Unit 4: Towards a Sustainable Future

Content Area:	**Science**
Course(s):	
Time Period:	**MP4**
Length:	**45 days**
Status:	**Published**

NJSLS - Science

HS-ESS3-2	Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on climate change and other 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 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 (i.e., climate change).
HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
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.

Science and Engineering Practices

Analyzing and Interpreting Data — Analyze data and the results of climate models to make an evidence-based forecast. *(HS-ESS3-5)*

Using Mathematics and Computational Thinking — Use a computational representation to illustrate and quantify relationships among Earth systems. *(HS-ESS3-6)*

Constructing Explanations and Designing Solutions — Design and refine technological solutions to reduce human impacts, breaking complex problems into manageable parts. *(HS-ESS3-4, HS-ETS1-2)*

Engaging in Argument from Evidence — Evaluate competing energy solutions using cost-benefit ratios and prioritized trade-offs. *(HS-ESS3-2, HS-ETS1-3)*

Disciplinary Core Ideas

ESS3.D: Global Climate Change — Human activities, especially the release of greenhouse gases, are a major factor in the current rate of global climate change; models are used to forecast impacts. *(HS-ESS3-5, HS-ESS3-6)*

ESS3.A: Natural Resources — Energy resources — fossil, nuclear, and renewable — differ in availability, and all forms of energy production carry economic, social, and environmental costs and benefits. *(HS-ESS3-2)*

ESS3.C: Human Impacts on Earth Systems — Energy use and waste generation impact Earth systems; management practices and technologies can reduce these impacts. *(HS-ESS3-4)*

ETS1.B / ETS1.C: Developing and Optimizing Solutions — Complex problems are broken into manageable sub-problems, and solutions are optimized against criteria, constraints, and trade-offs. *(HS-ETS1-2, HS-ETS1-3)*

Crosscutting Concepts

Cause and Effect — Greenhouse-gas emissions are analyzed as a cause of climate change, and mitigation as a way to alter effects. *(HS-ESS3-5)*

Systems and System Models — Computational and climate models represent interactions among Earth systems and human activity. *(HS-ESS3-6)*

Energy and Matter — Energy resources and flows are tracked through production, use, and waste. *(HS-ESS3-2)*

Stability and Change — Sustainability is framed as maintaining stable Earth systems in the face of human-driven change. *(HS-ESS3-4)*

Influence of Science, Engineering, and Technology on Society and the Natural World — Energy and waste solutions are shaped by, and reshape, society and the environment. *(HS-ETS1-2, HS-ETS1-3)*

Rationale and Transfer Goals

This capstone unit asks, "How is human activity changing the climate, how do our energy and waste choices drive environmental change, and how can we build a sustainable future?" Students analyze the evidence for climate change and use models to forecast its impacts; compare the costs, benefits, and risks of fossil, nuclear, and renewable energy; and examine waste management from municipal solid waste to hazardous waste. The unit culminates in the Savvas Unit 5 Anchoring Phenomenon Project on supporting a sustainable future.

The crosscutting concepts of cause and effect, systems and system models, and energy and matter organize the disciplinary core ideas. The transfer goal is for students to independently use climate and Earth-system models together with cost-benefit reasoning to evaluate and design solutions for energy, waste, and climate — and to articulate an evidence-based position on building a sustainable future.

Enduring Understandings

- Human release of greenhouse gases is the primary driver of the current rate of climate change; models let us forecast impacts and evaluate responses.
- Our energy choices — fossil fuels, nuclear power, and renewables — each carry distinct benefits, costs, and risks that can be compared with cost-benefit analysis.

- Transitioning toward renewable energy and reducing waste are central to a sustainable future.
- Waste management — reducing, reusing, recycling, and safely handling hazardous waste — reflects the choices societies make about materials and impact.
- Sustainability requires evaluating solutions by criteria, constraints, and trade-offs across environmental, economic, and social dimensions.

Essential Questions

- How do we know the climate is changing, and how can we forecast its impacts?
- What are the trade-offs among fossil fuels, nuclear power, and renewable energy?
- Do the benefits of renewable energy outweigh the costs?
- What can we do with our waste — and with old landfills?
- How can you support a sustainable future?

Content - What will students know?

- Earth's climate system is driven by solar radiation and the greenhouse effect; greenhouse-gas concentrations have risen due to human activity.
- Evidence for climate change comes from multiple sources, including ice cores, temperature records, and climate models.
- Climate change has wide-ranging effects; responses include both mitigation and adaptation.
- Energy resources are classified as nonrenewable (fossil fuels, nuclear) or renewable; fossil-fuel use has significant environmental consequences.
- Renewable sources — biomass, geothermal, hydropower, ocean, solar, wind, and hydrogen — differ in availability, cost, and impact.
- Waste is generated as municipal, industrial, and hazardous streams; reducing, reusing, and recycling minimize solid waste, and hazardous waste requires special handling.
- Sustainability integrates environmental, economic, and social considerations in resource and energy decisions.

Skills - What will students be able to do?

- Analyze geoscience data and climate-model output to forecast the rate and impacts of climate change (HS-ESS3-5).
- Use a computational representation to illustrate relationships among Earth systems and human activity (HS-ESS3-6).
- Evaluate competing energy solutions using cost-benefit ratios (HS-ESS3-2).
- Design and refine a technological solution that reduces emissions or waste, breaking the problem into manageable parts (HS-ESS3-4, HS-ETS1-2).
- Evaluate energy and waste solutions using prioritized criteria and trade-offs (HS-ETS1-3).

