Target Performances for *Human Energy Systems* Activities

All *Carbon TIME units* are organized around a common purpose: *assessing and scaffolding students' three-dimensional engagement with phenomena.* Every *Carbon TIME* activity has its specific expectation for students' three-dimensional engagement with phenomena, what we call its **target performance**. Each activity also includes tools and strategies that teachers can use to asses and scaffold the target performance in rigorous and responsive ways.

The target performances for each activity in the *Ecosystems* unit are listed in the table below.

Activity	***Target Performance***
Lesson 1 – Pretest and Expressing Ideas about Arctic Sea Ice (students as questioners and investigators)	
Activity 1.1 Human Energy Systems Unit Pretest (20 min)	Students show their initial proficiencies for the overall unit goals: 1. Questioning, investigating, and explaining how the Earth's climate is changing 2. Explaining and predicting how carbon cycles and energy flows in Earth systems.
Activity 1.2: Expressing Ideas and Questions about Arctic Sea Ice (40 min)	Students express ideas and record questions about why Arctic sea ice seems to be shrinking.
Activity 1.3: Graphing Arctic Sea Ice (45 min)	Students use data on Arctic sea ice to construct graphs showing patterns in changing coverage over time.
Activity 1.4: Drawing a Trend Line (40 min)	Students use multi-year averages to construct a trend line using data on Lake Superior ice cover.
Activity 1.5: Finding a Trend in Arctic Sea Ice Data (40 min)	Students use multi-year averages to construct a trend line using data on Arctic sea ice.
Lesson 2 – Finding Patterns in Large Scale Data (students as investigators)	
Activity 2.1: Home Groups: Four Considerations for Large Scale Data (45 min)	Students in home groups express initial ideas about patterns and changes over time for four variables in Earth systems: global temperatures, global sea levels, Arctic sea ice, and atmospheric CO_2 concentrations.
Activity 2.2: Expert Groups: Analysis of Large-Scale Data (45 min)	Students in expert groups investigate multiple representations of the four variables in and the Earth systems that they measure, generating explanations and questions.

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Activity 2.3: Home Groups: Share Expertise (60 min)	Students return to home groups and share their expertise about patterns of change for four variables in Earth systems: global temperatures, global sea levels, Arctic sea ice, and atmospheric CO_2 concentrations.
Activity 2.4: Evidence-Based Argument for Earth Systems (30 min)	Students compare patterns of change for the four Earth systems variables and record questions about what causes the patterns and how the patterns are related to one another.
Lesson 3 – Explaining Connections between Patterns (students as explainers)	
Activity 3.1: Millions of Flasks of Air (25 min)	Students explain why Charles David Keeling went to Hawaii to collect data on atmospheric CO_2 concentrations and how he made his measurements.
Activity 3.2: The Greenhouse Effect (20 min)	Students use a computer simulation to explain how carbon dioxide absorbs visible light and emits infrared radiation—the Greenhouse Effect.
Activity 3.3: Explaining Relationships Between Earth Systems (40 min)	Students use the Greenhouse Effect to explain how atmospheric CO_2 concentration is the driver that causes changes in other Earth systems.
Lesson 4 – Fossil Fuels and Carbon Pools (students as questioners, investigators, and explainers)	
Activity 4.1: Questions for this Lesson (30 min)	Students apply the large-scale Four Questions to two patterns in the Keeling curve (showing atmospheric CO_2 concentrations): the annual cycle and the long-term trend.
Activity 4.2: Carbon Pools and Fossil Fuels (35 min)	Students identify carbon pools in Earth systems and investigate the fluxes associated with human use of one pool: fossil fuels.
Activity 4.3: Tiny World Modeling (50 min)	Students investigate the relationship between pools and fluxes in a physical model of a tiny world, showing how changing photosynthesis, cellular respiration, and combustion fluxes can account for both an annual cycle and a long-term trend in the atmospheric CO_2 pool.
Activity 4.4: Global Computer Model (50 min)	Students use an online computer model to make quantitative predictions of how changes in photosynthesis, cellular respiration, and combustion fluxes will affect the long-term trend in the atmospheric CO_2 pool.

Activity	***Target Performance***
Optional Activity 4.5: Effects of Seasons and Oceans (50 min)	Students use a diagrammatic carbon cycle model to investigate how oceans and seasons in the Northern and Southern Hemispheres affect the annual cycle and a long-term trend in the atmospheric CO_2 pool.
Lesson 5 – Consequences of Our Lifestyles (students as explainers)	
Activity 5.1 Extreme Makeover: Lifestyle Edition (45 min)	Students choose preferred lifestyles based on data about four countries (United States, France, China, Ethiopia) and compare CO_2 emissions based on those lifestyles.
Activity 5.2 Carbon Emissions Jigsaw (60 min)	Students explain the mechanisms through which human activities and technologies in four different areas (electricity, transportation, buildings, food) lead to CO_2 emissions.
Activity 5.3 Energy Scenarios (30 min)	Students explain how different personal activities (energy scenarios) lead to CO_2 emissions.
Activity 5.4 Strategies for Lowering Carbon Emissions (45 min)	Students create and share posters explaining strategies for reducing CO_2 emissions.
Lesson 6 – Global Implications and Posttest (students as explainers and predictors)	
Activity 6.1 Making Predictions About the Future of Earth's Systems (30 min)	Students use the long-term trends in the Keeling Curve and Arctic Sea Ice graphs to make predictions about future trends and identify sources of uncertainty in those predictions.
Activity 6.2 Using Models to Predict Future Conditions (50 min)	Students use the online Very, Very Simple Climate Model to make predictions about future atmospheric CO_2 concentrations and global temperatures based on CO_2 emissions scenarios.
Activity 6.3 How Our Decisions Affect Earth's Future (30 min)	Students use graphs of projections from computer models to consider the impacts of increasing atmospheric CO_2 on Earth's systems and on living things.
Activity 6.4: Human Energy Systems Unit Posttest (20 min)	Students show their initial proficiencies for the overall unit goals: 1. Questioning, investigating, and explaining how the Earth's climate is changing 2. Explaining and predicting how carbon cycles and energy flows in Earth systems.