Climate Change and Solar Energy and Relevant MS and HS STE Learning Standards

Grade 6

6.MS-PS4-1. Waves and Their Applications in Technologies for Information Transfer 6.MS-PS4-1. Use diagrams of a simple wave to explain that (a) a wave has a repeating pattern with a specific amplitude, frequency, and wavelength, and (b) the amplitude of a wave is related to the energy of the wave. Pg 62

Lesson or Project: Radiation wavelength and the greenhouse effect  
Resource: <https://timeforchange.org/radiation-wavelength-and-greenhouse-effect>  
<http://blogs.edf.org/climate411/2007/07/25/greenhouse_effect/>  
<http://earthguide.ucsd.edu/virtualmuseum/images/ElectromagRadiationFromSun.html>

6.MS-ETS1. Engineering Design 6.MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions.\* 6.MS-ETS1-5(MA). Create visual representations of solutions to a design problem. Accurately interpret and apply scale and proportion to visual representations.\* Clarification Statements: • Examples of visual representations can include sketches, scaled drawings, and orthographic projections. • Examples of scale can include ¼ʺ = 1ʹ0ʺ and 1 cm = 1 m. 2016 Massachusetts Science and Technology/Engineering Curriculum Framework 53 6.MS-ETS1-6(MA). Communicate a design solution to an intended user, including design features and limitations of the solution. Clarification Statement: • Examples of intended users can include students, parents, teachers, manufacturing personnel, engineers, and customers.

Lesson or Project: Students proposing a solar installation at their school

Grade 7

7.MS-ESS3-2. Obtain and communicate information on how data from past geologic events are analyzed for patterns and used to forecast the location and likelihood of future catastrophic events. Clarification Statements: • Geologic events include earthquakes, volcanic eruptions, floods, and landslides. • Examples of data typically analyzed can include the locations, magnitudes, and frequencies of the natural hazards.

Lesson or Project: Looking at how major volcano eruptions show global cooling in historic climate model data  
Resource: <https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

7.MS-ESS3-4. Construct an argument supported by evidence that human activities and technologies can mitigate the impact of increases in human population and per capita consumption of natural resources on the environment. Clarification Statements: • Arguments should be based on examining historical data such as population graphs, natural resource distribution maps, and water quality studies over time. • Examples of negative impacts can include changes to the amount and quality of natural resources such as water, mineral, and energy supplies.

Lesson or Project: Renewable vs Non-renewable energy; Renew-A-Bean Game (Activity 1)  
Resource: <https://www.ucsusa.org/sites/default/files/legacy/assets/documents/clean_energy/renewablesready_fullreport.pdf>  
<https://www.eia.gov/energyexplained/?page=us_energy_home>

7.MS-PS3-3. Apply scientific principles of energy and heat transfer to design, construct, and test a device to minimize or maximize thermal energy transfer.\* Clarification Statement: • Examples of devices could include an insulated box, a solar cooker, and a vacuum flask. State Assessment Boundary: • Accounting for specific heat or calculations of the total amount of thermal energy transferred is not expected in state assessment.

Lesson: Solar Thermal or Solar PV Efficiency

7.MS-ETS3-4(MA). Show how the components of a structural system work together to serve a structural function. Provide examples of physical structures and relate their design to their intended use. Clarification Statements: • Examples of components of a structural system could include foundation, decking, wall, and roofing. • Explanations of function should include identification of live vs. dead loads and forces of tension, torsion, compression, and shear. • Examples of uses include carrying loads and forces across a span (such as a bridge), providing livable space (such as a house or office building), and providing specific environmental conditions (such as a greenhouse or cold storage).

Lesson: Solar Parking Canopy Design

Grade 8

8.MS-ESS1-1b. Develop and use a model of the Earth-Sun system to explain the cyclical pattern of seasons, which includes Earth’s tilt and differential intensity of sunlight on different areas of Earth across the year. Clarification Statement: • Examples of models can be physical or graphical.

Lesson: Solar site assessment; Solar Production Graphs (Activity 2)

8.MS-ESS2-6. Describe how interactions involving the ocean affect weather and climate on a regional scale, including the influence of the ocean temperature as mediated by energy input from the Sun and energy loss due to evaporation or redistribution via ocean currents.

Lessons: The Thermohaline Circulation  
Resource: <https://oceanservice.noaa.gov/education/tutorial_currents/05conveyor1.html>  
<https://www.washingtonpost.com/news/energy-environment/wp/2015/03/23/global-warming-is-now-slowing-down-the-circulation-of-the-oceans-with-potentially-dire-consequences/?utm_term=.01952c6712c7>

Lessons: Albedo effect  
Resource: <https://nsidc.org/cryosphere/seaice/processes/albedo.html>

8.MS-ESS3-5. Examine and interpret data to describe the role that human activities have played in causing the rise in global temperatures over the past century. Clarification Statements: • Examples of human activities include fossil fuel combustion, deforestation, and agricultural activity. • Examples of evidence can include tables, graphs, and maps of global and regional temperatures; atmospheric levels of gases such as carbon dioxide and methane; and the rates of human activities.

Lesson: Anthropogenic Climate Change vs. Natural Climate Change  
Resource: <https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

High School

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth’s hydrosphere can create feedbacks that cause changes to other Earth systems.

Lessons: Albedo effect  
Resource: <https://nsidc.org/cryosphere/seaice/processes/albedo.html>

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth’s systems over different time scales result in changes in climate. Analyze and interpret data to explain that long-term changes in Earth’s tilt and orbit result in cycles of climate change such as Ice Ages. Clarification Statement: • Examples of the causes of climate change differ by timescale: large volcanic eruption and ocean circulation over 1–10 years; changes in human activity, ocean circulation, and solar output over tens to hundreds of years; changes to Earth’s orbit and the orientation of its axis over tens to hundreds of thousands of years; and long-term changes in atmospheric composition over tens to hundreds of millions of years.

Lessons: What is causing today’s climate change?  
Resource: <https://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

HS-ESS3-1. Construct an explanation based on evidence for how the availability of key natural resources and changes due to variations in climate have influenced human activity.

HS-ESS3-2. Evaluate competing design solutions for minimizing impacts of developing and using energy and mineral resources, and conserving and recycling those resources, based on economic, social, and environmental cost-benefit ratios.

HS-ESS3-3. Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity.

HS-ESS3-5. Analyze results from global climate models to describe how forecasts are made of the current rate of global or regional climate change and associated future impacts to Earth systems.

HS-LS2-7. Analyze direct and indirect effects of human activities on biodiversity and ecosystem health, specifically habitat fragmentation, introduction of non-native or invasive species, overharvesting, pollution, and climate change. Evaluate and refine a solution for reducing the impacts of human activities on biodiversity and ecosystem health.\* Clarification Statement: • Examples of solutions can include captive breeding programs, habitat restoration, pollution mitigation, energy conservation, and ecotourism.