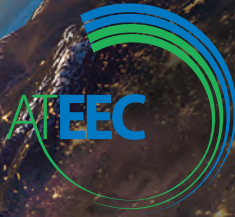


Defining Energy Technologies and Services



Advanced Technology
**Environmental and
Energy Center**



DEFINING ENERGY TECHNOLOGIES AND SERVICES

A REPORT OF THE DEFINING ENERGY TECHNOLOGY FORUM
APRIL 20 AND 21, 2016

Acknowledgments

The Advanced Technology Environmental and Energy Center (ATEEC) would like to acknowledge and thank the energy technology professionals who generously shared their time and expertise in defining the energy technology career field. Their professional insights are critical to developing energy education and training programs that clarify occupations and meet workforce needs. The contributors are listed at the end of this report.

Forum Coordination and Report Production

Linda Baxley

Coordinator
Director, ATEEC

Gloria Hanne

Report Editor
Project Coordinator, ATEEC

Michael Beck

Co-facilitator/Report Designer
Technical Writer, ATEEC

Ellen Kabat Lensch

Principal Investigator
Executive Director, ATEEC

Melonee Docherty

Co-facilitator/Report Editor
Instructional Designer, ATEEC

© 2016 ATEEC



TABLE OF CONTENTS

Table of Contents

Introduction.....	2
The Issues.....	2
The Forum.....	4
The Results.....	7
Defining the Energy Technologies and Services Field—Occupational Chart.....	8
Occupational Categories, Titles, and Functions.....	10
Buying and Selling Energy Products and Services.....	12
Energy Assessment.....	14
Energy Systems Design and Construction—Utility and Distribution.....	16
Exploration and Resource Acquisition.....	18
Utility-Scale Generation.....	19
Facilities Operations and Maintenance.....	20
Utility-Scale Generation Operations and Maintenance.....	24
Compliance.....	26
Transmission and Distribution.....	28
Alternative Fuel Vehicles (AFVs) and Infrastructure.....	30
Cross-Cutting Knowledge and Skills.....	32
Emerging Areas and Future Trends.....	33
Community College Responsibilities.....	34
Industry Collaboration.....	35
Contributors.....	36

THIS PROJECT WAS SUPPORTED, IN PART, BY
THE ADVANCED TECHNOLOGICAL EDUCATION
PROGRAM AT THE NATIONAL SCIENCE
FOUNDATION UNDER GRANT NO. DUE-1204958.
THE OPINIONS EXPRESSED IN THIS REPORT ARE
THOSE OF THE FORUM PARTICIPANTS AND DO
NOT NECESSARILY REPRESENT NSF POLICY.

Additional copies of this
report can be
downloaded at ATEEC's
website:
www.ateec.org.



INTRODUCTION

THE ISSUES

The energy field is in a state of diversification and transition. As advances in renewable energy are developed and established, the United States will continue to depend on both traditional and renewable energy sources to meet the nation's high energy demand. Emerging industries provide new jobs while a retiring workforce opens existing ones.

Solar and wind technician jobs are expected to grow by 24 and 108 percent, respectively, from 2014–2024.^{1,2} Between 2010 and 2020, 62 percent of electric and gas utility workers are expected to retire.³ The energy field needs a skilled workforce, and this workforce needs training now to avoid a gap in the talent pipeline. In 2016, the Advanced Technology Environmental and Energy Center (ATEEC) conducted a national forum for defining energy technology. The goal of the forum was to validate and update occupational information from ATEEC's 2008 *Energy Technologies and Services* report.

The objectives were to validate, revise, and/or update the:

- Title and definition of the field of energy technology,
- Definition of technician,
- Energy technology occupational categories,
- Technician-level occupational titles, and
- Job functions typically performed in each occupational category.

ATEEC invited experienced practitioners and educators in energy technology with a broad perspective of the various occupational areas included in this field to take part in forum. The participants included business, industry, and government agency representatives, as well as several National Science Foundation (NSF) Centers of Excellence in the Advanced Technological Education program. ATEEC attempted to gather a regional representation of the country that included a variety of energy technology areas and industries that would employ energy technicians.

