using computational models to make valid and reliable scientific claims. (HS-ESS3-5)

Engaging in Argument from Evidence

Evaluate competing design soluons to a real-world problem based on scientific ideas and principles, empirical

evidence, and logical arguments regarding relevant factors (e.g. economic, societal, environmental, and ethical considerations). (HS-ESS3-2)

Constructing Explanations and Designing Soluons

Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' invasions, models, theories, simulations, and 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. (HS-ESS3-1)

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. (HS-ESS3-4)

Evaluate a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-ETS1-3)

Disciplinary Core Ideas

ESS3.A: Natural Resources

Resource availability has guided the development of human society. (HS-ESS3-1)

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. (HS-ESS3-2)

ESS3.B: 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 migraines. (HS-ESS3-1)

ESS3.C: Human Impacts on Earth Systems

The sustainability of human societies and the biodiversity that supports them requires responsible management of natural resources. (HS-ESS3-3)

Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. (HS-ESS3-4)

ESS3.D: 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. (HS-ESS3-5)

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. (HS-ESS3-6)

ETS1.B: Developing Possible Soluons

When evaluating soluons, 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. (HS-ETS1-3)

LS4.C: Adaptaon

Changes in the physical environment, whether naturally occurring or human-induced, have thus contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline–and sometimes the lexicon–of some species. (HS-LS4-6)

LS4.D: Biodiversity and Humans

Humans depend on the living world for the resources and other benefits provided by biodiversity. But human acvity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, the 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. (HS-LS4-6)

Crosscutting Concepts

Cause and Effect

Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects. (HS-ESS3-1)(HS-LS4-6)

Systems and System Models

When investing 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. (HS-ESS3-6)

Stability and Change

Change and rates of change can be quantified and modeled over very short or very long periods. Some system changes are irreversible. (HS-ESS3-3),(HS-ESS3-5)

Feedback (negative or positive) can stabilize or destabilize a system. (HS-ESS3-4)

Influence of Science, Engineering, and Technology on Society and the Natural World

Modern civilization depends on major technological systems. (HS-ESS3-1),(HS-ESS3-3)

Analysis of costs and benefits is a critical aspect of technology decisions. (HS-ESS3-2)

Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-ESS3-2),(HS-ESS3-4)

New technologies can have deep impacts on society and the environment, including some that were not anticipated. (HS-ESS3-3)

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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 soluons. (HS-ESS3-2)

Science knowledge indicates what can happen in natural systems— not what should happen. The law involves ethics, values, and human decisions about the use of knowledge. (HS-ESS3-2)

Many decisions are not made using science alone but rely on social and cultural contexts to resolve issues. (HS-ESS3-2)

Science is a Human Endeavor

Science is a result of human endeavors, imagination, and creativity. (HS-ESS3-3)

Scientific Invesgaons Use a Variety of Methods

Science investors use diverse methods and do not always use the same set of procedures to obtain data. (HS-ESS3-5)

New technologies advance scientific knowledge. (HS-ESS3-5)

Scientific Knowledge is Based on Empirical Evidence

Science knowledge is based on empirical evidence. (HS-ESS3-5)

science arguments are strengthened by multiple lines of evidence supporting a single explanation. (HS-ESS3-5)

Rationale and Transfer Goals

In this unit, students construct an explanation based on evidence for how the availability of natural resources, and the occurrence of natural hazards are connected to human acvity. Additionally, while students are exploring this idea they apply scientific and engineering ideas to design, evaluate, and refine a device that can be used to minimize the impacts of natural hazards. They create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity, and create or revise a simulation to test a solution to mitigate adverse impacts of human acvity on biodiversity. They use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human acvity and evaluate or refine a technological solution that reduces the impacts of human activities on natural systems. The crosscutting concepts of cause and effect, stability and change, systems, and system models are called out as an organizing concepts for these disciplinary core ideas.

