TN Department of Education | College, Career and Technical Education

Foundations of Energy

Primary Career Cluster:	Energy and Sustainable Resources
Course Contact:	CTE.Standards@tn.gov
Course Code:	TBD
Prerequisite:	None
Credit(s):	1
Grade Level(s):	9
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Clean Energy courses.
Program Of Study (POS) Concentrator:	This course satisfies one out of two required courses to meet the Perkins V concentrator definition when taken in sequence in an approved program of study.
Program of Study Sequence:	This is the first course in the *Clean Energy* program of study.
Aligned Student Organization(s):	Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning (WBL):	Teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
Tennessee Promoted Student Industry Credentials:	Credentials are aligned with postsecondary and employment opportunities and with the competencies and skills that students acquire through their selected program of study. For a listing of promoted student industry credentials, visit https://www.tn.gov/education/educators/career-and-technical-education/student-industry-certification.html.
Teacher Endorsement(s):	015, 016, 017, 125, 127, 129, 211, 212, 214
Required Teacher Certifications:	None
Required Teacher Training:	None
Teacher Resources:	Best for All Central: https://bestforall.tnedu.gov/

Course at a Glance

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Using a Career and Technical Student Organization (CTSO) in Your Classroom

CTSOs are a great resource to put classroom learning into real-life experiences for students through classroom, regional, state, and national competitions, and leadership opportunities. Below are CTSO connections for this course; note this is not an exhaustive list.

- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests highlighting job demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as the National Leadership and Skills Conference, National Week of Service, and 21st Century Skills.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1.1-1.3** | Invite a guest speaker to discuss the various forms of energy.
- **Standards 2.2** | Invite a professional to explain the environmental impacts of energy use.
- **Standards 5.1-5.2** | Invite a professional from an Energy company to discuss energy policies.
- **Standards 6.1-6.2** | Research emerging energy technologies in Energy and present to an advisory board or industry panel.

Course Description

Foundations of Energy is the first course in the Clean Energy program of study. It introduces students to the basics of energy, focusing on different types of energy, their sources, and the importance of energy security and transitioning to clean energy. It will lay the groundwork for understanding the scientific, environmental, and economic aspects of energy production and consumption.

Course Standards

1. Introduction to Energy

1.1 Forms of Energy: Identify and explain the **different forms of energy**. The explanation should include the categorization of various forms of energy such as potential, kinetic, thermal, chemical, mechanical, etc.

1.2 Energy Conversion and Efficiency: Illustrate the concept of **energy conversion** and its applications in everyday life. Compare the **efficiency of different energy conversion methods** (e.g., combustion, electrical generation). Analyze how energy efficiency impacts energy consumption and environmental outcomes.

1.3 Thermodynamics: Investigate the **laws of thermodynamics** as they apply to energy production.

1.4 Historical Context of Energy Usage: Investigate the **history and evolution of energy use** from early human society to modern times. Discuss key milestones in the development of energy technology (e.g., steam engines, electricity generation, nuclear power). Analyze the relationship between industrialization and increased energy demand.

2. Global Energy Demand and Consumption

2.1 Current Global and National Energy Consumption: Investigate **global patterns of energy consumption** and identify **major energy-consuming nations**. Compare energy consumption in the United States with other countries, including sources of energy and usage trends. Analyze the role of economic development in global energy consumption patterns.

2.2 Environmental Impact of Energy Use: Explain the **environmental impacts of different energy sources**, focusing on carbon emissions, pollution, and climate change. Discuss the concept of the carbon footprint. Investigate the consequences of energy use on ecosystems and human health, including air and water pollution.

2.3 Energy Independence and Security: Define **energy independence** and explain its **significance to national security**. Analyze the importance of securing stable energy supplies and the challenges faced by nations that rely on energy imports.

3. Fossil Fuels

3.1 Types of Fossil Fuels: Identify and describe the **three primary types of fossil fuels**: coal, oil, and natural gas. Compare the energy content and uses of different fossil fuels in various sectors.