The audience for this report includes:

- Counselors, faculty, and administrators of academic institutions at all levels but particularly in high schools and two-year colleges;
- Technicians and employers of technicians (e.g., companies, government agencies);
- Leaders of professional societies; and
- Federal, state, and local government officials responsible for the quality and quantity of the nation's technical workforce.

INTRODUCTION (cont)

A primary purpose of this report is to enhance counselor, teacher, and student awareness of energy technology careers at the technician level. Ultimately, the report should contribute to addressing the workforce development needs of business, industry, and government by providing educators with information needed to develop relevant curricula that prepares students for energy technology careers.

The report is also being used to provide direction for ATEEC, a Center of Excellence partially funded through a grant from the NSF. The Center brings together institutions from across the nation to promote and assist energy technology programs. ATEEC's core partners are the Partnership for Environmental Technology Education, the University of Northern Iowa, the National Renewable Energy Laboratory, and the NSF.

THE FORUM

The 2016 Defining Energy Forum participants reviewed the 2008 *Energy Technologies and Services* report prior to the workshop and considered these questions:

- Does the “energy technologies and services” title and definition accurately describe the field? If not, how would you revise it?
- What definition of “technician” accurately describes the position?
- How would you categorize occupations in the energy technology field?
- What specific technician-level occupations are typically found in each occupational category?
- What technician-level job functions are typically performed in each occupation?
- What are the emerging employment trends in the energy field?
- What is the role of community colleges in technician education and training?

The forum began on April 20th at the O’Hare Sheraton hotel in Chicago. Participants were welcomed and presented with information on ATEEC’s mission and goals. The group then reviewed the agenda, objectives, and work processes for the forum.

The first action item was the participants' review of the 2008 report's definition of "energy technologies and services." The participants focused on making the definition concise and simple to make it more accessible and understandable for the intended target audiences.



Next, the participants worked to validate or revise each of the energy technologies and services occupational categories listed in the 2008 report. Consensus was reached on the following occupational categories.

- Buying and Selling Energy Products and Services
- Energy Assessment
- Energy Systems Design and Construction—Utility and Distribution
- Exploration and Resource Acquisition
- Utility-Scale Construction
- Facilities Operations and Maintenance
- Utility-Scale Generation Operations and Maintenance
- Compliance
- Transmission and Distribution
- Alternative Fuel Vehicles (AFVs) and Infrastructure

INTRODUCTION (cont)

The group reported that jobs marked as "emerging" in 2008 have now become mainstream, including several renewable energy jobs. The group identified renewable energy jobs for purposes of potential specialized training, even though these basic job requirements are identical to traditional energy jobs. It was noted that energy technologies and services is a STEM field, encompassing science, technology, engineering, and math knowledge and skills.

The participants then broke into small groups, working in the areas where they felt their specific expertise would be of most value. Again, ATEEC's 2008 report was used as a basis for validation. The majority of the small-group work was spent in creating, validating, updating, and refining technician-level job titles and job functions. The small groups paid particular attention to reorganizing and realigning jobs in a more logical format. The groups also honed the job titles for improved accuracy and clarity.

The small groups then shared and discussed their specific results with the whole group, reaching a forum consensus on the areas covered in this report. Using these findings, the participants then verified the definitions of "energy technologies and services" and "technician" in a final large-group discussion. Additionally, the participants identified "cross-cutting" areas—functional areas that cut across most energy technology occupational categories.

For example, while companies may have one or more designated safety professionals, the group identified "safety and health" as something in which every worker needs to have knowledge and be engaged. The remainder of the workshop was spent identifying emerging areas and trends in the energy technologies and services field.

Following the forum in Chicago, participants spent further time refining the materials they had developed. Additional experts in the field from business, education, and government organizations were invited to review and comment on the initial documentation from the forum, resulting in a validation and consensus of expert opinions. ATEEC will continue to solicit and update additional occupational data through online input.