Enduring Understandings

- We need energy to live. Everything we use in modern society relies on energy as well. (cars, phones, appliances, etc.)
- Most of the energy in the US is powered by non-renewable energy sources. These resources are finite, and many are controlled by other countries.
- Non-renewable resources also generate pollution and are used by the Middle East for resources.
- Energy costs us money. We pay the electric company or oil company every month for heat and electricity in our homes. We pay money for gas to run our cars.
- Conserving energy, and using less energy, will save us money, and will help the environment.
- Using renewable resources may cost more money initially (since it is a new technology)
- Renewable resources will not run out and will become cheaper over me (like any new technology)
- Demanding more renewable resources and conserving non-renewable resources is a lifestyle choice. The market WILL respond if there is increased demand by consumers (people)
- Moving towards "greener" technology will have a great impact on businesses that rely on technology from non-renewable resources. There will be loss of jobs and economic impact on auto industries, and those who work in coal mines or the oil industry. It will lead to important questions that we, the members of society, need to address.
- Polics will come into play as people's livelihoods become jeopardized. This has happened in the past during times of change. (EX: Industrial Revoluon) We need to decide what will be beer for everyone and the environment that we live in, for the long term.

Essential Questions

- How do human activities influence the global ecosystem?
- How might we change habits if we replaced the word “environment” with the word “life support system”?
- Is the damage done to the global life support system permanent?
- How can the impacts of human activities on natural systems be reduced?
- What are the relationships among earth’s systems and how are those relationships being modified due to human acvity?

Content - What will students know?

- Resource vitality has guided the development of human society.
- Natural hazards and other geologic events have shaped the course of human history.
- Empirical evidence is required to differentiate between cause and correlation and make claims about how the availability of natural resources, the occurrence of natural hazards, and climate changes have influenced human activities.
- Modern civilization depends on major technological systems.
- climate changes can affect the population or drive mass migration.
- Change and rates of change can be quantified and modeled over very short or very long periods.
- Some system changes are irreversible.
- Changes in the physical environment, whether naturally occurring or human-induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species.
- Humans depend on the living world for the resources and other benefits provided by biodiversity. But human acvity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, the introduction of invasive species, and climate change.
- Thus sustaining biodiversity so that ecosystems’ 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.
- When evaluating soluons, 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.
- Both physical models and computers can be used in various ways to aid the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test ways of solving a problem or to see which one is most efficient or economical, and in making a persuasive presentation to a client about how a given design will meet his or her needs.
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.
- Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
- Feedback (negative or positive) can stabilize or destabilize natural systems.
- Current models predict that, although future regional climate changes will be complex and will vary, 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 how these gases are absorbed by the ocean and biosphere.
- Criteria may need to be broken down into similar ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed.

- Human activities can modify the relationships among Earth systems.

Skills - What will students be able to do?

- ID non-renewable energy sources.
- ID renewable energy sources.
- Calculate the power that various appliances use, in kilowatt hours.
- Calculate the energy cost of using various appliances, and calculate savings by switching to more energy-efficient brands.
- ID problem areas in houses that might be resulting in higher electric bills for the owner. Give them PS for fixing those areas, along with the costs they would incur with the savings over me.
- Calculate fuel efficiencies for various models of cars. Compare costs and savings.
- Analyze and compare how incorporating green technologies can cause controversy. Debate and form an opinion on whose interests should be best served. (EX: in Cape Cod, the wind farm would generate savings over the long term for the entire area, but might be considered an eyesore to the people who have waterfront property worth millions of dollars).
- Look for cause-and-effect relationships between human population distribution and resource availability and distinguish between causality and correlation.
- Use evidence from data analysis to make inferences and predictions about the impacts of future climate change and global warming on the displacement or migration of humans.
- Know that the sustainability of human societies and the biodiversity that supports them require responsible management of natural resources.
- Students collect data on growth patterns (exponential, logistic) and carrying capacity using, for example, bacterial populations in a petri dish, status of local fish and mollusk populations in Narragansett Bay, erosion of eelgrass beds, or continued Quonset Point dredging. Data could also be collected on Asian Shore Crab infestation and companion with lo c al crabs, or the negative effect of warming coast t al estuary water temperature on flounder reproduction rates.
- Investigate and research the major contributions of scientists and engineers who have developed technologies to produce less pollution and waste to prevent ecosystem degradation.
- Designing and evaluating a solution for a proposed problem related to threatened or endangered species.

