

## **Career & Technical Education (CTE) Standards Revision Project**

### **Cluster: Energy**

**Pathways: Fossil Energy Extraction, Processing & Distribution, Electromechanical Generation & Maintenance, Electrical Energy Transmission & Distribution, Renewable Energy Production, Energy Efficiency & Environmental Technology**

**The standards for this cluster area a result of a compilation of Energy standards from State CTE Standards developed in Ohio and California and introductory course standards from Colorado community colleges. The attached standards for each of the pathways identify links to Colorado core content standards which have been validated by content specialists in each of the core content areas.**

**Michael Womochil, Program Director, Agriculture, Natural Resources & Energy**

<b>Career Cluster/Cluster Grouping:</b>	<b>Energy</b>
<b>Pathway(s):</b>	<b>Renewable Energy Production</b>
<b>Prepared Completer Competencies: ENY 05. Analyze the various types of renewable energy sources available &amp; their feasibility as a commercial energy source</b>	
<b>High School Expectations</b>	
<b>Concepts and skills students know include: ENY 05.01 Compare and contrast renewable and non renewable energy sources</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.01 A</b> Define renewable and non renewable in designation of energy sources (SCI 3.5a)</p> <p><b>ENY 05.01 B</b> Classify energy sources currently available into renewable or non-renewable (SCI 3.5 b)</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p>

<p><b>ENY 05.01 C</b> Compare and contrast the advantages and disadvantages of using renewable vs. non-renewable energy sources</p> <p>(SCI 3.5a SCI 3.5b)</p>	<p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b>	
<b>ENY 05.02 Explain solar radiation as energy from the sun.</b>	
<b>Evidence Outcomes - Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.02 A</b> Describe what happens to the sun’s radiation as it passes through the earth’s atmosphere and into contact with the earth’s crust.</p> <p>(SCI3.6c; SCI3.2a; SCI3.2b; SCI3.2c)</p> <p><b>ENY 05.02 B</b> Determine the effect that atmospheric conditions have on the sun’s radiation.</p> <p>(SCI3.6a; SCI3.6b; SCI3.6c )</p> <p><b>ENY 05.02 C</b> Explain global dimming and its predicted effect on future solar energy.</p> <p>(SCI 3.6c )</p> <p><b>ENY 05.02 D</b> Discuss the capacity of the sun’s radiation as a viable energy source.</p> <p>(SCI 3.6a; SCI 3.6c)</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI3.2.a-Science, Earth Science, As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet’s geosphere, atmosphere, and biosphere in a variety of ways- Develop, communicate, and justify an evidence-based scientific explanation addressing questions around the extraterrestrial forces and energies that influence Earth</p> <p>SCI3.2.b-Science, Earth Science, - Analyze and interpret data regarding extraterrestrial forces and energies</p> <p>SCI3.2.c-Science, Earth Science, - Clearly identify assumptions behind conclusions regarding extraterrestrial forces and energies and provide feedback on the validity of alternative explanations</p>

	<p>SCI3.6.a-Science, Earth Science, The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes - Develop, communicate, and justify an evidence-based scientific explanation addressing questions regarding the interaction of Earth's surface with water, air, gravity, and biological activity</p> <p>SCI3.6.b-Science, Earth Science, -Analyze and interpret data, maps, and models concerning the direct and indirect evidence produced by physical and chemical changes that water, air, gravity, and biological activity create</p> <p>SCI3.6.c-Science, Earth Science, - Evaluate negative and positive consequences of physical and chemical changes on the geosphere</p>
	<p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>

<b>High School Expectations</b>	
<b>Concepts and skills students know include: ENY 05.03 Analyze solar as a renewable energy source.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.03 A</b> Define solar power.</p> <p>(SCI 3.2a)</p> <p><b>ENY 05.03 B</b> Trace the evolution of the applications of solar energy.</p> <p><b>ENY 05.03 C</b> Describe the primary applications for solar energy.</p> <p><b>ENY 05.03 D</b> Differentiate plants' use from humans' use of solar energy.</p> <p>(SCI 2.1c)</p> <p><b>ENY 05.03 E</b> Compare and contrast the advantages and disadvantages of solar power.</p> <p>(SCI3.5a SCI3.5b)</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI2.1.c-Science, Life Science, Matter tends to be cycled within an ecosystem, while energy is transformed and eventually exits an ecosystem - Analyze and interpret data from experiments on ecosystems where matter such as fertilizer has been added or withdrawn such as through drought</p> <p>SCI3.2.a-Science, Earth Science, As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways- Develop, communicate, and justify an evidence-based scientific explanation addressing questions around the extraterrestrial forces and energies that influence Earth</p>