3.2 Extraction, Processing, and Utilization: Explain the **processes involved in extracting fossil fuels, including mining, drilling, and fracking**. Investigate the refining and processing of fossil fuels into usable forms of energy. Analyze the economic and environmental costs associated with fossil fuel extraction and utilization.

3.3 Environmental and Health Impacts: Evaluate the **environmental impacts of fossil fuel usage**. Investigate how regulations and policies mitigate the environmental and health impacts of fossil fuels.

4. Introduction to Clean Energy

4.1 Types of Clean Energy: Define clean energy and differentiate it from **traditional energy sources**. Identify and describe **various forms of clean energy**.

4.2 Clean versus Traditional Energy Sources: Compare the environmental, economic, and efficiency-related **differences between traditional fossil fuels and clean energy sources**.

4.3 Benefits and Challenges of Clean Energy: Investigate both the **benefits and challenges of clean energy** (e.g., reducing carbon emissions, cost of implementation, etc.) in the environment.

5. Energy Policy and Regulation

5.1 Energy Policies in the United States and Tennessee: Analyze **key energy policies** at the **national and state levels** with a focus on Tennessee's energy regulations, such as Tennessee Valley Authority's (TVA) role in the state. Discuss how energy policy shapes the development of energy infrastructure and consumption patterns.

5.2 Role of Government and International Agreements in Energy Regulation: Investigate the **role of government agencies in regulating energy production and consumption**. Analyze the significance of international agreements in promoting sustainable energy policies.

5.3 Case Studies of Energy Policies: Examine case **studies of successful energy policies** at the state and national levels.

6. Future Trends in Energy

6.1 Emerging Technologies and Innovations in Energy: Explore **emerging energy technologies such as hydrogen fuel cells, advanced nuclear reactors, and carbon capture systems**. Investigate the potential of energy storage technologies to support renewable energy integration.

6.2 Role of Research and Development: Explain the **importance of research and development** in improving the efficiency and affordability of alternative energy technologies.

6.3 Career and Technical Student Organization Introduction: Introduce the program's aligned CTSO, **Technology Student Association (TSA)**, through an interactive activity, such as a classroom competition.

6.4 Ethical Artificial Intelligence (AI): Explore the ethical implications of AI usage through interactive discussions and case studies, learning to identify bias, ensure fairness, and protect privacy in AI systems. **Develop critical thinking skills** to **evaluate the societal impact of AI technologies**, while fostering a sense of responsibility and ethical decision-making in the use of AI tools.

6.5 Careers in the Energy Sector: Identify **career pathways in the energy sector** (e.g., fossil fuel management, energy policy, nuclear welding, nuclear engineers, etc.) Investigate the skills and education required for these careers. Analyze future job market trends and opportunities in the energy sector as society transitions to cleaner energy sources.

7. Data Analysis

7.1 Data Analysis in Clean Energy: **Research** the **uses of data** in **energy production** and **consumption industries**. Include data that is generated internally by businesses, and externally by local communities, state, and the nation. Explore examples of how the data is used, including the following:

a. Customer/client use of products and services;
b. Demographics of end users;
c. Community, state, and national statistics; and
d. Data that must be reported to another entity.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
  - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.

Fundamentals of Clean Energy

Primary Career Cluster:	Energy and Sustainable Resources
Course Contact:	CTE.Standards@tn.gov
Course Code:	TBD
Prerequisite:	None
Credit(s):	1
Grade Level(s):	10
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Clean Energy courses.
Program Of Study (POS) Concentrator:	This course satisfies one out of two required courses to meet the Perkins V concentrator definition when taken in sequence in an approved program of study.
Program of Study Sequence:	This is the second course in the *Clean Energy* program of study.
Aligned Student Organization(s):	Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning (WBL):	Teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
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Teacher Resources:	Best for All Central: https://bestforall.tnedu.gov/

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- Participate in the CTSO Fall Leadership Conference to engage with peers by demonstrating logical thought processes and developing industry-specific skills that involve teamwork and project management.
- Participate in contests highlighting job demonstration, interviewing skills, community service activities, extemporaneous speaking, and job interviews.
- Participate in leadership activities such as the National Leadership and Skills Conference, National Week of Service, and 21st Century Skills.

Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 1-5** | Invite a guest speaker to discuss the various forms of energy.
- **Standard 6** | Invite a professional to explain the integration of renewable energy.
- **Standard 7** | Create a cost analysis of the forms of energy to present to an energy industry panel.

Course Description

Fundamentals of Clean Energy is the second course in the Clean Energy program of study. This course explores various forms of renewable energy, focusing on wind, solar, biomass, and hydropower. Students will gain an understanding of how these technologies work, their benefits, and their role in the global energy mix.

Course Standards

1. Introduction to Renewable Energy

1.1 Importance of Renewable Energy: Define **renewable energy** and explain its **significance** in the context of global energy consumption. Investigate the environmental, economic, and societal benefits of transitioning to renewable energy sources.

1.2 Different Renewable Energy Sources: Identify and describe the **major types of renewable energy**: wind, solar, biomass, hydropower, and geothermal. Compare and contrast the advantages and limitations of different renewable energy sources.

1.3 Global Trends in Renewable Energy: Analyze **current global trends in renewable energy adoption**, focusing on leading countries and regions. Investigate the role of government policies, international agreements, and private investment in promoting renewable energy.

2. Wind Energy

2.1 Principles of Wind Power Generation: Explain the scientific **principles of wind energy**, including how the wind is converted into mechanical and electrical energy. Investigate the relationship between wind speed, turbine size, and energy output.

2.2 Wind Turbine Design and Technology: Identify the **key components of a wind turbine** and explain how they function. Compare the different types of wind turbines (e.g., horizontal-axis, vertical-axis) and their applications.

2.3 Impacts of Wind Energy: Evaluate the **environmental impacts of wind energy**, including effects on wildlife, noise pollution, and land use. Identify the economic benefits of wind energy, such as job creation, cost reductions, and energy independence.

3. Solar Energy

3.1 Photovoltaic (PV) Cells and Solar Thermal Technology: Explain how photovoltaic (PV) cells convert sunlight into electricity. Compare **photovoltaic technology with solar thermal technology**, describing their respective applications and benefits.

3.2 Applications of Solar Energy: Identify the different **applications of solar energy** at residential, commercial, and utility scales. Analyze the role of solar energy in powering off-grid systems and remote locations.

3.3 Challenges and Opportunities in Solar Energy: Investigate the **economic and technological challenges of solar energy adoption**, including storage and grid integration. Evaluate the environmental benefits of solar energy, including its potential to reduce greenhouse gas emissions.

4. Biomass Energy

4.1 Types of Biomasses and their Sources: Identify the **various types of biomasses used for energy production** (e.g., wood, agricultural residues, waste). Investigate the sources of biomass, including forestry, agriculture, and organic waste.

4.2 Conversion Technologies: Explain the **different technologies used to convert biomass into energy**, including combustion, gasification, and fermentation. Analyze the efficiency and environmental impacts of biomass conversion technologies.

4.3 Impact of Biomass Energy: Investigate the **sustainability of biomass energy**, including land use, water consumption, and carbon neutrality. Analyze the environmental impacts of biomass energy production, including deforestation, habitat loss, and greenhouse emissions.

5. Hydropower

5.1 Basics of Hydropower Generation: Explain **how water is used to generate electricity through hydropower**. Investigate the principles of kinetic energy in moving water and how it is converted into electrical power. Analyze the potential of hydropower in different geographical regions, focusing on water availability and infrastructure.

