# Colorado CTE Course – Scope and Sequence

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| **Course Name** | **Introduction of Energy** | **Course Details**<br>**Course = 0.50 Carnegie Unit Credit** | First course in the secondary course sequence for the Energy Pathway under the Energy cluster. |
| **Course Description** | Competencies taken from the US Department of Energy - Energy Literacy- Essential Principles and Fundamental Concepts for Energy Education. This course offers basic units of the physical and biological process of energy. It also covers how energy can affect our daily lives. | | |
| **Note:** | This is a suggested scope and sequence for the course content. The content will work with any textbook or instructional resource. If locally adapted, make sure all essential knowledge and skills are covered. | | |
| SCED Identification # | 18506 | Schedule calculation based on 60 calendar days of a 90-day semester. Scope and sequence allows for additional time for guest speakers, student presentations, field trips, remediation, or other content topics. | |

All courses taught in an approved CTE program must include Essential Skills embedded into the course content. The Essential Skills Framework for this course can be found at **https://www.cde.state.co.us/standardsandinstruction/essentialskills**

| Instructional Unit Topic | CTE or Academic Standard Alignment | Competency / Performance Indicator | Outcome / Measurement | CTSO Integration |
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| **Unit 1: Physical Quantity** | 1.0 Energy is a physical quantity that follows precise natural laws. *SCIENCE: SC.HS.1.6 SC.HS.1.7 SC.HS.1.9* | 1.1 Energy is a quantity that is transferred from system to system. | List characteristics of transferrable energy. | |
| | | 1.2 The energy of a system of object that results in its temperature is called thermal energy. | Define Convention, conduction, radiation | |
| | | 1.3 Energy is neither created nor destroyed. | Change in the total amount of energy is always equal to the difference between the amount of energy transferred in and the amount transferred. | |
| | | 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. | |
| | | 1.5 Energy comes in different forms and can be divided into categories. | Kinetic and potential energy/light energy, elastic energy, chemical energy, etc. | |
| | | 1.6 Chemical and nuclear reactions involve the transfer and transformation of energy. | The energy associated with nuclear reactions is much larger than that associated with chemical reactions for a given amount of mass. Nuclear reactions take place at the centers of stars, in nuclear bombs, and in both fission- and fusion | |

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| | | | based nuclear reactors. Chemical reactions are pervasive in both living and non-living Earth systems. | |
| | | 1.7 Many different units are used to quantify energy. | Joules, calories, ergs, kilowatt-hours, BTU's – 1 calorie =4,186 joules. | |
| | | 1.8 Power is a measure of energy transfer rate | Rate of Power, 1joule/second = 1 watt. | |
| **Unit 2: Physical Processes** | 2.0 Physical processes on Earth are the result of energy flow through the Earth's system.<br>*SCIENCE: SC.HS.3.6 SC.HS.3.7* | 2.1 Energy is constantly changing as energy flows through the system. | Geological, fossil, and ice records provide evidence of significant changes throughout Earth's history. These changes are always associated with changes in the flow of energy through the Earth's system. Both living and non-living processes have contributed to this change. | |
| | | 2.2 Sunlight, gravitational potential, decay of radioactive isotopes, and rotation of the Earth are the major sources of energy driving physical processes on Earth. | Radioactive isotopes, gravitational potential, tidal energy, geothermal energy, etc. | |
| | | 2.3 Earth's weather and climate are mostly driven by energy from the sun. | Unequal warming of Earth's surface and atmosphere by the Sun drives convention within the atmosphere, producing winds and influencing ocean currents. | |
| | | 2.4 Water plays a major role in the storage and transfer of energy in the Earth's systems. | Identify energy roles in storage and transfer. | |
| | | 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. Understand the influence of carbon in the atmosphere. | |
| | | 2.6 Greenhouse gases affect energy flow through the Earth's system. | Explain how greenhouse gases affect energy flow. | |