	<p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.04 Examine the classifications of solar power technology.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.04 A</b> Analyze direct solar power as a transformation of sunlight into usable forms of energy (e.g., photovoltaic cells creating electricity, thermal mass heating, solar sail on a space craft, direct lighting).</p> <p>SCI 1.6a; SCI 1.6c; SCI 1.6d)</p> <p><b>ENY 05.04 B</b> Describe and diagram indirect solar power as a multiple transformation of sunlight into usable forms of energy (e.g., photosynthesis, hydroelectric dams, wind turbines, ocean thermal energy production, fossil fuels derived from captured vegetation, reflected sunlight).</p> <p>(SCI 1.6a SCI 1.6b SCI 1.6c)</p> <p><b>ENY 05.04 C</b> Differentiate passive from active solar systems, primarily in building construction.</p> <p><b>ENY 05.04 D</b> Differentiate concentrating (e.g., lenses, mirrors) from non-concentrating (e.g., photovoltaic cells) solar systems.</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI1.6.a-Science, Physical Science, When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases - Use direct and indirect evidence to develop and support claims about the conservation of energy in a variety of systems, including transformations to heat</p> <p>SCI1.6.c-Science, Physical Science, - Describe energy transformations both quantitatively and qualitatively</p> <p>SCI1.6.d-Science, Physical Science, - Differentiate among the characteristics of mechanical and electromagnetic waves that determine their energy</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>

<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.05</b> Analyze the types of technologies developed to make use of solar radiation.	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.05 A</b> Describe the current solar technologies used in architecture (e.g., heating, cooking, lighting, photovoltaic cells).</p> <p><b>ENY 05.05 B</b> Explore the function and operation of solar thermal electric power plants.</p> <p><b>ENY 05.05 C</b> Discuss the function and operation of solar ponds.</p> <p><b>ENY 05.05 D</b> Describe the solar chemical process.</p> <p><b>ENY 05.05 E</b> Compare the relationship between biofuels and solar power.</p>	<b>Academic Content Knowledge Alignment:</b>
	<b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b>

High School Expectations	
Concepts and skills students know include: ENY 05.06 Explain the issues and trends affecting the distribution and storage of solar energy.	
Evidence Outcomes Students can:	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>ENY 05.06 A</b> Distinguish between the amount of solar radiation contacting the earth’s surface, the amount of available power and the amount of delivered power.</p> <p>(SCI3.2a; SCI3.2b; SCI3.4a)</p> <p><b>ENY 05.06 B</b> Identify current means for storing solar energy (e.g., thermal mass, batteries, pumped-storage hydroelectricity, hydraulic accumulator).</p> <p>(SCI1.6c SCI3.4b)</p> <p><b>ENY 05.06 C</b> Discuss transferring excess power to a grid and drawing it back when needed.</p> <p><b>ENY 05.06 D</b> Discuss consumption in terms of time of day, demand and peak power available.</p> <p>(SCI3.4c)</p> <p><b>ENY 05.06 E</b> Explain the economic issues affecting storage and distribution.</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>RWC4.2.a-Reading, Writing and Communicating, Research and Reasoning, Analyze and develop a logical argument that distinguishes facts, opinions, evidence and inferences. - Synthesize information logically: distinguish among facts opinions, evidence, and inferences; identify false premises or assumptions; and detect potential bias and “loaded” language (e.g., sarcasm, personal attack, appeal to pity)</p> <p>RWC4.2.b- Summarize ideas including alternate views, rich detail, well-developed paragraphs, and logical argumentation.</p> <p>RWC4.2.d- If the presentation is or oral a visual product: Prepare notes and visuals for clarity of content and effect, grammatically correct use of language, spelling, and mechanics.</p>

**ENY 05.06 F** Analyze current government, international, national and state utility policies on application and financing of solar energy systems.

(RWC 4.2.a; RWC 4.2.b RWC 4.2d; RWC 4.11.i; RWC 4.11.m; RWC 4.11.a; RWC 4.11.b; RWC 4.11.c; RWC 4.11.d; RWC 4.11.e; RWC 4.11.f; RWC 4.11.g; RWC 4.11.h; RWC 4.11.i; RWC 4.11.j; RWC 4.11.k; RWC 4.11.l; RWC 4.11.m)

RWC4.11.a-Reading, Writing and Communicating, Research and Reasoning, Use quality reasoning and effective problem solving strategies. - Analyze the purpose, question at issue, information, points of view, implications and consequences, inferences, assumptions and concepts inherent in thinking.