5.2 Types of Hydropower Plants: Identify and describe the **different types of hydropower plants**, including run-of-river, pumped storage, and large-scale dam projects. Compare the benefits and limitations of various hydropower technologies.

5.3 Impact on Ecosystems and Water Resources: Analyze the **ecological impacts of hydropower** on rivers, fish populations, and surrounding ecosystems. Investigate the role of water management in ensuring the sustainability of hydropower.

6. Integration of Renewable Energy

6.1 Grid Integration and Storage Solutions: Investigate the challenges of **integrating renewable energy into existing electricity grids**. Explain the importance of energy storage solutions, such as batteries and pumped hydro, in supporting renewable energy reliability. Explain the importance of inertia on grid stability when integrating inverter-based renewable energy.

6.2 Economic Viability of Renewable Energy Projects: Investigate the **economic factors that influence the development of and deployment of renewable energy projects**, including initial costs, long-term savings, and return on investment. Compare the cost-effectiveness of renewable energy with nonrenewable energy, focusing on life cycle costs and externalities.

6.3 Case Studies of Successful Renewable Energy Implementations: Investigate **case studies of successful renewable energy projects at local, national, and international levels**. Analyze the factors that contributed to the success of these projects, including technological innovations, policy frameworks, and community involvement.

7. Team Project

7.1 Team Project with Data Analysis: As a team, **identify a problem** related to the program of study as a whole. **Research and utilize the Engineering Design Process to design a solution**. Document the following steps in an engineering design notebook for inclusion in the program portfolio. When possible, connect the problem to an existing CTSO event.

a. **Problem Identification**: Brainstorm specific problems and challenges within the program of study. Conduct basic research to understand the scope and implications of the identified problem. Identify one problem as a focus area.
b. **Research and Analysis**: Conduct in-depth research on chosen topics related to the problem. Locate and analyze a dataset related to the problem.
c. **Review the Stages of the Engineering Design Process**: Define the problem, research, brainstorm solutions, develop prototypes, test and evaluate, and iterate. Consider constraints such as cost, efficiency, and environmental impact during the design process.
d. **Project Implementation**: Assign specific roles within the design teams (e.g., project manager, researcher, designer, tester). Design a solution tailored to address the identified problem or scenario. Document progress through design journals, sketches, diagrams, and digital presentations. (Note: Prototype is optional in the Level II course.)
e. **Presentation and Reflection**: Showcase the problem and solution to the class. Share the data that was analyzed and how it affected the solution. Discuss the design process and challenges. As a class, critically evaluate the effectiveness and feasibility of the solutions and propose potential improvements.

Standards Alignment Notes

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Fundamentals of Nuclear Energy

Primary Career Cluster:	Energy and Sustainable Resources
Course Contact:	CTE.Standards@tn.gov
Course Code:	TBD
Prerequisite:	None
Credit(s):	1
Grade Level(s):	11
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Clean Energy courses.
Program Of Study (POS) Concentrator:	This course satisfies one out of two required courses to meet the Perkins V concentrator definition when taken in sequence in an approved program of study.
Program of Study Sequence:	This is the third course in the *Clean Energy* program of study.
Aligned Student Organization(s):	Technology Student Association (TSA): http://www.tntsa.org
Coordinating Work-Based Learning (WBL):	Teachers who hold an active WBL certificate may offer placement for credit when the requirements of the state board's WBL Framework and the Department's WBL Policy Guide are met. For information, visit https://www.tn.gov/education/educators/career-and-technical-education/work-based-learning.html.
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Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standards 2.1-2.3** | Invite an industry speaker to explain nuclear reactor technology.
- **Standards 3.1-3.3** | Tour an industry or take a virtual field trip to a nuclear power plant to learn about electricity generation with nuclear power.
- **Standards 8.1-8.2** | Research careers in nuclear energy, including the various roles and responsibilities. Present the research to middle school students interested in the Clean Energy sector.