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| | | 2.7 The effects of changes in Earth's energy system are often not immediately apparent. | Understand responses to inputs vs. outputs. | |
| **Unit 3: Biological Processes** | 3.0 Biological processes depend on energy flow through the Earth's system. | 3.1 The sun is the major source of energy for organisms and the ecosystem of which they are a part. | Describe the role of the sun on energy production. | |
| | | 3.2 Food is biofuel used by organisms to acquire energy for internal living processes. | Food is composed of molecules that serve as fuel and building materials 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. | |
| | | 3.3 Energy is available to do useful work decreases as it is transferred from organism to organism. | The chemical elements that make up the molecules of living things are passed through food chains and are combined and recombined in different ways. At each level in the food chain, some energy is stored in newly made chemical structures, but most is dissipated into the environment. Continual input of energy, mostly of sunlight, keeps the process going. | |
| | | 3.4 Energy flows through food webs in one direction, from producers to consumers, and decomposers. | An organism that eats lower on the food chain is more energy efficient than one eating higher on the food chain. Eating producers is the lowest, and thus the most energy-efficient, level at which an animal can eat. | |
| | | 3.5 Ecosystems are affected by changes in the availability of energy and matter. | The amount and kind of energy and matter available constrains the distribution and abundance of organisms in an ecosystem and the ability of the ecosystem to recycle materials. | |
| | | 3.6 Humans are part of Earth's ecosystems and influence energy flow through these systems. | Humans are modifying the energy balance of Earth's ecosystems at an increasing rate. Shifts occur, for example, because of | |

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| | | | changes in agriculture and food processing technology, consumer habits, and human population size. | |
| **Unit 4: Energy for Human Activities** | 4.0 Various sources of energy can be used to power human activities, and often this energy must be transferred from source to destination. | 4.1 Humans transfer and transform energy from the environment into forms useful for human endeavors. | The primary sources of energy in the environment include fuels like coal, oil, natural gas, uranium, and biomass. All primary source fuels except biomass are non-renewable. Primary sources also include renewable sources like sunlight, wind, moving water, and geothermal. | |
| | | 4.2 Humans use energy is subject to limits and constraints. | Industry, transportation, urban development, agriculture, and most other human activities are closely tied to the amount and kind of energy available. The availability of energy resources is constrained by the distribution of natural resources, availability of affordable technology, socioeconomic policies, and socioeconomic status. | |
| | | 4.3 Fossil Fuels and biofuels are organic matter that contain energy captured from sunlight. | The energy in fossil fuels such as oil, natural gas, and coal comes from energy that producers like plants, algae, and cyanobacteria captured from sunlight long ago. The energy in biofuels such as food, wood, and ethanol come from energy that producers captured from sunlight recently. Energy stored in these fuels is released during chemical reactions such as combustion, respiration, which also release carbon dioxide into the atmosphere. | |
| | | 4.4 Humans transport Energy from place to place | Fuels are often not used at their source but are transported, sometimes over long distances. Fuels are transported primarily by pipelines, trucks, ships, and trains. Electrical energy can be generated from a variety of energy resources and can be transformed into almost any other form of | |

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| | | | energy. Electric circuits are used to distribute energy to distant locations. Electricity is not a primary source of energy, but an energy carrier. | |
| | | 4.5 Humans generate electricity in multiple ways. | When a magnet moves or magnetic field changes relative to a coil of wire, electrons are induced to flow in the wire. Most human generation of electricity happens in this way. Electrons can also be induced to flow through direct interaction with light particles, this is the basis upon which a solar cell operation. Other means of generating electricity, include electrochemical, piezoelectric, and thermoelectric. | |
| | | 4.6 Humans Intentionally store energy for later use in several different ways. | Examples include batteries, water reservoirs, compressed air, hydrogen, and thermal storage. Storage of energy involves many technological environment and social challenges. | |
| | | 4.7 Different sources of energy and the different ways energy can be transformed, transported, and stored each have different benefits and drawbacks. | A given energy system, from source to sink, will have an inherent level of energy efficiency, monetary cost, and environmental risk. Each system will also have national security, access, and equity implications. | |
| **Unit 5: Economic, political, environmental, and social factors** | 5.0 Energy decisions are influenced by economic, political, environmental, and social factors.<br>*SCIENCE: SC.HS.3.9* | 5.1 Decisions concerning the use of energy resources are mad at many levels. | Identify individual, community, national, and international energy decisions. | |
| | | 5.2 Energy infrastructure has inertia. | Explain the impact governments, corporations, and individuals have made towards the energy industry. | |
| | | 5.3 Energy decisions can be made using a system-based approach. | Define a systems-based approval decision making strategy in regards to the energy industry. | |
| | | 5.4 Energy decisions are influenced by economic factors | Describe how the monetary costs of energy affect energy decisions. | |