RWC4.11.b- Assess strengths and weaknesses of their thinking and thinking of others by using criteria including: relevance, clarity, accuracy, fairness, significance, depth, breadth, logic and precision.

RWC4.11.c- Articulate goal and purpose

RWC4.11.d- State the problem clearly and precisely.

RWC4.11.e- Identify the type of problem at hand.

RWC4.11.f- Determine what parts of the problem are solvable.

RWC4.11.g- Determine the information needed to solve the problem.

RWC4.11.h- Analyze and interpret information.

RWC4.11.i- Make inferences after considering information.

	<p>RWC4.11.j- Identify and evaluate options for advantages and disadvantages.</p> <p>RWC4.11.k- Determine appropriate forms of action.</p> <p>RWC4.11.l- Monitor the implications of actions.</p> <p>RWC4.11.m- Be prepared to revise strategy if situation requires it.</p> <p>SCI1.6.c-Science, Physical Science, When energy changes form, it is neither created nor destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases - Describe energy transformations both quantitatively and qualitatively</p> <p>SCI3.2.a-Science, Earth Science, As part of the solar system, Earth interacts with various extraterrestrial forces and energies such as gravity, solar phenomena, electromagnetic radiation, and impact events that influence the planet's geosphere, atmosphere, and biosphere in a variety of ways- Develop, communicate, and justify an evidence-based scientific explanation addressing questions around the extraterrestrial forces and energies that influence Earth</p>
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	<p>SCI3.2.b-Science, Earth Science, - Analyze and interpret data regarding extraterrestrial forces and energies</p> <p>SCI3.4.a-Science, Earth Science, Climate is the result of energy transfer among interactions of the atmosphere, hydrosphere, geosphere, and biosphere - Develop, communicate, and justify an evidence-based scientific explanation that shows climate is a result of energy transfer among the atmosphere, hydrosphere, geosphere and biosphere</p> <p>SCI3.4.b-Science, Earth Science, - Analyze and interpret data on Earth's climate</p> <p>SCI3.4.c-Science, Earth Science, - Explain how a combination of factors such as Earth's tilt, seasons, geophysical location, proximity to oceans, landmass location, latitude, and elevation determine a location's climate</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.07 Explain how photovoltaic (PV) cells produce electrical energy.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.07 A</b> Describe the function of each PV cell component.</p> <p><b>ENY 05.07 B</b> Trace the production of electricity through PV cells (i.e., from the sun’s rays to electrical output).</p> <p><b>ENY 05.07 C</b> Compare and contrast the solar cell with the rechargeable battery.</p> <p><b>ENY 05.07 D</b> Compare and contrast different PV technologies. (e.g., crystalline, thin film, emerging technologies).</p> <p><b>ENY 05.07 E</b> Analyze PV cell performance and the effects of heat and sunlight spectrum.</p> <p><b>ENY 05.07 F</b> Compare and contrast PV cell manufacturing methods in terms of cost, environmental impact, embodied energy and materials.</p>	<b>Academic Content Knowledge Alignment:</b>
	<b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b>

<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.08 Explain how solar thermal systems collect and transfer energy.</b>	
<b>Evidence Outcomes - Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.08 A</b> Compare solar thermal technologies to solar electrical technologies.</p> <p><b>ENY 05.08 B</b> Describe different types of solar thermal systems (e.g., parabolic, flat plate, solar cooking, evacuated tubes, hot air).</p> <p><b>ENY 05.08 C</b> Identify different delivery methods for solar thermal systems (e.g., closed loop hydronic, open loop hydronic, mass, forced air).</p>	<b>Academic Content Knowledge Alignment:</b>
	<b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b>

<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.09</b> Explain wind power as an energy source.	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.09 A</b> Research the origin and natural sources of wind.</p> <p>( SCI 3.4a 3.4b 3.4c)</p> <p>ENY 05.09 B Describe how wind is converted into mechanical and electrical energy.</p> <p>(SCI1.6c)</p> <p><b>ENY 05.09 C</b> Identify and explain the function of the basic parts of a wind turbine.</p> <p><b>ENY 05.09 D</b> Correlate wind variability and turbine power.</p> <p>( SCI1.5d )</p> <p><b>ENY 05.09 E</b> Discuss the capacity of wind as a viable energy source.</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI1.6.c-Science, Physical Science, When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases - Describe energy transformations both quantitatively and qualitatively</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>