Activities - How will we teach the content and skills?

- Construct an explanation based on valid and reliable evidence for how the availability of natural resources, the occurrence of natural hazards, and climate changes have influenced human acvity.
- Use empirical evidence to differentiate between how the availability of natural resources, the occurrence of natural hazards, and climate changes have influenced human acvity.
- Create a computational simulation to illustrate the relationships among the management of natural resources, the sustainability of human populations, and biodiversity.
- Quantify and model change and rates of change in the relationships among management of natural resources, the sustainability of human populations, and biodiversity.
- Create or revise a simulation based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations to test a solution to mitigate adverse impacts of human

acvity on biodiversity.
- Use empirical evidence to make claims about the impacts of human acvity on biodiversity.
- Break down the criteria for the design of a simulation to test a solution for migrating adverse impacts of human acvity on biodiversity into simpler ones that can be approached systematically based on consideration of tradeoffs.
- Design a solution for a proposed problem related to threatened or endangered species or to genetic variation of organisms for multiple species.
- Analyze costs and benefits of solutions to mitigate adverse impacts of human activity on human biodiversity
- Evaluate or refine a technological solution that reduces the impacts of human activities on natural systems based on scientific knowledge and student-generated sources of evidence; prioritize criteria and tradeoff considerations.
- Use a computational representation to illustrate the relationships among Earth systems and how these relationships are being modified due to human activity.
- Describe the boundaries of Earth systems.
- Analyze and describe the inputs and outputs of Earth systems.

Evidence/Assessments - How will we know what students have learned?

Environmental Benchmark #3

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Changes in the physical environment, whether naturally occurring or human-induced, have contributed to the expansion of some species, the emergence of new distinct species as populations diverge under different conditions, and the decline—and sometimes the extinction—of some species. • Thus sustaining biodiversity so that ecosystems' functioning and productivity are maintained is essential to supporting and enhancing	• Organisms, and populations of organisms, are dependent on their environmental interactions both with other living things and with nonliving factors • In any ecosystem, organisms, and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction. • Ecosystems are dynamic;	• Resources from the Holt Environmental Science Text: o Using the Figure: Power Plant Efficiency o Reading Skill Builder: Prediction Guide o Interpreting Stascs: Energy consumption o Interpreting Stascs: Energy Production o Case Study: Methane Hydrates o MathPracce: World Energy Use o Using the Figure:

life on Earth. Sustaining biodiversity also aids humanity by preserving landscapes of recreational or inspirational value. • Change and rates of change can be quantified and modeled over very short or very long periods. • Know that the sustainability of human societies and the biodiversity that supports them require responsible management of natural resources. • Humans depend on the living world for the resources and other benefits provided by biodiversity. But human acvity is also having adverse impacts on biodiversity through overpopulation, overexploitation, habitat destruction, pollution, the introduction of invasive species, and climate change. • Students collect data on growth paerns (exponential, logistic) and carrying capacity using, for example, bacterial populations in a petri dish, status of local fish and mollusk populations in Narragansett Bay, erosion of eelgrass beds, or continued Quonset Point dredging. Data could also be collected on Asian Shore Crab infestation and companion with local crabs, or the negative effect of warming coastal estuary water temperature on flounder reproduction rates. • Use evidence from data	their characteristics can vary over me. Disruptions to any physical or biological component of an ecosystem can lead to this in all its populations. • Adaptation by natural selection acng over generations is one important process by which species change over in response to changes in environmental conditions. Traits that support successful survival and reproduction in the new environment become more common; those that do not become less common. Thus, the distribution of traits in a population changes. • Changes in biodiversity can influence human resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling. • The planet's systems interact over scales that range from microscopic to global in size, and they operate over fractions of a second to billions of years. These interactions have shaped Earth's history and will determine its future. • The complex paerns of the changes and the movement of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather paerns. • Human activities have significantly altered the biosphere, sometimes damaging or destroying	Fossil Fuel Predictions o Student Opportunities: Design Contests o Using the Figure: Mesa Verde o Case Study: A Super-Efficient Home o Student Opportunities: Renewable Energy Opportunities o Use the Figure: Solar Cells and Light o Interpreting Stascs: The cost of Wind Power o Career: Renewable Energy