Course Description

Fundamentals of Nuclear Energy is the third course in the Clean Energy program of study. This course provides an in-depth study of nuclear energy, focusing on its role as a clean source of energy. Students will learn about physics, reactor technology, safety issues, waste management, and the environmental implications of nuclear power.

Course Standards

1. Basics of Nuclear Energy

1.1 Atomic Structure and Nuclear Reactions: Define the **structure of an atom**, including protons, neutrons, and electrons. Explain the **concept of nuclear reactions** focusing on fission and fusion.

1.2 Fission versus Fusion: Compare **nuclear fission and nuclear fusion** and discuss their potential for energy production.

1.3 History and Development of Nuclear Energy: Trace the **history of nuclear energy**. Investigate the role of nuclear energy in global energy production. Analyze significant milestones in the advancement of nuclear technology.

2. Nuclear Reactor Technology

2.1 Types of Nuclear Reactors: Identify and describe the different types of **nuclear reactors**, including Pressure Water Reactors (PWR), Boiling Water Reactors (BWR), and fast reactors. Compare the safety features, efficiency, and use cases of various nuclear reactor designs.

2.2 Functions of Nuclear Reactors: Describe the key **components of a nuclear reactor** (e.g., core, control rods, cooling system). Investigate the role of moderators and coolants in maintaining reactor stability.

2.3 Nuclear Fuel Cycle: Examine the **stages of the nuclear fuel cycle**, including mining, enrichment, fuel fabrication, and reprocessing. Investigate how fuel recycling and reprocessing can reduce waste and enhance stability.

3. Nuclear Energy Production

3.1 Electricity Generation using Nuclear Power: Explain the **steps of electricity generation using nuclear power** from fission reactions to the production of electrical energy. Investigate how heat generated in the reactor is converted into electrical power.

3.2 Efficiency of Nuclear Power Plants: Compare the **efficiency of nuclear power plants** with other nonrenewable energy sources (e.g., coal, natural gas, etc.). Analyze factors that affect the efficiency of nuclear power plants, including heat loss and energy conversion processes. Investigate how advancements in reactor technology improve energy efficiency.

3.3 Comparison with Other Nonrenewable Sources: Compare the **environmental, economic, and operational aspects of nuclear energy with fossil fuels**. Analyze the role of nuclear energy in reducing carbon emissions compared to fossil fuel-based power generation.

4. Safety and Risk Management

4.1 Safety Protocols: Describe the **safety systems and protocols** in place to prevent accidents **in nuclear power plants**. Investigate the role of regulatory bodies and international safety standards in nuclear energy operations.

4.2 Case Studies of Nuclear Accidents: Analyze **major nuclear accidents** (e.g., Chernobyl, Fukushima, Three Mile Island), **their causes**, and **regulatory corrections**. Investigate the short-term and long-term consequences of these accidents on human health and the environment.

4.3 Effects of Radiation: Define radiation and explain the difference between ionizing and non-ionizing radiation. Investigate the **biological effects of radiation exposure** on human health.

5. Nuclear Security and Safeguards

5.1 Security and Safeguard Protocols: Define Nuclear Materials Control & Accounting (MC&A) and explain its **importance in maintaining nuclear security**. Describe international and national **standards for the control and accounting of nuclear materials** (e.g., International Atomic Energy Agency (IAEA) safeguards, Nuclear Regulatory Commission (NRC) regulations.)

5.2 Case Studies in Nuclear Security: Analyze case **studies of nuclear security incidents** (e.g., the theft of nuclear materials, sabotage, cyberattacks) and discuss the lessons learned from each.

5.3 Personnel Security: Describe the screening, clearance, and background check **processes for personnel working in nuclear facilities**. Identify the importance of ongoing security awareness and training programs for all employees in nuclear sectors.

6. Nuclear Waste Management

6.1 Types of Nuclear Waste: Identify and describe **different types of nuclear waste**, including low-level waste, high-level waste, and spent nuclear fuel. Investigate the sources and characteristics of each type of nuclear waste.