<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b>	
<b>ENY 05.10 Analyze wind power as a renewable energy source.</b>	
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<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.10 A</b> Trace the origins and technical development of wind energy.</p> <p><b>ENY 05.10 B</b> Describe the primary applications for wind energy.</p> <p><b>ENY 05.10 C</b> Compare and contrast the differences between small wind, small utility scale and large utility scale projects.</p> <p><b>ENY 05.10 D</b> Identify basic technical factors affecting wind energy (e.g., stand-alone systems, utility interconnection).</p> <p><b>ENY 05.10 E</b> Analyze basic economic factors affecting wind energy (e.g., installation, energy costs, operation, maintenance).</p> <p>(RWC 4.2.a; RWC 4.2.b RWC 4.2d; RWC 4.11.i; RWC 4.11.m; RWC 4.11.a; RWC 4.11.b; RWC 4.11.c; RWC 4.11.d; RWC 4.11.e; RWC 4.11.f; RWC 4.11.g; RWC 4.11.h; RWC 4.11.i; RWC 4.11.j; RWC 4.11.k; RWC 4.11.l; RWC 4.11.m)</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>RWC4.2.a-Reading, Writing and Communicating, Research and Reasoning, Analyze and develop a logical argument that distinguishes facts, opinions, evidence and inferences. - Synthesize information logically: distinguish among facts opinions, evidence, and inferences; identify false premises or assumptions; and detect potential bias and “loaded” language (e.g., sarcasm, personal attack, appeal to pity)</p> <p>RWC4.2.b- Summarize ideas including alternate views, rich detail, well-developed paragraphs, and logical argumentation.</p> <p>RWC4.2.d- If the presentation is or oral a visual product: Prepare notes and visuals for clarity of content and effect, grammatically correct use of language, spelling, and mechanics.</p>

**ENY 05.10 F** Compare and contrast the advantages and disadvantages of wind power in relation to location, wildlife and performance.

RWC4.11.a-Reading, Writing and Communicating, Research and Reasoning, Use quality reasoning and effective problem solving strategies. - Analyze the purpose, question at issue, information, points of view, implications and consequences, inferences, assumptions and concepts inherent in thinking.

RWC4.11.b- Assess strengths and weaknesses of their thinking and thinking of others by using criteria including: relevance, clarity, accuracy, fairness, significance, depth, breadth, logic and precision.

RWC4.11.c- Articulate goal and purpose

RWC4.11.d- State the problem clearly and precisely.

RWC4.11.e- Identify the type of problem at hand.

RWC4.11.f- Determine what parts of the problem are solvable.

RWC4.11.g- Determine the information needed to solve the problem.

RWC4.11.h- Analyze and interpret information.

RWC4.11.i- Make inferences after considering information.

	<p>RWC4.11.j- Identify and evaluate options for advantages and disadvantages.</p> <p>RWC4.11.k- Determine appropriate forms of action.</p> <p>RWC4.11.l- Monitor the implications of actions.</p> <p>RWC4.11.m- Be prepared to revise strategy if situation requires it.</p> <hr/> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.11 Examine the growth and development of small-scale, small utility scale and large utility scale wind turbine utilization.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.11 A</b> Identify and describe different types of small-scale, small utility scale and large utility scale wind turbines for individual, institutional, industrial and community use.</p> <p><b>ENY 05.11 B</b> Discuss the technological developments and capacities of small-scale, small utility scale and large utility scale wind turbines for individual, institutional, industrial and community use.</p> <p><b>ENY 05.11 C</b> Identify and describe basic infrastructure requirements as well as hardware and software systems used to transport, distribute, store and utilize energy produced by small-scale, small utility scale and large utility scale wind turbines.</p> <p><b>ENY 05.11 D</b> Compare and contrast among small-scale, small utility scale and large utility scale turbines other than size.</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>RWC4.2.a-Reading, Writing and Communicating, Research and Reasoning, Analyze and develop a logical argument that distinguishes facts, opinions, evidence and inferences. - Synthesize information logically: distinguish among facts opinions, evidence, and inferences; identify false premises or assumptions; and detect potential bias and “loaded” language (e.g., sarcasm, personal attack, appeal to pity)</p> <p>RWC4.2.b- Summarize ideas including alternate views, rich detail, well-developed paragraphs, and logical argumentation.</p> <p>RWC4.2.d- If the presentation is or oral a visual product: Prepare notes and visuals for clarity of content and effect, grammatically correct use of language, spelling, and mechanics.</p>

