# Agricultural and Environmental Systems Career Field

## Energy Systems Management

**Subject Code: 010715**

**Course and Unit Descriptions**

**Course Description:**

Students will apply basic principles of energy accounting, thermodynamics and heat transfer, energy conversion and efficiency to heating, power generation, and transportation. Students will apply the principles and practices needed for managing renewable and non-renewable energy resources. Throughout this course, future energy systems and energy use scenarios are investigated, with a focus on promoting the use of renewable energy resources and technologies.

**Unit: Environmental Aspects of Renewable Energy**

Students will analyze the positive and negative effects renewable energy may have on our environment. Students will research the purpose and impact government regulations and laws have on the installation of renewable energy processing centers. Students will perform presentations on local and national issues surrounding renewable energy.

**Outcome 1.3**

Business Ethics and Law: Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competency:**

1.3.1 Analyze how regulatory compliance (e.g., United States Department of Agriculture [USDA], Food and Drug Administration [FDA], United States Department of Interior [USDI], Ohio Livestock Care Standards, water quality standards, local water regulations, building codes) affects business operations and organizational performance.

1.3.4 Identify how federal and state consumer protection laws affect products and services.

**Outcome 6.10**

Ecosystems: Evaluate biotic and abiotic components and relationships in ecosystems to apply restoration and conservation practices that maintain functionality.

**Competency:**

6.10.1 Describe ecological levels, including population, community, ecosystem, biome, and biosphere.

6.10.2 Distinguish the flow of energy through ecosystems.

6.10.3 Identify and classify interactions among organisms, including predation, symbiosis and competition, to determine species interdependent relationships.

6.10.4 Describe the process of succession and its impact on ecosystems.

6.10.5 Connect biotic interactions with the abiotic environment.

6.10.6 Describe biogeochemical cycles (e.g., carbon, nitrogen, phosphorous, hydrological) and their roles in maintaining equilibrium in an ecosystem.

6.10.7 Identify interactions of ecosystems to differentiate biomes.

6.10.8 Select and implement restoration ecology practices to repair damaged ecosystems.

6.10.9 Identify and describe impacts of native and non-native invasive species on ecosystems.

**Outcome 9.1**

Energy Sources: Identify energy sources according to their economic viability, sustainability, and environmental impact.

**Competency:**

9.1.1. Identify, compare, and contrast fossil fuel sources (e.g., oil, natural gas, and coal) and the technology used to generate energy.

9.1.2. Identify, compare, and contrast renewable energy sources and the technology used to generate energy.

9.1.3. Identify, compare, and contrast alternative and emerging energy sources and technology used to generate energy (e.g., fuel cells, hydrogen, nuclear).

9.1.4. Identify the social, economic, and environmental drivers and barriers that influence the development and use of energy sources.

9.1.5. Identify and describe energy density properties of different types of fuel sources according to industry standards.

9.1.6. Trace the transformations of energy within a system (e.g., mechanical to electrical, chemical to mechanical).

9.1.7. Identify and describe best management practices (e.g., carbon sequestration, conservation, animal safety, efficiency) that lessen environmental impact.

9.1.8. Calculate the theoretical available energy given specific wind and solar conditions and derate actual power versus theoretical power.

**Unit: Site Selection**

Following local, state, and national regulations, students will identify locations where alternative energy processing centers can be designed and built.  Students will use design and build principles along with surveying and mapping to determine layout and designs. Students will research local government and societal issues to determine if a site is suitable for construction.

**Outcome 1.3**

Business Ethics and Law: Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competency:**

1.3.1 Analyze how regulatory compliance (e.g., United States Department of Agriculture [USDA], Food and Drug Administration [FDA], United States Department of Interior [USDI], Ohio Livestock Care Standards, water quality standards, local water regulations, building codes) affects business operations and organizational performance.

1.3.4 Identify how federal and state consumer protection laws affect products and services.

**Outcome 5.3**

Design and Estimate: Interpret basic site plan for a desired outcome or company specification.

**Competency:**

5.3.1. Identify and interpret symbols, drawings, prints, and blueprints.

5.3.2. Apply proportional measurement and scale techniques.

5.3.3. Complete a site inventory and analysis, including physical conditions, code and utilities requirements, and the environmental impact.