THE RESULTS

The next section of this document contains the occupational chart, "Defining Energy Technologies & Services," providing a valuable snapshot of the field. Included in the chart are the energy technologies and services definition and the technician definition, as well as representative technician-level job titles for each of the occupational categories. Emerging occupations, where jobs currently exist but may not yet be fully defined, are indicated with an asterisk on the occupational chart that was created to provide a summary of the forum results. The asterisk denotes these types of jobs throughout the report. Many of the functions for these jobs will become clearer and more defined as the energy technologies and services field matures.

Following the chart are more detailed listings of job titles and many of the specific job functions developed during the forum. The last section of the report presents the cross-cutting areas and emerging trends identified during the forum, a listing of community college responsibilities, and collaborative industry recommendations.

REFERENCES

1. U.S. Bureau of Labor Statistics. "Wind Turbine Technicians." Retrieved 5/25/2016. <http://www.bls.gov/ooh/installation-maintenance-and-repair/wind-turbine-technicians.htm>.
2. U.S. Bureau of Labor Statistics. "Solar Photovoltaic Installers." Retrieved 5/25/2016. <http://www.bls.gov/ooh/construction-and-extraction/solar-photovoltaic-installers.htm>.
3. Brandt, Jaclyn. "Who is educating the energy workforce of the future?" *Smart Grid News*. April 23, 2015. Retrieved 5/26/2016. <http://www.smartgridnews.com/story/who-educating-energy-workforce-future/2015-04-23>.

Defining Energy

Occupational Categories

Occupational Titles

Buying & Selling Energy Products & Services

- Customer service representative
- Emissions trading analyst
- Energy broker/trader
- Financing specialist
- Purchasing agent
- Sales representative/account executive

Energy Assessment

- Energy analyst
- Energy auditor
- Energy portfolio planner
- Industrial process specialist
- Measurement and verification technician

Energy Systems Design & Construction—Utility & Distribution

- Architecture technician
- Commissioning agent
- Commissioning technician
- Construction tradesperson
- Energy systems designer/retrofitter
- Energy systems installer
- Project developer
- Warehouse clerk/manager

Exploration & Resource Acquisition

- Biomass-to-energy/waste-to-energy technician
- Coal miner
- Energy site assessment technician*
- Energy site surveyor
- Geospatial technician
- Geothermal site evaluator
- Hydropower site evaluator

- Ocean energy site evaluator
- Oil and gas field technician
- Real estate and right-of-way agent
- Solar site evaluator
- Unmanned aerial vehicle (drone) operator
- Wind site evaluator

Utility-Scale Generation**

- Boiler technician
- Coal gasification technician
- Electrical maintenance technician
- Instrument/control technician and process operator
- Mechanical maintenance technician
- Nuclear fuel enrichment/reprocessing technician
- Nuclear radiation protection technician
- Ocean power technician*
- Power plant operator/technician
- Solar photovoltaic technician
- Turbine generator maintenance technician
- Wind turbine technician

Facilities Operations & Maintenance

- Building control operator
- Building control systems technician
- Building operator/technician
- Building systems automation technician*
- Direct digital control (DDC) programmer
- Energy cost analyst
- Energy manager/specialist/consultant
- Industrial process equipment maintenance and operations specialist
- Lighting specialist
- Maintenance technician

- Performance monitoring/continuous commissioning technician
- Program/project coordinator
- Renewable energy maintenance technician
- Resource conservation/efficiency manager
- Sustainability coordinator*
- Waste management/recycling technician



What are Energy Technologies & Services?

Energy Technologies and Services is a career field that uses technology to optimize the safe and reliable production, delivery, and use of energy.

Note: This is a STEM field, i.e., encompasses science, technology, engineering, and math knowledge and skills.

What is a Technician?