**ENY 05.11 E** Analyze the advantages and disadvantages of each scale in relationship with each other.

(RWC 4.2.a; RWC 4.2.b RWC 4.2d; RWC 4.11.i; RWC 4.11.m; RWC 4.11.a; RWC 4.11.b; RWC 4.11.c; RWC 4.11.d; RWC 4.11.e; RWC 4.11.f; RWC 4.11.g; RWC 4.11.h; RWC 4.11.i; RWC 4.11.j; RWC 4.11.k; RWC 4.11.l; RWC 4.11.m)

RWC4.11.a-Reading, Writing and Communicating, Research and Reasoning, Use quality reasoning and effective problem solving strategies. - Analyze the purpose, question at issue, information, points of view, implications and consequences, inferences, assumptions and concepts inherent in thinking.

RWC4.11.b- Assess strengths and weaknesses of their thinking and thinking of others by using criteria including: relevance, clarity, accuracy, fairness, significance, depth, breadth, logic and precision.

RWC4.11.c- Articulate goal and purpose

RWC4.11.d- State the problem clearly and precisely.

RWC4.11.e- Identify the type of problem at hand.

RWC4.11.f- Determine what parts of the problem are solvable.

RWC4.11.g- Determine the information needed to solve the problem.

RWC4.11.h- Analyze and interpret information.

RWC4.11.i- Make inferences after considering information.

	<p>RWC4.11.j- Identify and evaluate options for advantages and disadvantages.</p> <p>RWC4.11.k- Determine appropriate forms of action.</p> <p>RWC4.11.l- Monitor the implications of actions.</p> <p>RWC4.11.m- Be prepared to revise strategy if situation requires it.</p> <hr/> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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<b>High School Expectations</b>	
<b>Concepts and skills students know include: ENY 05.12 Analyze hydropower as a renewable energy source.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.12 A</b> Explain the process of producing electricity from water flow.</p> <p>(SCI 1.6c)</p> <p><b>ENY 05.12 B</b> Trace the historical development of hydropower.</p> <p><b>ENY 05.12 C</b> Identify the different types of hydropower installations.</p> <p><b>ENY 05.12 D</b> Describe the geological implications affecting the location of hydropower installations.</p> <p>(SCI3.5a SCI 3.5b)</p> <p><b>ENY 05.12 E</b> Distinguish potential energy from kinetic energy.( SCI 1.5a )</p> <p><b>ENY 05.12 F.</b> Calculate the amount of electricity generated in relation to height and speed of water flow</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI1.1.b-Science, Physical Science, Newton's laws of motion and gravitation describe the relationships among forces acting on and between objects, their masses, and changes in their motion – but have limitations - Develop, communicate and justify an evidence-based analysis of the forces acting on an object and the resultant acceleration produced by a net force</p> <p>SCI1.6.c-Science, Physical Science, When energy changes form, it is neither created not destroyed; however, because some is necessarily lost as heat, the amount of energy available to do work decreases - Describe energy transformations both quantitatively and qualitatively</p>

<p>(SCI 1.1b)</p> <p><b>ENY 05.12 G</b> Discuss the capability of producing and delivering hydropower for consumption.</p> <p><b>ENY 05.12 H</b> Correlate the relationship between hydropower and thermal installations.</p>	<p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p> <hr/> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.13 Explain the issues and trends affecting the production, distribution and storage of hydroelectricity.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.13 A</b> Describe the societal issues affecting the placement of hydropower facilities.</p> <p><b>ENY 05.13 B</b> Explain the state and federal laws and regulations affecting hydropower installations and production.</p> <p><b>ENY 05.13 C</b> Contrast the economics of installation versus operations and maintenance.</p> <p><b>ENY 05.13 D</b> Discuss the potential for future hydropower installations.</p> <p><b>ENY 05.13 E</b> Explain consumption in terms of time of day, demand and peak power available.</p> <p><b>ENY 05.13 F</b> Differentiate between the advantages and disadvantages of hydropower installations. (</p> <p>SCI 3.5a SCI 3.5b)</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>