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| | | 5.5 Energy decisions are influenced by political factors. | Governmental structure, power balances, and self-serving actions taken by individuals and groups effect energy decisions. | |
| | | 5.6 Energy decisions are influences by environmental factors. | Environmental costs of energy decisions effect energy decision making at all levels. | |
| | | 5.7 Energy decisions are influenced by social factors. | Questions of ethics, morality, and social norms affecting energy decisions making at all levels. | |
| **Unit 6: Factors that affect Energy** | 6.0 The amount of energy used by human society depends on many factors. | 6.1 Conservation of energy has two very different meanings. | Differentiate between the two different meanings of energy. | |
| | | 6.2 One way to manage energy resources is through conservation. | Conservation includes reducing wasteful energy use, using energy for a given purpose more efficiently, making strategic choices as to sources of energy and reducing energy use altogether. | |
| | | 6.3 Human demand for energy is increasing. | Infer how population growth, industrialization, and socioeconomic development have resulted in an increase demand for energy. | |
| | | 6.4 Earth has limited energy resources. | How is human energy consumption putting stresses on the natural processes that renew some energy resources? | |
| | | 6.5 Social and technological innovation affects the amount of energy used by human society. | Connect social and technological innovations with the amount of energy used in society. | |
| | | 6.6 Behavior and design affect the amount of energy used by human society. | Propose changes in behavior or changes I the design of technology and infrastructure to benefit the conservation of energy. | |
| | | 6.7 Products and services carry with them embedded energy. | The energy needed for the entire life cycles of a product or service is called “embedded” or “embodied” energy. An account of the embedded energy in a product or service, along with knowledge of the source(s) of the energy is essential when calculating the amount of energy used and in assessing impacts and consequences. | |

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| | | 6.8 The amount of energy used can be calculated and monitored. | Understand utility costs, knowing where consumer goods and food come from and energy efficiency in relation to home, work, and transportation processes. | |
| **Unit 7: Quality of life affected through Energy Choices** | 7.0 The quality of life of individuals and society is affected by energy choices. | 7.1 Economic security is impacted by energy choices. | Individuals and society continually make energy choices that have economic consequences. The consequences come in the form of monetary cost in general and in the form of price in fluctuation and instability specifically. | |
| | | 7.2 National Security is impacted by energy choices. | The security of a nation is dependent, in part, on the sources of that nation's energy supplies. For example, a nation that has diverse sources of energy that come mostly from within its borders is more secure than a nation largely dependent on foreign energy supplies. | |
| | | 7.3 Environmental quality is impacted by energy choices | Identify the environmental consequences. | |
| | | 7.4 Increasing demand for and limited supplies of fossil fuels affect quality of life. | Fossil fuels provide most of the world's energy. Fossil fuels supplies are limited. If society has not transitioned to sources of energy that are renewable before depleting Earth's fossil fuel supplies, it will find itself in a situation where energy demand far exceeds energy supply. This situation will have many social and economic consequences. | |
| | | 7.5 Access to energy resources affects quality of life. | How does access to energy affect human health, access to education, socioeconomic status, gender, equality, global partnerships, and the environment? | |
| | | 7.6 Some populations are more vulnerable to impacts of energy choices than others. | Identify the environmental consequences that energy decisions have on economic, social, and environmental consequences. | |

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| **Unit 8: Electricity Basics** | Understand the basics of electrical charges | Explain 3 ways charge can be transferred.<br>Understand the importance of grounding a system.<br>List the 3 subatomic particles, their charges, and where they are located in an atom.<br>Describe the 3 “rules” of charge.<br>Draw a picture and use it to explain how charge can be induced on an object. | Define the following vocabulary:<br>• Electrons<br>• Protons<br>• Neutrons<br>• Nucleus<br>• Grounding<br>• Static Electricity<br>• Charge<br>• Induction/induced<br>• Polarization<br>• Friction<br>• Law of conservation of charge<br>• Electroscope<br>• Conductor<br>• Insulator | |
| | Understand the basics of electrical current. | Explain the relationship between voltage, current, and resistance in a circuit.<br>Calculate the voltage in a circuit if given the current and resistance.<br>Test different materials for conductance<br>Know how to use a voltmeter/multimeter.<br>Understand the difference between an insulator and a conductor.<br>Explain how a battery works.<br>Describe the four factors that affect resistance. | Define the following vocabulary:<br>• Electricity<br>• Current<br>• Amperes<br>• Voltage Difference<br>• Volts<br>• Resistance<br>• Ohms<br>• V=IR (and the triangle of glory)<br>• Circuit<br>• Battery | |
| | Understand the basics of electrical circuits | Design circuits in parallel and series. | Define the following vocabulary:<br>• Parallel Circuit | |