A technician applies knowledge, skills, capabilities, and tools to perform scientific, technical, communication, and regulatory tasks.

Technologies & Services

Utility-Scale Generation Operations & Maintenance**

- Boiler technician
- Coal gasification technician
- Electrical maintenance technician
- Energy storage technician*
- Fuel storage technician
- Instrument/control technician
- Mechanical maintenance technician
- Nuclear radiation protection technician
- Ocean power technician*
- Power plant operator/technician
- Solar photovoltaic technician

- Turbine generator technician
- Wind turbine technician

Compliance

- Compliance specialist
- Critical infrastructure protection (CIP) specialist
- Cybersecurity specialist
- Environmental, health, and safety (EHS) specialist
- Inspector
- Laboratory/field technician
- Paralegal

- Permit coordinator/reviewer
- Training coordinator

Transmission & Distribution

- Distribution systems controller
- Distribution technician
- Gas technician
- Line mechanic (lineman)
- Meter and control technician
- Pipeline technician
- Smart grid technician*
- Substation (relay) technician
- Systems analysis technician

Alternative Fuel Vehicles (AFVs) & Infrastructure*

- AFV infrastructure technician
- AFV mechanic
- Battery repair and maintenance technician*
- Biofuels processing technician*
- Fleet manager
- Life cycle/recycling specialist

*Indicates an emerging occupational field, existing but not yet fully defined.

**These categories contain many of the same job titles, but are distinct enough areas within the energy field to warrant separating into two categories.





OCCUPATIONAL CATEGORIES, TITLES, AND FUNCTIONS

Important Notes

1. To avoid unnecessary duplication, the following section assumes that all occupations must adhere to all health and safety procedures (including selection and use of proper personal protective equipment) and follow applicable standard operating procedures.
2. The following job titles and functions are dependent on system size and scale of operation. Many jobs may be combined and there is often a great deal of crossover of skill sets.



BUYING AND SELLING ENERGY PRODUCTS AND SERVICES

Occupational Titles

- Customer Service Representative
- Emissions Trading Analyst
- Energy Broker/Trader
- Financing Specialist
- Purchasing Agent
- Sales Representative/Account Executive

Customer Service Representative

- Acquire product knowledge of basic systems, equipment, and services.
- Use the telephone and personal contact to interact with customer and others.
- Use customer care software systems.
- Demonstrate good oral and written communication skills.
- Deal constructively with a variety of customer situations and emotions.
- Describe energy company/energy supplier rates.
- Market products and services.
- Prepare and conduct presentations.
- Coordinate overall service with customer.
- Maintain quality of service.
- Coordinate with other technical staff.

Emissions Trading Analyst

- Assess the carbon potential and feasibility of specific sectors.
- Formulate sector strategies and frameworks.
- Identify CO₂ emission sources and new technologies to abate emissions.
- Monitor new methodologies.
- Quantify the carbon potential of specific sectors and technologies by undertaking studies aimed at quantifying the size and location of potential sectors, assessing technology feasibility, and screening projects' development potential.

Energy Broker/Trader

- Monitor and predict the rise and fall of energy commodities.
- Price the commodity based on market conditions.
- Sell the commodity.
- Educate the customer.
- Explain contracts and documents.
- Manage the flow of the commodity.
- Provide ongoing customer service.
- Provide reports on the status of markets and clients.
- Interact with multiple levels within the power selling chain.
- Solicit new clients.

Financing Specialist

- Identify and apply applicable government incentive financing for energy projects.

BUYING AND SELLING ENERGY PRODUCTS AND SERVICES

Purchasing Agent (Utility and Private)

- Describe the basics of the energy industry and trading.
- Describe the basic regulatory structure of the Public Service Commission/Public Utility Commissions.
- Monitor market conditions.
- Analyze rate structures.
- Create and/or evaluate Request for Proposals (RFPs).
- Evaluate proposals.
- Negotiate pricing and contracts.
- Interpret technical literature.
- Apply basic economic principles such as life-cycle costing and discount rates.