<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b>	
<b>ENY 05.14</b> Analyze geothermal as a renewable energy source.	
<b>Evidence Outcomes - Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.14 A</b> Define geothermal as an energy source.</p> <p><b>ENY 05.14 B</b> Explain the systems and processes of producing energy from geothermal installations.</p> <p><b>ENY 05.14 C</b> Identify the best locations for geothermal power installations.</p> <p><b>ENY 05.14 D</b> Differentiate between the advantages and disadvantages of geothermal power as a viable energy source.</p> <p><b>ENY 05.14 E</b> Describe the primary applications of geothermal energy.</p> <p><b>ENY 05.14 F</b> Explain the economic factors in terms of installation cost versus operation and maintenance.</p> <p><b>ENY 05.14 G</b> Describe the environmental implications of geothermal power installations.</p> <p>(SCI 3.5a SCI 3.5b)</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>

High School Expectations	
Concepts and skills students know include: ENY 05.15 Explain biomass as a renewable energy source.	
Evidence Outcomes Students can:	21 <sup>st</sup> Century Skills and Readiness Competencies
<p><b>ENY 05.15 A</b> Explain the process of producing electricity from biomass.</p> <p>(SCI 1.4a SCI 1.4b)</p> <p><b>ENY 05.15 B</b> Trace the historical development of biomass sources.</p> <p><b>ENY 05.15 C</b> Identify the different types of biomass installations.</p> <p><b>ENY 05.15 D</b> Describe the implications affecting the location of biomass installations.</p> <p><b>ENY 05.15 E</b> Distinguish potential energy from kinetic energy. (SCI 1.4a)</p> <p><b>ENY 05.15 F</b> Calculate the amount of electricity generated from different biomass fuel sources</p> <p><b>ENY 05.15 G</b> Discuss the capability to produce and deliver biomass energy for consumption.</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI1.4.a Atoms bond in different ways to form molecules and compounds that have definite properties- Develop, communicate, and justify an evidence-based scientific explanation supporting the current models of chemical bonding</p> <p>SCI1.4.b -Gather, analyze, and interpret data on chemical and physical properties of different compounds such as density, melting point, boiling point, pH, and conductivity</p> <p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p>

<p><b>ENY 05.15 H</b> Compare relationship between biomass and biodiesel fuels.</p> <p><b>ENY 05.15 I</b> Analyze the societal issues affecting the placement of biomass (e.g., sorghum, bagasse) facilities.</p> <p><b>ENY 05.15 J</b> Identify the state and federal laws and regulations affecting biomass installations and production.</p> <p><b>ENY 05.15 K</b> Discuss the potential for future biomass/fossil fuel installations.</p> <p><b>ENY 05.15 L</b> Differentiate the advantages of biomass/fossil fuel installations.</p> <p><b>ENY 05.15 M</b> Explain the disadvantages of biomass/fossil fuel installations (e.g., ecological, geographical, carbon dioxide).</p> <p>(SCI 3.5a SCI 3.5b)</p>	<p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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## High School Expectations

**Concepts and skills students know include:**  
**ENY 05.16 Analyze biodiesel as an energy source.**

### Evidence Outcomes Students can:

- ENY 05.16 A** Trace the evolution of biodiesel from its origin.
- ENY 05.16 B** Justify biodiesel as an energy source.
- ENY 05.16 C** Explain the process of producing energy from biodiesel.  
  
(SCI 1.4a SCI 1.4d)
- ENY 05.16 D** Diagram the production process and raw materials used to produce biodiesel.
- ENY 05.16 E** Compare the efficiencies of raw materials used to produce biodiesel.  
  
(SCI 1.4b)
- ENY 05.16 F** Describe the co-products in the production of biodiesel.
- ENY 05.16 G** Identify the physical properties and technical standards of biodiesel as an energy source.

### 21<sup>st</sup> Century Skills and Readiness Competencies

#### Academic Content Knowledge Alignment:

RWC4.1.a-Reading, Writing and Communicating, Research and Reasoning, Conduct self-designed research that gathers and analyzes information from a variety of sources to answer a question, propose solutions or share findings and conclusions. - Define and narrow a topic for research (e.g., thesis statement, hypothesis, research question).

RWC4.11.a-Reading, Writing and Communicating, Research and Reasoning, Use quality reasoning and effective problem solving strategies. - Analyze the purpose, question at issue, information, points of view, implications and consequences, inferences, assumptions and concepts inherent in thinking.

RWC4.11.b- Assess strengths and weaknesses of their thinking and thinking of others by using criteria including: relevance, clarity, accuracy, fairness, significance, depth, breadth, logic and precision.