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| | Understand the basics of electrical magnetism. | Calculate the amount of resistance needed in a circuit to protect the components added.<br>Make a lightbulb illuminate in a series circuit and a parallel circuit.<br>Draw parallel and series circuits<br>Name examples of parallel and series circuits in the world.<br>Compare and contrast parallel and series circuits<br>Know the symbols for drawing components in a circuit.<br>Explain the relationship between electricity and magnetism.<br>Describe the force that exists between magnetic objects, including where it is the strongest, and how this force acts similarly to other forces we've learned about (such as electrical force and gravitational force.)<br>Differentiate between the magnetic domains of magnetic elements vs. nonmagnetic elements. I can compare and contrast these by drawing them.<br>Understand how magnets are used to generate electricity in a generator. | • Series Circuit<br>• Switch<br>• Resistor<br>• Ammeter<br>• Voltmeter<br>• Fuse<br>• Circuit Breaker<br>Define the following vocabulary:<br>• Magnetism<br>• Magnetic / Electric field<br>• Magnetic Poles<br>• Domains<br>• Ferromagnetism<br>• Electromagnet<br>• Generator<br>• Electric Motor | |

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| | | Make a generator and test the voltage produced with a voltmeter.<br>Test the electricity generated from a model wind turbine.<br>Build an electromagnet and understand two ways to increase the strength of an electromagnet.<br>Build a simple AC Generator.<br>Design an experiment to test the voltage produced by a generator, altering one variable at a time. | | |

**Energy Standards:**

US Department of Energy - Energy Literacy Standards: **https://www.energy.gov/eere/education/energy-literacy-essential-principles-energy-education**

Energy Literacy Standards Resource: **https://www.fuelcellstore.com/energy-literacy**

**CAS Academic Standards Alignment:** Online Version: https://www.cde.state.co.us/apps/standards/**;** Download version: https://www.cde.state.co.us/apps/standards/

**Reading, Writing, and Communicating:**

**Math:**

**Science:**

- SC.HS.1.6 – Energy is a quantitative property of a system that depends on the motion and interactions of matter and radiation within that system.

- SC.HS.1.7 – Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
- SC.HS.1.9 – Although energy cannot be destroyed, it can be converted to less useful forms as it is captured, stored, and transferred.
- SC.HS.3.6 – The planet's dynamics are greatly influenced by water's unique chemical and physical properties.
- SC.HS.3.7 – The role of radiation from the sun and its interactions with the atmosphere, ocean, and land are the foundational for the global climate system. Global climate models are used to predict future changes, including changes influences by human behavior and natural factors.
- SC.HS.3.9 – Resource availability has guided the development of human society and use of natural resources has associated costs, risks, and benefits.

**Essential Skills:**

Problem Solver:

- Critical Thinking and Analysis: The ability to apply a deliberate process of identifying problems, gathering information, and weighing possible solutions, including: making choices rooted in understanding patterns, cause-and-effect relationships, and the impacts that a decision can have on the individual and others.
- Creativity and innovation: the ability to demonstrate curiosity and imagination through experimenting with new and emerging ideas.

Community Member:

- Social Awareness: the ability to understand the perspectives of, empathize with, feel compassion for, and recognize strengths in others, including those from diverse backgrounds, cultures, and contexts and how they affect social interactions.
- Civic Engagement: The ability to develop and apply knowledge, skills, and habits gained from experiences – within communities of diverse perspectives – to address issues, affect change, and/or solve problems.
- Global and cultural awareness: the ability to collaborate with individuals from diverse backgrounds and/or cultures to address national and global issues, and to develop complex, appropriate, and workable solutions.

Communicator:

- Interpersonal communication: the ability to establish and maintain healthy and supportive relationships, including: the capacity to communicate clearly by successfully conveying information and feelings, listening actively, setting boundaries, negotiating conflict constructively, and seeking or offering support and help when needed.

Empowered Individual:

- Self-Awareness: the ability to understand one's own emotions, thoughts, and values, and how personal actions and emotions influence behavior across contexts, including: the capacity to recognize one's strength and limitations with a well-grounded sense of confidence and purpose.
- Career Awareness: The ability to apply the knowledge and understanding of how one's dreams, experiences, and interests translate into career fulfillment and lifelong pursuits in local, regional, national, and global career pathways and opportunities.