6.2 Storage and Disposal Methods: Analyze the current **methods for storing and disposing of nuclear waste**, including dry cask storage, geological repositories, and on-site storage.

Investigate the challenges and benefits of long-term storage solutions. Research emerging technologies for reducing and managing nuclear waste.

6.3 Long-term Environmental and Ethical Considerations: Investigate the **environmental implications of long-term nuclear waste disposal**. Discuss the ethical considerations involved in the management of nuclear waste, including intergenerational impacts.

7. Nuclear Energy Policy

7.1 National Energy Policies: Investigate the **role of national and international policies** in **regulating nuclear energy production and waste management**. Analyze key international treaties and agreements related to nuclear energy.

7.2 Role of the Nuclear Regulatory Commission (NRC): Explain **the role of the NRC in regulating and overseeing nuclear power plants** in the United States. Investigate how the NRC enforces safety standards and manages nuclear waste. Analyze the challenges the NRC faces in balancing safety, environmental protection, and energy production.

7.3 Public Perception and Societal Impacts: Analyze the **societal impacts of nuclear energy**, including job creation, environmental justice, and energy access. Discuss the role of media, environmental groups, and industry stakeholders in shaping public opinion on nuclear energy.

8. Careers in Nuclear Energy

8.1 Career in Nuclear Energy: Explore **career paths in the nuclear energy field**, including reactor operators, nuclear engineers, radiation safety specialists, and more, including careers that intersect with other career clusters.

8.2 Roles and Responsibilities: Investigate the **roles and responsibilities of professionals working in nuclear power plants**, research laboratories, regulatory agencies, and engineering firms.

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Energy Practicum

Primary Career Cluster:	Energy and Sustainable Resources
Course Contact:	CTE.Standards@tn.gov
Course Code:	TBD
Prerequisite:	None
Credit:	1
Grade Level:	12
Elective Focus-Graduation Requirement:	This course satisfies one of three credits required for an elective focus when taken in conjunction with other Clean Energy courses.
Program Of Study (POS) Concentrator:	This course satisfies one out of two required courses to meet the Perkins V concentrator definition when taken in sequence in an approved program of study.
Program of Study Sequence:	This is the fourth course in the *Clean Energy* program of study.
Aligned Student Organization:	Technology Student Association (TSA): http://www.tntsa.org
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Using Work-Based Learning (WBL) in Your Classroom

Sustained and coordinated activities that relate to the course content are the key to successful work-based learning. Possible activities for this course include the following. This is not an exhaustive list.

- **Standard 4.2** | Research renewable energy. Create a presentation to increase awareness and adoption of renewable energy to community and educational leaders.
- **Standards 5.1-5.3** | Partner with a local business and/or industry to complete the capstone project. Incorporate feedback to strengthen project plans.
- **Standards 6.1-6.3** | Participate in a mock interview to prepare for a position in the energy sector.

Course Description

Energy Practicum is the fourth course in the Clean Energy program of study. The practicum course offers students hands-on experience in clean energy products. Students will apply their knowledge in real-world scenarios, working on projects that involve planning, designing, and implementing clean energy solutions.

Course Requirements

This capstone course aligns with the requirements of the Work-Based Learning Framework (established in Tennessee State Board High School Policy), with the Tennessee Department of Education's Work-Based Learning Policy Guide, and with state and federal Child Labor Law. As such, the following components are course requirements.

Course Standards

1. Project Planning and Design

1.1 Identifying Project Goals and Objectives: Define clear and measurable **goals for an alternative energy project**. Outline project objectives aligned with energy needs, environmental considerations, and community impact. Collaborate with peers, instructors, and industry partners to refine project goals and develop a project timeline.

