# Agricultural and Environmental Systems Career Field

## Solar and Wind Energy

**Subject Code: 010716**

**Outcome & Competency Descriptions**

**Course Description:**

Students will conduct Energy Site Assessments by using and interpreting resource maps, performance data, zoning requirements and interferences, installation timelines and price. They will read plans, lay out components and assemble electrical system components. Students will perform system checkouts and interpret results from mechanical and electrical diagnostic reports and compile and maintain system records. Throughout the course, students will apply safety regulations and identify and resolve public safety issues.

**Strand 1.**  **Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**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.

**Competencies**

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).

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

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.

**Outcome: 1.2.**  **Leadership and Communications**

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

**Competencies**

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.

1.2.10. 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.

**Outcome: 1.3.**  **Business Ethics and Law**

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

**Competencies**

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.

1.3.5. Access and implement safety compliance measures (e.g., quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], United States Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

**Outcome: 1.6.**  **Business Literacy**

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

**Competencies**

1.6.1. Identify business opportunities.

1.6.5. Describe organizational structure, chain of command, the roles and responsibilities of the

organizational departments and interdepartmental interactions.

1.6.6. Identify the target market served by the organization, the niche that the organization fills and an outlook of the industry.

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

1.6.8. Identify the features and benefits that make an organization’s product or service competitive.

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.

**Competencies**

1.10.2. Determine the customer's needs and identify solutions.

1.10.3. Communicate features, benefits and warranties of a product or service to the customer.

1.10.4. Identify the company policies and procedures for initiating product and service improvements.

1.10.5. Monitor customer expectations and determine product/service satisfaction by using measurement tools.

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.

**Competencies**

1.11.1. Identify the economic principles that guide geographic location of an industry's facilities (e.g., relative scarcity, price, quantity of products and services).

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.

**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.

**Competencies**

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.

1.12.4. Describe how working under the influence of drugs and alcohol increases the risk of accident, lowers productivity, raises insurance costs and reduces profits.

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.

1.12.12. Apply inspection, rejection criteria, hitch configurations and load handling practices to slings and rigging hardware.

1.12.13. Demonstrate the proper use of American National Standards Institute (ANSI) hand signals.

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.

1.12.17. Identify symptoms of exposure to health-threatening environments (e.g., temperature; chemical noise, vibration, harshness [NVH] hazards).

**Strand 4.**  **Power Systems**

Learners apply principles of tool use, power transmission, hydraulics, pneumatics, two- and four-stroke cycle combustion, , exhaust, ignition, fuel, starting and charging, steering, HVAC, and lubrication systems to operate, maintain and repair equipment.

**Outcome: 4.1.**  **Tool, Stationary and Mobile Equipment Maintenance**

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

**Competencies**

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

4.1.2. Identify the 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 the electrical systems and components.

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

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

**Outcome: 4.2.**  **Equipment Operations**

Operate and maintain mechanical equipment and power systems.

**Competencies**

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

**Strand 5.**  **Elements of Production**

Learners apply principles of practice related to the management and maintenance of food, agriculture and natural resources systems.

**Outcome: 5.1.**  **Electrical Theory**

Interpret and apply electrical and electronic principles and theories.

**Competencies**

5.1.1. Read and interpret wiring diagrams and symbols.

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

5.1.4. 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 between 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.

5.1.13. Identify and describe single-phase and three-phase poser and the advantages of each.

**Outcome: 5.2.**  **Structural Electrical Circuits**

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

**Competencies**

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

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.

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

**Outcome: 5.3.**  **Design and Estimate**

Plan and design a basic site plan for a desired outcome.

**Competencies**

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.

**Outcome: 5.4.**  **Surveying and Mapping**

Perform surveying procedures to construct a site plan.

**Competencies**

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.

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

**Outcome: 5.12.**  **Precision Agriculture**

Analyze data from precision agriculture platforms and prepare recommendations.

**Competencies**

5.12.14. Calibrate, repair and maintain electronic equipment per manufacturer's specifications.

**Outcome: 5.13.**  **Electronic Systems**

Learners apply principles of electronics related to electronic theory, alternating and direct current, electronic components, electronic circuits, digital electronics and power supply.

**Competencies**

5.13.2. Measure the source voltage and perform voltage drop and current draw tests in electronic circuits.

5.13.5. Inspect and test switches, connectors, relays, solenoid and wires of electronic circuits.

**Outcome: 5.14.**  **Motors and Programmable Logic Controllers**

Learns will apply the principles of installing motors, variable-frequency drives (VFD) and power wiring; as well as program, install and monitor digital computers used for automation of electronic mechanical processes to perform tasks.

**Competencies**

5.14.3. Calculate motor loads.

**Strand 6.**  **Environmental Science**

Learners apply earth, life, and physical sciences to the production, extraction, processing, protection, use, and renewal of both renewable and non-renewable resources.

**Outcome: 6.1.**  **Soils**

Apply knowledge of soil characteristics and soil information resources to overcome any existing soil use limitations while maintaining or improving soil quality.

**Competencies**

6.1.6. Identify and describe soil conservation practices to reduce soil erosion and compaction.

6.1.9. Evaluate soil survey data and implement management decisions.

**Outcome: 6.3.**  **Air Quality**

Analyze, interpret and manage the biological, chemical and physical properties of air quality.

**Competencies**

6.3.1. Determine the chemical and physical properties of air (e.g., composition, density, pressure).

**Outcome: 6.8.**  **Contaminants and Pollution Control**

Assess an affected area, determine the source and type of contaminant and respond.

**Competencies**

6.8.5. Describe the environmental impact from both industrial and nonindustrial processes.

**Strand 9.**  **Energy**

Learners apply principles of physics, chemistry, the earth sciences and mathematics to energy sources, transformations, acquisition, applications and their impacts.

**Outcome: 9.1.**  **Energy Sources**

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

**Competencies**

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 available given specific solar and wind conditions and derate actual power versus theoretical power.

9.1.9. Calculate and determine the total solar resource factor for the array.

9.1.10. Identify and describe the various stages involved and utilized within a charge controller.

**Outcome: 9.2.**  **Crude Oil and Natural Gas**

Describe the processes for exploring, drilling, producing, transporting, refining and marketing products of crude oil and natural gas.

**Competencies**

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

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

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

**Outcome: 9.3.**  **Bio Mass**

Describe and manage processes required to extract energy from biomass.

**Competencies**

9.3.1. Identify applications for biomass energy production.

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

9.3.4. 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.

**Outcome: 9.4.**  **Solar Energy**

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

**Competencies**

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.

9.4.2. Conduct a site evaluation to identify an appropriate solar panel installation.

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

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.

9.4.7. Install, test and maintain a solar energy installation.

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

9.4.9. Identify and describe the importance of the array given a specific load demand.

9.4.10. Identify and describe how solar modules are rated (e.g. STC, NOCT, Voc, Isc, Vmp, Imp, Mppt).

**Outcome: 9.5.**  **Wind Energy**

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

**Competencies**

9.5.1. Describe the internal and external components of wind energy technologies 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 turbine 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.

9.5.9. Understand and describe aerodynamics and how it affects the operation of a wind turbine (e.g. Bernoulli's Principle).

9.5.10. Differentiate between synchronous asynchronous, fixed speed and variable speed generators.

9.5.11. Identify, describe, and differentiate various wind turbine configurations (e.g., vertical axis wind turbine, horizontal axis wind turbine, number of blades).

9.5.12. Calculate wind shear based on environmental conditions, and tower height.