5.3.4. Develop a program list, including intended use, budget, economics, customer wants and needs, and maintenance.

5.3.8. Calculate the space requirements and compute various attributes, including length, angle measurement, surface area, and volume.

5.3.9. Identify construction documents, common scales, specifications, and materials used in construction or fabrication.

5.3.10. Identify material, input, and equipment needs based on availability to calculate costs in production or application.

5.3.11. Establish the sequential steps of construction and installation.

**Outcome 5.4**

Surveying and Mapping: Perform surveying procedures to construct a site plan.

**Competency:**

5.4.1 Identify civil drafting symbols and abbreviations.

5.4.2 Interpret maps, topographic site plans, deeds, and aerial or satellite imagery for site planning.

5.4.3 Perform site measurements.

5.4.4 Integrate map and surveying data into geographic information system (GIS) or computer aided design (CAD) software.

5.4.5 Identify topographical and existing features of areas, including property lines, benchmarks, utilities, streets, and setbacks, on survey maps, parcel maps, and plats.

**Unit: Biomass**

Students will analyze ethanol, biodiesel, and anaerobic digestion as a renewable energy source. Students will describe the chemical reactions and physical processes that occur during processing. Following industry standards, students will convert biomass feedstocks to biofuel products and test for quality.

**Outcome 9.1**

Energy Sources: Identify energy sources according to their economic viability, sustainability, and environmental impact.

**Competency:**

9.1.6. Trace the transformations of energy within a system (e.g., mechanical to electrical, chemical to mechanical).

9.1.7. Identify and describe best management practices (e.g., carbon sequestration, conservation, animal safety, efficiency) that lessen environmental impact.

9.1.8. Calculate the theoretical available energy given specific wind and solar conditions and derate actual power versus theoretical power.

**Outcome 9.2**

Crude Oil and Natural Gas: Describe the processes for exploring, drilling, producing, transporting, marketing, refining, and marketing products of crude oil and natural gas.

**Competency:**

9.2.1. Describe the role of geology in the formation, migration, and trapping of crude oil and natural gas.

9.2.2. Assess how crude oil and natural gas wells are placed, designed, and installed.

9.2.6. Identify the different processes for producing, treating, transporting, processing crude oil, and natural gas byproducts.

9.2.7. Identify and describe equipment used in the extraction and processing of crude oil and natural gas for up, mid, and down streams process.

**Outcome 9.3**

Biomass: Describe and manage processes required to extract energy from biomass.

**Competency:**

9.3.1. Identify applications for biomass energy production.

9.3.2. Describe the thermal, chemical, and biochemical methods of converting biomass into energy.

9.3.3. Identify feedstock materials used to produce biofuels and compare the energy potential of each material.

9.3.4. Identify and differentiate the aerobic and anaerobic digestion of biomass.

9.3.5. Test source materials and final products and compare the results to industry standards.

9.3.6. Process source materials for energy conversion.

9.3.7. Identify and describe technical standards and governance for on placing agricultural, commercial, and industrial biomass operations.

9.3.8. Identify the byproducts generated in the production of biofuels and their use and disposal according to industry standards.

9.3.9. Identify and describe storage and distribution systems for biofuels.

**Unit: Principles of Electricity**

Students will demonstrate how electricity works along with the components that go with the collection, storage, and distribution of electrical power and their supply systems. Students will interpret wiring diagrams, install electrical wiring and equipment. Students will measure the amperage, volts, watts, and resistance in electrical systems.

**Outcome 5.1**

Electrical Theory: Interpret and apply electrical and electronic principles and theories.

**Competency:**

5.1.1. Read and interpret wiring diagrams and symbols.

5.1.2. Describe the features, benefits, and applications of electrical and electronic systems.

5.1.3. Describe the relationship between electrical effect and electromagnetic effect.

5.1.4. Explain methods of producing electrical current.

5.1.5. Describe the differences between alternating current (AC) and direct current (DC).

5.1.6. Compare and contrast conductors and insulators.

5.1.7. Differentiate the relationships among voltage, current, resistance, and power in circuits and understand the basics of transformers.

5.1.8. Measure the amperage of AC and DC electrical systems and system components.

5.1.9. Calculate voltage, current, resistance, impedance, and power in circuits using Ohm’s Law, Kirchhoff's Law, and Watt’s Law.