1.2 Conducting Feasibility Studies and Site Assessments: Conduct a **site assessment to determine the sustainability of the location for renewable energy solutions**. Analyze the technical, environmental, and economic feasibility of the proposed energy system. Investigate potential challenges, risks, and opportunities associated with the energy project.

1.3 Designing Energy Systems and Solutions: Develop a **comprehensive design for an alternative energy system**, incorporating key components such as energy source, generation, storage, and distribution. Create technical drawings and models to represent the system design.

2. Energy System Implementation

2.1 Installation and Setup of Renewable Energy Systems: Perform the **installation of renewable energy systems**, such as solar panels, wind turbines, or biomass converters. Apply electrical and mechanical skills during the installation process.

2.2 Troubleshooting and Maintenance: Diagnose common issues that arise during system installation and operation, **applying troubleshooting techniques**. Develop a maintenance schedule and plan for long-term system upkeep.

2.3 Compliance with Regulations and Safety Standards: Investigate relevant federal, state, and local regulations that impact the installation and operation of alternative energy systems. Ensure **compliance with safety standards**, including electrical safety, mechanical safety, and environmental protection.

3. Data Collection and Analysis

3.1 Monitoring and Measuring Energy Output and Efficiency: Use appropriate tools and technology to **monitor energy system output, efficiency, and performance**. Measure key performance indicators such as energy production, system losses, and conversion efficiency. Track energy consumption and savings achieved through system implementation.

3.2 Analyzing Data for System Optimization: Analyze collected data to identify trends, inefficiencies, and areas for improvement in the system. Propose **modifications and optimizations to improve system performance** and reduce waste. Compare project results with initial projections and design specifications.

3.3 Reporting and Documentation: Compile **comprehensive reports on energy system performance**, including data visualizations, analysis, and recommendations. Develop technical documentation to support system operation, maintenance, and troubleshooting.

4. Sustainability and Community Impact

4.1 Assessing the Environmental and Social Impact of Projects: Evaluate the **environmental impact of the energy system**, including carbon footprint, resource use, and ecosystem effects. Investigate the social implications of energy projects, focusing on community benefits, challenges, and involvement.

4.2 Community Engagement and Education: Collaborate with community leaders, educators, and stakeholders to **promote renewable energy awareness** and adoption.

4.3 Long-term Sustainability Planning: Develop strategies for **ensuring the long-term sustainability of energy projects**, including financial viability, maintenance, and technological updates.

5. Capstone Project

5.1 Comprehensive Clean Energy Project: Plan, design, and implement a **capstone project that demonstrates mastery of clean energy concepts and skills**. Collaborate with peers, mentors, and industry professionals to refine and execute the project.

5.2 Presentation of Project Findings and Outcomes: Prepare a **formal presentation of the capstone project**, detailing goals, processes, challenges, and results. Present findings to a panel of instructors, industry experts, or community members, incorporating feedback. Develop multimedia materials, such as posters, videos, or interactive displays, to enhance the presentation.

5.3 Reflections: Identify **key lessons learned and areas for growth in both technical and soft skills**. Document reflections in a written report or journal, focusing on the impact of the project on future career aspirations.

6. Career Readiness

6.1 Resume Building and Interview Preparation: Develop a **professional resume highlighting alternative energy skills, projects, and certifications**. Participate in mock interviews with instructors and industry partners to refine communication and presentation skills.

6.2 Networking: Explore **opportunities for apprenticeships, internships, and work-based learning in the energy sector**.

6.3 Education and Career Opportunities in the Energy Sector: Investigate **postsecondary education options**, including degree programs and certifications, in energy and related fields.

6.4 Portfolio Development: Create a **personal portfolio** that illustrates mastery of skills and knowledge in the program of study.

Standards Alignment Notes

*References to other standards include:

- P21: Partnership for 21st Century Skills Framework for 21st Century Learning
    - Note: While not all standards are specifically aligned, teachers will find the framework helpful for setting expectations for student behavior in their classroom and practicing specific career readiness skills.