Activities - How will we teach the content and skills?

- Climate: launch with the Chapter 16 Central Case (“Rising Seas May Flood the Maldive Islands”) and “Climate Clues in Ice”; run the “Effects of Greenhouse Gas” modeling and “Tracking CO2 and Temperature” to analyze data and forecast change (HS-ESS3-5).
- Nonrenewable energy: use the Chapter 17 Central Case (“Oil or Wilderness on Alaska's North Slope?”) with “Carbon Dioxide From Fossil Fuels” and “Radiation and Human Health,” and compare energy sources by cost-benefit (HS-ESS3-2).
- Renewable energy: use the Chapter 18 Central Case (“Germany's Big Bet on Renewable Energy”), the “Energy From Wind” lab, and the “Are Biofuels Better for the Environment?” Point Counterpoint with “Comparing Biofuels.”
- Waste: use the Chapter 19 Central Case (“Transforming New York's Fresh Kills Landfill” — a regionally relevant case) with “Reduce, Reuse, Recycle,” “Where Waste Goes,” and “Observing a Compost”; design a waste-reduction solution (HS-ETS1-2).
- Culminate in the Savvas Unit 5 Anchoring Phenomenon Project (“How can you support a sustainable future?”) as an end-of-course capstone.
- Structure lessons around authentic, community-connected questions; provide multiple means of representation and varied grouping (UDL).

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

- **Assessments can be reviewed for each course in[this folder](this folder).**

- Formative: climate-data and model analysis, an energy cost-benefit comparison, and a waste audit.
- Summative: Savvas Chapter 16–19 assessments, an energy-solution evaluation, and the sustainable-future capstone project.
- Analyze geoscience data and climate models to make an evidence-based forecast of climate change and its impacts.
- Use a computational representation to illustrate how human activity is modifying relationships among Earth systems.
- Evaluate competing energy solutions based on cost-benefit ratios and prioritized trade-offs.
- Design or refine a technological solution that reduces the impacts of human activities on natural systems.
- Environmental Benchmark #4 (administered during the last week of MP4; assesses Unit 4 content and may serve as the end-of-course capstone assessment).

Spiraling for Mastery

The spiral column draws on Unit 3 (Earth's Resources) and earlier foundational units.

Content or Skill for This Unit	Spiral Focus from Previous Unit	Instructional Activity

Forecasting climate change from data and models (HS-ESS3-5).	Unit 3: the atmosphere, air pollution, and greenhouse gases (Ch. 15).	Build from atmospheric pollution to global climate modeling using ice-core and CO2 data.
Cost-benefit evaluation of energy solutions (HS-ESS3-2).	Unit 3: cost-benefit evaluation of mineral resources and mining (Ch. 13, HS-ESS3-2).	Extend cost-benefit reasoning from minerals to comparing entire energy portfolios.
Reducing impacts through technology (HS-ESS3-4, HS-ETS1-2).	Unit 3: pollution-control and reclamation technologies (Ch. 14–15).	Apply solution design to renewable-energy adoption and waste reduction.
Modeling Earth-system relationships modified by human activity (HS-ESS3-6).	Unit 1: Earth's spheres and system feedbacks (Ch. 3, HS-ESS2-2, HS-ESS2-6).	Scale up systems modeling from local cycles to global human-climate interactions.

Key Resources

Primary text and platform: Savvas Environmental Science (Withgott & Laposata) — Unit 5 (Toward a Sustainable Future), Chapters 16–19. This capstone unit closes with the course's culminating sustainability project.

- Central Cases: “Rising Seas May Flood the Maldive Islands” (Ch. 16), “Oil or Wilderness on Alaska's North Slope?” (Ch. 17), “Germany's Big Bet on Renewable Energy” (Ch. 18), “Transforming New York's Fresh Kills Landfill” (Ch. 19).
- Features: “Climate Clues in Ice” (Ch. 16), “Using Coal to Generate Electricity” (Ch. 17), “Are Biofuels Better for the Environment?” Point Counterpoint (Ch. 18), “The Recycling Process” (Ch. 19).
- Labs, Real Data, and Modeling: “Effects of Greenhouse Gas,” “Tracking CO2 and Temperature,” “Carbon Dioxide From Fossil Fuels,” “Radiation and Human Health,” “Energy From Wind,” “Comparing Biofuels,” “Reduce, Reuse, Recycle,” “Where Waste Goes,” and “Observing a Compost.”
- Savvas online course: investigative-phenomenon videos, interactive climate and energy simulations, and the Unit 5 Anchoring Phenomenon Project (course capstone).

Career Readiness, Life Literacies, & Key Skills

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).
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).
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.
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).

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).
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

Standard	Companion Standard Description
RST.11-12.1	Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions and gaps or inconsistencies in the account.
RST.11-12.7	Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, charts) to address an environmental question or problem.
WHST.11-12.1	Write arguments focused on discipline-specific content, supporting a claim with reasoning and evidence (e.g., a policy or cost-benefit position).
WHST.11-12.7	Conduct short and sustained research projects to answer a question or solve a problem, synthesizing multiple sources on an environmental topic.
HSN-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in environmental data.
HSS-ID.B.6	Represent data on two quantitative variables on a scatter plot and describe how the variables are related.