5.1.10. Describe the purpose of grounding and common methods used for grounding.

5.1.11. Describe the uses of series, parallel, and series-parallel circuits.

5.1.12. Use a digital multimeter to determine voltage, current, frequency, and phase.

**Outcome 5.2**

Structural Electrical Circuits: Describe features of an electrical schematic that illustrates a wiring system and interpret and install the design.

**Competency:**

5.2.1. Describe over-current protective devices and their functions.

5.2.2. Identify key information and follow manufacturer's recommendation to repair or replace motors per manufacturer specifications.

5.2.3. Map circuits and label the service panel directory to reflect devices installed on each circuit.

5.2.4. Calculate service requirements for an electrical installation and evaluate for safe capacity.

5.2.5. Identify types of cable, conduit, boxes, switches, outlets, and other common wiring devices.

5.2.6. Identify fasteners, anchors, and fire stop systems.

5.2.7. Select materials and lay out rough-in wiring runs according to specifications, drawings, and code requirements.

5.2.8. Select and install lighting technologies and systems.

5.2.9. Make conductor terminations and connect appliances to circuits.

**Unit: Wind Energy**

Students will learn the importance of wind energy as an alternative energy source by identifying the processes of collecting, storing, and distributing wind energy and accompanying systems. Students will determine what type of wind collection system is needed by testing environmental and geographical factors surrounding an area by performing site surveys.

**Outcome 9.1**

Energy Sources: Identify energy sources according to their economic viability, sustainability, and environmental impact.

**Competency:**

9.1.6. Trace the transformations of energy within a system (e.g., mechanical to electrical, chemical to mechanical).

9.1.7. Identify and describe best management practices (e.g., carbon sequestration, conservation, animal safety, efficiency) that lessen environmental impact.

9.1.8. Calculate the theoretical available energy given specific wind and solar conditions and derate actual power versus theoretical power.

**Outcome 9.5**

Wind Energy: Plan and maintain a wind energy installation that captures, stores, and distributes electrical energy.

**Competency:**

9.5.1. Describe the internal and external components of wind energy technology and installations.

9.5.2. Conduct a site evaluation to identify an appropriate wind turbine installation.

9.5.3. Identify and describe technical standards and governance for wind energy technologies and installations.

9.5.4. Identify, describe, and differentiate wind technologies used for wind energy production.

9.5.5. Select and design an appropriate wind energy installation for commercial and residential applications.

9.5.6. Review and interpret an electric schematic and site plan for a wind energy installation.

9.5.7. Install, test, and maintain components of a wind energy installation.

9.5.8.        Identify and describe project decommissioning recycling and disposal methods for a wind energy installation.

**Outcome 4.2**

Equipment Operations: Operate and maintain mechanical equipment and power systems.

**Competency:**

4.2.1. Follow original equipment manufacturer (OEM) recommended operating procedures and adjustment specifications as found in the operator’s manual.

4.2.2. Differentiate among the functions, limitations, and proper use of equipment, equipment controls, and instrumentation.

4.2.3. Perform pre- and post-operation inspections and adjustments and report malfunctions.

4.2.4. Perform appropriate start-up, operating, and shut-down procedures.

4.2.5. Select and operate equipment and attachments needed to complete the task per the original equipment manufacturer (OEM) operator’s manual.

**Unit: Solar Energy**

Students will learn the importance of solar energy from sunlight as an alternative energy source by analyzing the processes of collecting, storing, and distributing solar energy. Students will determine if a site is suitable for a solar collection system by researching environmental and geographical factors. Students will explain and demonstrate the uses of photovoltaic cells. Students will adapt mechanical and electrical designs to installation such as water distribution systems.

**Outcome 9.1**

Energy Sources: Identify energy sources according to their economic viability, sustainability, and environmental impact.

**Competency:**

9.1.6. Trace the transformations of energy within a system (e.g., mechanical to electrical, chemical to mechanical).

9.1.7. Identify and describe best management practices (e.g., carbon sequestration, conservation, animal safety, efficiency) that lessen environmental impact.

9.1.8. Calculate the theoretical available energy given specific wind and solar conditions and derate actual power versus theoretical power.

