

Development of an Energy Literacy Measure for Middle School Students

DOE Energy Literacy Essential Principle	NGSS	Biofuel Connection	Draft outcome statements
Physical Science			
1.4 Energy available to do useful work decreases as it is transferred from system to system. During all transfers of energy between two systems, some energy is lost to the surroundings. In a practical sense, this lost energy has been “used up,” even though it is still around somewhere. A more efficient system will lose less energy, up to a theoretical limit.	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.	How much energy is lost in the process from tree to jet?	Students will be able to explain why the energy output of a system will always be less than the energy input.
2.5 Movement of matter between reservoirs is driven by Earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life. Energy drives the flow of carbon between these different reservoirs.	HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. 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.	Foundational energy concept.	Students will explain the role of energy in the flow of carbon between different reservoirs.
2.6 Greenhouse gases affect energy flow through the Earth system. Greenhouse gases in the atmosphere, such as carbon dioxide and water vapor, are transparent to much of the incoming Sunlight but not to the infrared light from the warmed surface of Earth. These gases play a major role in determining average global surface temperatures. When Earth emits the same amount of energy as it absorbs its average temperature remains stable.	HS-ESS2-2 Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	Discuss disruption in plant populations?	Students will explain how greenhouse gases affect energy flow through the Earth system.
Life Science			
3.1 The Sun is the major source of energy for organisms and the ecosystems of which they are a part. Producers such as plants, algae and cyanobacteria use the energy from sunlight to make organic matter from carbon dioxide and water. This establishes the beginning of energy flow through almost all food webs.	HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	Foundational energy concept.	Students will trace energy flows from the sun through food webs that include plants and algae.
3.2 Food is a biofuel used by organisms to acquire energy for internal living processes. Food is composed of molecules that serve as fuel and building material for all organisms as energy stored in the molecules is released and used. The breakdown of food molecules enables cells to store energy in new molecules that are used to carry out the many functions of the cell and thus the organism.	HS-LS1-5 Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.	This is biofuel can also serve as the power needed for transportation.	Students will explain how energy is transferred between, released by and/or stored by organisms.

Table 1: DOE Energy Literacy Principle alignment with NGSS, biofuel connection and outcome statements.