Sales Representative/Account Executive (Utility/Private)

- Acquire product knowledge of basic systems, equipment, and services.
- Keep pace with the changing energy markets and portfolios.
- Cultivate new customers.
- Assess customer needs and determine the benefits of product/service to meet their needs.

- Customize energy management product and service packages.
- Assist with customer service.
- Demonstrate good oral and written communication skills.
- Prepare sales proposals and contracts.
- Apply basic knowledge of building systems for residential, commercial, and industrial facilities.
- Market products and services.
- Maintain quality of service.
- Analyze energy costs.
- Provide estimate of preliminary costs.
- Close the sale.
- Coordinate with other technical staff.
- Work with architects, engineers, contractors, utility personnel, and others to ensure correct specification and application of goods and services.
- Identify and apply basics of financial analysis/life cycle costing.



ENERGY ASSESSMENT

Occupational Titles

- Energy Analyst
- Energy Auditor
- Energy Portfolio Planner
- Industrial Process Specialist
- Measurement and Verification Technician

Energy Analyst

- Perform duties of an energy auditor.
- Investigate/analyze opportunities for energy savings and pollution reduction (including power factor and peak demand charge).
- Identify and explain the costs and environmental impact of using different types of energy.
- Educate clients on energy consumption and energy conservation.
- Compare energy company tariffs and energy market prices and make recommendations.
- Apply existing facility operation and energy consumption data in evaluating alternative rate schedules.
- Investigate energy usage scenarios to determine the optimal rate from energy supplier or to determine if the customer qualifies for an alternative rate.
- Investigate/analyze alternative energy applications.
- Analyze and generate energy audit reports and provide recommendations.
- Present energy analysis findings to client.
- Close a sale.

Energy Auditor

- Assess customer wants and needs.
- Establish/follow interview protocols for assessing customer needs.
- Analyze energy bills (including utility rates and tariffs) for historical energy usage data.

- Inspect and evaluate building envelopes, mechanical systems, electrical systems, and process systems to determine the energy consumption of each system.
- Determine pattern of building use to show annual needs for heating, cooling, and lighting.
- Select and operate various energy analysis measuring and monitoring devices.
- Collect, analyze, and validate energy usage field data.
- Prepare total energy profile for a facility.
- Identify and analyze opportunities for improving the operation, maintenance, and energy efficiency of each system.
- Write energy audit reports that provide energy analysis results and recommendations for energy cost savings.
- Interpret operations and maintenance manuals and other technical documents.
- Demonstrate an understanding of building and process systems and the interrelationships of those systems.
- Apply basic engineering principles regarding energy production and use, building construction, maintenance, operation, systems, and process systems.
- Describe the environmental impact(s) from recommended energy system changes.

Energy Portfolio Planner

- Describe the environmental impact(s) from recommended energy system changes.
- Make recommendations to management as to which fuel and technology is appropriate to accomplish specific tasks.
- Identify ways to lower demand in commercial applications.
- Identify and explain the way different renewable energy technologies can impact the demand load of a commercial building.
- Identify and explain ways to aggregate load.

Industrial Process Specialist

- Identify unit operations.
- Measure and evaluate system parameters.
- Perform energy balance.
- Perform materials balance.
- Establish a thermodynamic base to understand energy needs.
- Establish mathematical model of process.
- Prescribe process modifications.
- Investigate energy efficiency and pollution reduction improvements.
- Perform economic analysis:
 - Determine and estimate operating, maintenance, and capital costs.
 - Conduct life-cycle costing.
 - Determine present worth and value.
 - Calculate cost-benefit ratio, payback period, and return on investment.
- Write report of findings and recommendations.
- Identify industrial processes.
- Describe the environmental impact(s) of using different types of energy.
- Identify, interpret, and apply conversion factors, graphs, and spreadsheets.
- Apply basic engineering principles regarding energy use, maintenance, and operation of process systems.