**Outcome 9.4**

Solar Energy: Plan, install, and maintain a solar array that can collect, store, and distribute solar energy.

**Competency:**

9.4.1. Identify the different types of solar energy devices (e.g., photovoltaic [PV], solar thermal, concentrating solar power [CSP]) and how they produce energy.

9.4.3. Select the appropriate solar energy application for commercial and residential use.

9.4.4. Identify the basic design and components of a solar installation.

9.4.5. Identify and describe technical standards and governance for a residential, community, utility solar energy installation.

9.4.6. Review and interpret an electric schematic and site plan for a solar energy installation.

9.4.8. Identify and describe project decommissioning recycling and disposal methods for a solar energy installation.

**Outcome 5.8**

Water Distribution Systems: Calculate the demand for specific water applications and design and install water supply and drainage components.

**Competency:**

5.8.2. Compare the types, applications, and operating principles of pumps and controls.

5.8.4. Identify components of supply and drainage systems and describe their functions.

5.8.9. Select supply and drainage components based on their application for a given purpose.

5.8.11. Join pipe, pipefittings, and valves of similar and dissimilar materials using solder, brazing, solvents, and mechanical means of joining.

5.8.12. Connect plumbing fixtures and appliances to a supply and drainage system.

5.8.13. Compare and contrast sources of contamination in water supplies and methods of filtering and disinfecting water.

5.8.14. Prevent freezing and mechanical damage to pipes.

5.8.15. Describe how water moves from the source through the water distribution system to the fixture.

5.8.16. Test a water supply and drainage system for leaks and pressure using soap, inert gas, electronic sensors, and fluorescent dye.

**Unit: Equipment Maintenance**

Students will inspect and perform maintenance to basic machinery and instruments used on stationary and mobile equipment used in the production and operation of renewable energy facilities. Students will inspect and safely operate specialized equipment with some limitations to adjustments and functions

**Outcome 1.12**

Site and Personal Safety Procedures: Follow site and personal safety procedures in specific situations with specialized tools and equipment, evaluate the situation, and take corrective action.

**Competency:**

1.12.1 Use Occupational Safety and Health Administration (OSHA) defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries, and labeling.

1.12.2 Interpret safety signs and symbols.

1.12.5 Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms, and exits.

1.12.6 Identify procedures for the handling, storage, and disposal of hazardous materials.

1.12.7 Select, use, store, maintain, and dispose of personal protective equipment (PPE), appropriate to job tasks, conditions, and materials.

1.12.8 Identify safety hazards and take corrective measures.

1.12.9 Identify, inspect, and use safety equipment appropriate for the task.

1.12.10 Follow established procedures for the administration of first aid and contact emergency medical personnel when necessary.

1.12.14 Identify the source of electrical hazards and use shutdown and established lock-out/tag-out procedures.

1.12.15 Select and operate fire extinguishers based on the class of fire.

**Outcome 4.1**

Tool, Stationary, and Mobile Equipment Maintenance: Inspect, clean, maintain, and perform planned preventative maintenance on equipment.

**Competency:**

4.1.1. Inspect, clean, maintain, and perform preventative maintenance on equipment.

4.1.2. Identify types of hand tools, power tools, and equipment, and describe their functions.

4.1.3. Ensure the presence and functionality of safety equipment.

4.1.4. Identify potential hazards and limitations related to the use of equipment.

4.1.5. Maintain organization, and cleanliness of facilities, machinery, equipment, and tools for safety and appearance.

4.1.6. Inspect and service electrical systems and components.

4.1.7. Inspect fluid leakage, fluid levels, and the condition of fluids.

4.1.8. Inspect, clean, lubricate, and adjust equipment for safe operation.

4.1.9. Select fluids, maintain fluid levels, and replace system filters per OEM (original equipment manufacturer) specification.

4.1.10. Inspect and maintain fluid conveyance and storage components.

4.1.11. Identify and maintain accuracy of tooling, machinery, and equipment when performing preventive maintenance and repairs.

4.1.12. Compare alternative sources of power for equipment.

**Unit: Business Leadership & Employability Skills**

Students will develop critical thinking and problem-solving skills through the use of a variety of practical scenarios. Students will demonstrate leadership skills through participation with peer groups, support services, and professional organizations.