RWC4.11.c- Articulate goal and purpose

<p><b>ENY 05.16 H</b> Evaluate the primary applications of biodiesel energy.</p> <p><b>ENY 05.16 I</b> Identify engine modifications that are necessary to utilize biodiesel.</p> <p><b>ENY 05.16 J</b> Investigate improvements in engine design and denaturants for biodiesel use.</p> <p>(RWC 4.11.a; RWC 4.11.b; RWC 4.11.c; RWC 4.11.d; RWC 4.11.e; RWC 4.11.f; RWC 4.11.g; RWC 4.11.h; RWC 4.11.i; RWC 4.11.j; RWC 4.11.k; RWC 4.11.l; RWC 4.11.m)</p> <p><b>ENY 05.16 K</b> Describe the concerns about gelling and water.</p> <p>(SCI 3.5a SCI 3.5b)</p>	<p>RWC4.11.d- State the problem clearly and precisely.</p> <p>RWC4.11.e- Identify the type of problem at hand.</p> <p>RWC4.11.f- Determine what parts of the problem are solvable.</p> <p>RWC4.11.g- Determine the information needed to solve the problem.</p> <p>RWC4.11.h- Analyze and interpret information.</p> <p>RWC4.11.i- Make inferences after considering information.</p> <p>RWC4.11.j- Identify and evaluate options for advantages and disadvantages.</p> <p>RWC4.11.k- Determine appropriate forms of action.</p> <p>RWC4.11.l- Monitor the implications of actions.</p> <p>RWC4.11.m- Be prepared to revise strategy if situation requires it.</p> <p>SCI1.4.a Atoms bond in different ways to form molecules and compounds that have definite properties- Develop, communicate, and justify an evidence-based scientific explanation supporting the current models of chemical bonding</p>
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	<p>SCI1.4.b -Gather, analyze, and interpret data on chemical and physical properties of different compounds such as density, melting point, boiling point, pH, and conductivity</p> <p>SCI1.4.d - Examine, evaluate, question, and ethically use information from a variety of sources and media to investigate the conservation of mass and energy</p> <p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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## High School Expectations

Concepts and skills students know include:

**ENY 05.17** Explain the issues and trends affecting the production, storage and distribution of biodiesel.

Evidence Outcomes Students can:

**ENY 05.17 A** Compare and contrast the advantages and disadvantages of biodiesel as a viable energy source. Copy from hydro

**ENY 05.17 B** Compare the economic factors of biodiesel to other fuels.

(SCI 3.6b)

**ENY 05.17 C** Identify the environmental implications of biodiesel.

(SCI 3.5a SCI 3.5b)

**ENY 05.17 D** Explain the current status for production, storage and distribution facilities.

21<sup>st</sup> Century Skills and Readiness  
Competencies

Academic Content Knowledge Alignment:

SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources

SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use

SCI3.6.b-Science, Earth Science, The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes-Analyze and interpret data, maps, and models concerning the direct and indirect evidence produced by physical and chemical changes that water, air, gravity, and biological activity create

	<b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b>

<b>High School Expectations</b>	
<b>Concepts and skills students know include: ENY 05.18 Analyze ethanol as an energy source.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.18 A</b> Trace the evolution of ethanol from its origin.</p> <p><b>ENY 05.18 B</b> Explain the processes of producing energy from ethanol.</p> <p>( SCI 1.4a SCI 1.4d)</p> <p><b>ENY 05.18 C</b> Diagram the production processes and raw materials used to produce ethanol.</p> <p><b>ENY 05.18 D</b> Compare the efficiencies of raw materials used to produce ethanol.</p> <p>(SCI 1.4b)</p> <p><b>ENY 05.18 E</b> Describe the co-products in the production of ethanol.</p> <p>(SCI 1.3a)</p> <p><b>ENY 05.18 F</b> Identify the physical properties and technical standards of ethanol as an energy source.</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>RWC4.11.a-Reading, Writing and Communicating, Research and Reasoning, Use quality reasoning and effective problem solving strategies. - Analyze the purpose, question at issue, information, points of view, implications and consequences, inferences, assumptions and concepts inherent in thinking.</p> <p>RWC4.11.b- Assess strengths and weaknesses of their thinking and thinking of others by using criteria including: relevance, clarity, accuracy, fairness, significance, depth, breadth, logic and precision.</p> <p>RWC4.11.c- Articulate goal and purpose</p> <p>RWC4.11.d- State the problem clearly and precisely.</p> <p>RWC4.11.e- Identify the type of problem at hand.</p> <p>RWC4.11.f- Determine what parts of the problem are solvable.</p>