Measurement and Verification Technician

- Assess energy systems for buildings and process controls.
- Assess energy use of building systems and processes.
- Take measurements (e.g., flow/temperature/pressure).
- Verify data quality.
- Analyze measurement data.
- Select and operate testing equipment.
- Safely install, remove, and troubleshoot electrical and mechanical instrumentation.
- Read plans and drawings.
- Write technical reports.
- Assess energy system performance.
- Operate measurement devices (e.g., data loggers, discrete systems).
- Operate basic system controls.
- Identify and apply applicable codes and guidelines, including:
 - International Performance Measurement and Verification Protocol (IPMVP)
 - American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)
 - Environmental Protection Agency (EPA)
- Perform data gathering and management.



ENERGY SYSTEMS DESIGN AND CONSTRUCTION— UTILITY AND DISTRIBUTION

Occupational Titles

- Architecture Technician
- Commissioning Agent
- Commissioning Technician
- Construction Tradesperson
- Energy Systems Designer/Retrofitter
- Energy Systems Installer
- Project Developer
- Warehouse Clerk/Manager

Architecture Technician

Commissioning Agent

- Monitor and measure system operation variables (e.g., fluid flows volume and speeds, temperatures, set-point limits).
- Participate in system startup commissioning and system operation tests.
- Tune (adjust and balance) system variables to obtain most efficient operations.

Commissioning Technician

- Verify systems operation and interoperations.
- Perform measurement and verification tasks.
- Support engineering, construction, and sales staff in designing energy management system (e.g., scope of work, estimating project costs).
- Develop project measurement and verification plan.
- Supervise installation of building and process systems.
- Help create sequence of operation for building and process systems.
- Execute sequence of mechanical system operation.
- Program the building's energy management system, including control strategies.
- Test and troubleshoot building and process systems.
- Verify field data.

- Train onsite staff in usage of system.
- Install and troubleshoot data acquisition equipment (i.e., data loggers).
- Collect data for evaluation and verification.
- Troubleshoot programming and electronic equipment.
- Read psychrometric charts.
- Read and interpret blueprints and operations and maintenance manuals.
- Apply troubleshooting skills in HVAC, electrical, and electronic systems.
- Identify and apply energy efficiency measures in HVAC system and all other building equipment.
- Identify energy controls (e.g., direct digital controls).
- Apply basic knowledge of instrumentation (e.g., read meters, gauges, etc.).
- Possess basic programming skills.
- Identify general construction practices.
- Obtain appropriate licenses (e.g., low voltage electrical).

Construction Tradesperson

- Identify and apply the latest energy efficient building techniques.
- Communicate with and lead others.
- Read blueprints.

Energy Systems Designer/Retrofitter (Utility, Commercial, Residential)

- Produce energy system design based on specifications from energy audit.
- Develop a Bill of Materials for energy system.
- Research and apply the rapid changes in the energy market and related codes.
- Demonstrate good oral and communication skills.
- Work cross-functionally with other energy professionals to ensure clients' needs are attained.
- Track all projects through the permitting process and communicate the status of a project to coworkers.

ENERGY SYSTEMS DESIGN AND CONSTRUCTION— UTILITY AND DISTRIBUTION

Energy Systems Installer

- Assemble components of the system as designed.
- Complete startup commissioning and perform system operation confirmation tests.
- Connect to utility systems and controls systems.
- Construct and place system components and support structures in designated locations and configurations per fire prevention and occupational health/safety codes.
- Operate tractor or skid loader.
- Perform potential tasks of:
 - Carpentry.
 - Climbing.
 - Concrete.
 - Electrical.
 - Roofing.
- Plan general job layout.
- Receive and/or verify equipment for the system is ready for assembly or construction.
- Remove brush/obstacles.
- Work with hand and power tools.

Project Developer

- Schedule project and tasks.
- Perform basic engineering tasks.
- Perform CAD/CAM and drafting tasks.
- Apply GIS to project parameters.