**Outcome 1.1**

Employability Skills: Develop career awareness and employability skills (e.g., face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

**Competency:**

1.1.1 Identify the knowledge, skills, and abilities necessary to succeed in careers.

1.1.2 Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience.

1.1.3 Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options.

1.1.4 Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships.

1.1.5 Develop strategies for self-promotion in the hiring process (e.g., filling out job applications, resumé writing, interviewing skills, portfolio development).

1.1.6 Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles.

1.1.7 Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.

1.1.8 Identify the correlation between emotions, behavior, and appearance, and manage those to establish and maintain professionalism.

1.1.9 Give and receive constructive feedback to improve work habits.

1.1.10 Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11 Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.

1.1.12 Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits, and abusive behavior.

**Outcome 1.2**

Leadership and Communications: Process, maintain, evaluate, and disseminate information in a business. Develop leadership and team building to promote collaboration.

**Competency:**

1.2.1 Extract relevant, valid information from materials and cite sources of information.

1.2.2 Deliver formal and informal presentations.

1.2.3 Identify and use verbal, nonverbal, and active listening skills to communicate effectively.

1.2.4 Use negotiation and conflict-resolution skills to reach solutions.

1.2.5 Communicate information (e.g., directions, ideas, vision, workplace expectations) for an intended audience and purpose.

1.2.6 Use proper grammar and expression in all aspects of communication.

1.2.7 Use problem-solving and consensus-building techniques to draw conclusions and determine next steps.

1.2.8 Identify the strengths, weaknesses, and characteristics of leadership styles that influence internal and external workplace relationships.

1.2.9 Identify advantages and disadvantages involving digital and/or electronic communications (e.g., common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).

1.2.10 Use interpersonal skills to provide group leadership, promote collaboration, and work in a team.

1.2.11 Write professional correspondence, documents, job applications, and resumés.

1.2.12 Use technical writing skills to complete forms and create reports.

1.2.13 Identify stakeholders and solicit their opinions.

1.2.14 Use motivational strategies to accomplish goals.

**Outcome 1.6**

Business Literacy: Develop foundational skills and knowledge in entrepreneurship, financial literacy, and business operations.

**Competency:**

1.6.7.    Identify the effect of supply and demand on products and services.

1.6.10. Describe the impact of globalization on an enterprise or organization.

**Outcome 1.10**

Sales and Marketing: Manage pricing, place, promotion, packaging, positioning, and public relations to improve quality customer service.

**Competency:**

1.10.6.  Discuss the importance of correct pricing to support a product’s or service’s positioning in the marketing mix.

**Outcome 1.11**

Principles of Business Economics: Examine and employ economic principles, concepts, and policies to accomplish organizational goals and objectives.

**Competency:**

1.11.2.  Identify the difference between monetary and nonmonetary incentives and explain how changes in incentives cause changes in behavior.

1.11.4.  Determine how the quality, quantity, and pricing of goods and services are affected by domestic and international competition in a market economy.

1.11.8.  Identify the relationships between economy, society, and environment that lead to sustainability.

**Unit: Research Management**

Students will learn how to use technology to compile research and analyze information to draw conclusions. Students will use the available technology to create reports and using communication skills, present their findings to small groups.

**Outcome 1.4**

Knowledge Management and Information Technology: Demonstrate current and emerging strategies and technologies used to collect, analyze, record, and share information in business operations.

**Competency:**

1.4.1 Use office equipment to communicate (e.g., phone, radio equipment, fax machine, scanner, public address systems).

1.4.2 Select and use software applications to locate, record, analyze, and present information (e.g., word processing, e-mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3 Verify compliance with security rules, regulations, and codes (e.g., property, privacy, access, accuracy issues, client, and patient record confidentiality) pertaining to technology specific to the industry pathway.

1.4.4 Use system hardware to support software applications.

**Outcome 3.1**

Research and Experiments: Use scientific methodology to conduct problem-based studies, develop products, and interpret results.

**Competency:**

3.1.1. Design a research plan, including the significance of the problem, purpose, hypotheses, objectives, appropriate controls, independent variables, dependent variables, methods of study, and a list of materials.

3.1.12. Prepare and present findings using scientific reports.