<p><b>ENY 05.18 G</b> Hypothesize the different sources of ethanol.</p> <p><b>ENY 05.18 H</b> Describe the primary applications of ethanol energy.</p> <p><b>ENY 05.18 I</b> Identify engine modifications that are necessary to utilize ethanol.</p> <p><b>ENY 05.18 J</b> Investigate improvements in engine design and denaturants for ethanol use.</p> <p>(RWC 4.11.a; RWC 4.11.b; RWC 4.11.c; RWC 4.11.d; RWC 4.11.e; RWC 4.11.f; RWC 4.11.g; RWC 4.11.h; RWC 4.11.i; RWC 4.11.j; RWC 4.11.k; RWC 4.11.l; RWC 4.11.m; SCI 3.5a; SCI 3.5b)</p>	<p>RWC4.11.g- Determine the information needed to solve the problem.</p> <p>RWC4.11.h- Analyze and interpret information.</p> <p>RWC4.11.i- Make inferences after considering information.</p> <p>RWC4.11.j- Identify and evaluate options for advantages and disadvantages.</p> <p>RWC4.11.k- Determine appropriate forms of action.</p> <p>RWC4.11.l- Monitor the implications of actions.</p> <p>RWC4.11.m- Be prepared to revise strategy if situation requires it.</p> <p>SCI1.3.a-Science, Physical Science, Matter Matter can change form through chemical or nuclear reactions abiding by the laws of conservation of mass and energy. - Recognize, analyze, interpret, and balance chemical equations (synthesis, decomposition, combustion, and replacement) or nuclear equations (fusion and fission)</p> <p>SCI1.4.a Atoms bond in different ways to form molecules and compounds that have definite properties- Develop, communicate, and justify an evidence-based scientific explanation supporting the current models of chemical bonding</p>
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	<p>SCI1.4.b - Gather, analyze, and interpret data on chemical and physical properties of different compounds such as density, melting point, boiling point, pH, and conductivity</p> <p>SCI1.4.d - Describe the role electrons play in atomic bonding</p> <p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p> <p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
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<b>High School Expectations</b>	
<b>Concepts and skills students know include:</b> <b>ENY 05.19 Explain the issues and trends affecting the production, storage and distribution of ethanol.</b>	
<b>Evidence Outcomes Students can:</b>	<b>21<sup>st</sup> Century Skills and Readiness Competencies</b>
<p><b>ENY 05.19 A</b> Compare and contrast the advantages and disadvantages of ethanol as a viable energy source. (SCI3.5a; SCI3.5b)</p> <p><b>ENY 05.19 B</b> Compare the economic factors of ethanol to other fuels. (SCI 3.6b)</p> <p><b>ENY 05.19 C</b> Describe the environmental implications of ethanol.</p> <p><b>ENY 05.19 D</b> Explain the current status for production, storage and distribution facilities.</p> <p><b>ENY 05.19 E</b> Describe ethanol logistics. (e.g., rail, blending, distribution).</p>	<p><b>Academic Content Knowledge Alignment:</b></p> <p>SCI3.5.a-Science, Earth Science, There are costs, benefits, and consequences of exploration, development, and consumption of renewable and nonrenewable resources - Develop, communicate, and justify an evidence-based scientific explanation regarding the costs and benefits of exploration, development, and consumption of renewable and nonrenewable resources</p> <p>SCI3.5.b-Science, Earth Science, - Evaluate positive and negative impacts on the geosphere, atmosphere, hydrosphere, and biosphere in regards to resource use</p> <p>SCI3.6.b-Science, Earth Science, The interaction of Earth's surface with water, air, gravity, and biological activity causes physical and chemical changes-Analyze and interpret data, maps, and models concerning the direct and indirect evidence produced by physical and chemical changes that water, air, gravity, and biological activity create</p>

<p><b>ENY 05.19 F</b> Identify and describe raw material logistics for ethanol.</p>	
<p><b>ENY 05.19 G</b> Explore the markets for different blends of ethanol and co-products.</p>	<p><b>Learning &amp; Behavioral Skills (Inquiry, Application in Society &amp; Technology &amp; Nature of...):</b></p>
<p><b>ENY 05.19 H</b> Diagram the political timeline of ethanol.</p>	