Warehouse Clerk/Manager



EXPLORATION AND RESOURCE ACQUISITION

Occupational Titles

- Biomass-To-Energy/Waste-To-Energy Technician
- Coal Miner
- Energy Site Assessment Technician*
- Energy Site Surveyor
- Geospatial Technician
- Geothermal Site Evaluator
- Hydropower Site Evaluator
- Ocean Energy Site Evaluator
- Oil And Gas Field Technician
- Real Estate And Right-Of-Way Agent
- Solar Site Evaluator
- Unmanned Aerial Vehicle (Drone) Operator
- Wind Site Evaluator

Biomass-To-Energy/Waste-To-Energy Technician

Coal Miner

Energy Site Assessment Technician*

Energy Site Surveyor

Geospatial Technician

- Collect, manage, and integrate spatial and attribute data using geographic information systems (GIS), remote sensing, and global positioning systems (GPS).

Geothermal Site Evaluator

- Measure the exposed foundation, walls, windows, and doors in building and determine their R-Value and the R-Value of the walls and ceiling.
- Operate software to determine building heating and cooling loads.
- Calculate the cost of operation using appropriate spreadsheets.

Hydropower Site Evaluator

- Determine monthly and annual flow of body of water.

- Determine the fall or head of a body of water.
- Determine hourly and annual electrical production, using flow and fall data.

Ocean Energy Site Evaluator

- Find and assess thermal gradients in ocean.
- Analyze data and provide estimated potential production from gradient.

Site Resource Surveyor

Oil and Gas Field Technician

- Extract oil.
- Extract gas.
- Extract oil shale and tar sand.

Oil Refinery/Process Technician

Real Estate and Right-Of-Way Agent

Solar Site Evaluator

- Operate appropriate equipment (e.g., Solar Pathfinder, tape measure compass, incline-o-meter, computer and computer software).
- Determine the potential solar resource on a monthly and yearly basis.
- Identify shading issues and roof orientation.
- Prepare estimate of potential production solar array.

Unmanned Aerial Vehicle (Drone) Operator

Wind Site Evaluator

- Observe landscape within two to five miles of site and identify obstructions and enhancements to wind turbine operation.
- Read a geological map and/or software, altimeter, and compass to determine elevation and direction of buildings and trees in vicinity of wind turbine.
- Determine wind resource on a monthly and annual basis.

Boiler Technician

UTILITY-SCALE GENERATION

Coal Gasification Technician

Electrical Maintenance Technician

Instrument/Control Technician And Process Operator

- Monitor and regulate energy production processes.
- Anticipate and adjust system to meet load and distribution demands.
- Develop and implement preventive maintenance practices and programs.
- Collect and analyze data to maintain proper conditions.
- Optimize operational efficiencies.
- Operate plant equipment and controls, including monitoring and testing equipment.
- Calibrate and operate instruments.
- Identify and practice standard environmental, health, safety, and spill practices and procedures.
- Develop a critical path outage plan.
- Analyze and respond to alarm conditions.

Mechanical Maintenance Technician

Nuclear Fuel Enrichment/Reprocessing Technician

Nuclear Radiation Protection Technician

Ocean Power Technician*

- Measure ocean power source quality and quantity to ensure it meets required characteristics for conversion equipment operations.
- Monitor equipment operating efficiency, output, and safe operation.
- Rebuild and/or repair components, if acceptable practice.
- Remove and replace components as determined by preventive maintenance plan.
- Test operation of reconditioned components before reusing.