analysis to make inferences and predictions about the impacts of future climate change and global warming on the displacement or migration of humans. • Change and rates of change can be quantified and modeled over very short or very long periods. • Criteria may need to be broken down into similar ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. • Human activities can modify the relationships among Earth systems. • Investigate and research the major contributions of scientists and engineers who have developed technologies to produce less pollution and waste to prevent ecosystem degradation.	natural habitats and causing the extinction of other species. But changes to Earth's environment can have different impacts (negative and positive) on different living things. • Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. • Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding human behavior and applying that knowledge wisely in decisions and activities.	

Key Resources

Cost-Benefit Analysis Primer: Students read this explanation about how cost-benefit analysis is derived and applied to apply this model to design soluons related to human sustainability. Students then read the application of CBA to water sanitation.

Carbon Stabilization Wedge: Students play this game to evaluate competing design soluons for developing, managing, and utilizing energy resources based on cost-benefit ratios.

One For All: A Natural Resources Game: Identify a strategy that would produce a sustainable use of resources in a similar game. Draw parallels between the chips used in the game and renewable resources upon which people depend. Draw parallels between the actions of parcipants in the game and the actions of people or governments in real-world situations.

Building Biodiversity and the PREDICTS project andGLOBIO project: Students explore this website to develop an understanding of how computational models of the impacts on biodiversity are created. Next, they explore Conservation Maps for a global perspective of land use and conservation efforts.

Career Readiness, Life Literacies, & Key Skills

TECH.9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
TECH.9.4.12.GCA.1	Collaborate with individuals to analyze a variety of potential solutions to climate change effects and determine why some solutions (e.g., political. economic, cultural) may work better than others (e.g., SL.11-12.1., HS-ETS1-1, HS-ETS1-2, HS-ETS1-4, 6.3.12.GeoGI.1, 7.1.IH.IPERS.6, 7.1.IL.IPERS.7, 8.2.12.ETW.3).
TECH.9.4.12.IML.2	Evaluate digital sources for timeliness, accuracy, perspective, credibility of the source, and relevance of information, in media, data, or other resources (e.g., NJSLSA.W8, Social Studies Practice: Gathering and Evaluating Sources.
TECH.9.4.12.IML.3	Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions (e.g., S-ID.B.6a., 8.1.12.DA.5, 7.1.IH.IPRET.8).
TECH.9.4.12.IML.4	Assess and critique the appropriateness and impact of existing data visualizations for an intended audience (e.g., S-ID.B.6b, HS-LS2-4).
TECH.9.4.12.IML.5	Evaluate, synthesize, and apply information on climate change from various sources appropriately (e.g., 2.1.12.CHSS.6, S.IC.B.4, S.IC.B.6, 8.1.12.DA.1, 6.1.12.GeoHE.14.a, 7.1.AL.PRSNT.2).
TECH.9.4.12.IML.6	Use various types of media to produce and store information on climate change for different purposes and audiences with sensitivity to cultural, gender, and age diversity (e.g., NJSLSA.SL5).
TECH.9.4.12.IML.7	Develop an argument to support a claim regarding a current workplace or societal/ethical issue such as climate change (e.g., NJSLSA.W1, 7.1.AL.PRSNT.4).

Interdisciplinary Connections/Companion Standards

LA.RST.11-12.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific

procedures/experiments, or technical processes.