Power Plant Operator/Technician, Including: Cogeneration, Geothermal, Hydropower, Solar Thermal, Waste-to-Energy

Solar Photovoltaic Technician

Occupational Titles

- Boiler Technician
- Coal Gasification Technician
- Electrical Maintenance Technician
- Instrument/Control Technician and Process Operator
- Mechanical Maintenance Technician
- Nuclear Fuel Enrichment/Reprocessing Technician
- Nuclear Radiation Protection Technician
- Ocean Power Technician*
- Power Plant Operator/Technician
- Solar Photovoltaic Technician
- Turbine Generator Maintenance Technician
- Wind Turbine Technician

Turbine Generator Maintenance Technician

Wind Turbine Technician

- Functionally test electrical circuits working with 24 to 600 V DC/AC.
- Troubleshoot and repair integrated systems.
- Troubleshoot complicated mechanical and hydraulic problems on turbines.
- Perform all mechanical, hydraulic, and electrical component maintenance, repair, or replacement of parts to correct malfunctions.
- Perform start-up procedures and equipment functional tests.
- Perform maintenance on turbine equipment per the commissioning manual.
- Collect turbine data for research and/or analysis.
- Report turbine conditions and complete reports and paperwork as required.
- Provide technical assistance to other technicians.
- Adhere to OSHA-compliant health and safety programs.
- Coordinate with engineering on technical issues and documentation.
- Prepare wind turbine generators for commercial operation.

*Indicates an emerging occupation, existing but not yet fully defined.

FACILITIES OPERATIONS AND MAINTENANCE

Occupational Titles

- Building Control Operator
- Building Control Systems Technician
- Building Operator/Technician
- Building Systems Automation Technician*
- Direct Digital Control (DDC) Programmer
- Energy Cost Analyst
- Energy Manager/Specialist/Consultant
- Industrial Process Equipment Maintenance and Operations Specialist
- Lighting Specialist
- Maintenance Technician
- Performance Monitoring/Continuous Commissioning Technician
- Program/Project Coordinator
- Renewable Energy Maintenance Technician
- Resource Conservation/Efficiency Manager
- Sustainability Coordinator*
- Waste Management/Recycling Technician

Building Control Operator

- Program automated control system.
- Troubleshoot building systems and controls.
- Install, replace, and repair basic building systems and controls.
- Respond to and coordinate with maintenance operation and service personnel.
- Optimize energy efficiency and alleviate environmental impacts.
- Participate in commissioning of buildings.
- Respond to building occupants' requests.

Building Control Systems Technician

- Prepare, administer, and perform emergency actions.
- Monitor environmental, health, and safety conditions.
- Interpret blueprints and other technical documents.
- Demonstrate an understanding of building and process systems and the interrelationships of those systems with each other and the environment.
- Assist with controls theory and application.
- Work with potentially hazardous materials (e.g., liquid nitrogen).

Building Operator/Technician

- Inspect facilities and equipment for proper operation and maintenance.
- Collect data for measurement, verification, and diagnostics.
- Troubleshoot equipment and systems for problems.
- Establish and maintain contact with energy companies and energy suppliers.
- Schedule and inspect new installations and maintenance work done in buildings.
- Supervise and schedule service personnel.
- Inventory equipment.
- Evaluate current control systems for HVAC and lighting and, when necessary, plan and/or install new control systems.
- Operate and monitor energy management systems (e.g., HVAC, lighting, controls system).
- Plan and administer overall budget (e.g., set baseline for energy use and compare actual use against budget).
- Negotiate rates and tariffs with energy companies.
- Prepare building reports for management.
- Install and calibrate controls and instruments.
- Read/interpret technical materials, including blueprints, and operations and maintenance manuals.
- Analyze graphs and trends.
- Identify and apply system commissioning concepts and procedures.
- Maintain accurate records and logs.
- Perform basic Computer-Aided Design (CAD) tasks.

FACILITIES OPERATIONS AND MAINTENANCE

- Identify and explain usage of other equipment (e.g., office equipment, kitchen equipment) in the building.
- Identify and apply instrumentation theory and application.
- Perform troubleshooting and diagnostic tests.
- Identify and explain the basics of Facilities Management Control System (FMCS) programming and software.
- Identify and explain energy efficiency and renewable energy concepts.
- Identify and explain ecological footprint analysis and other environmental impact tools.
- Relate landscaping practices to energy and the environment.
- Identify and apply basic environmental, health, and safety regulations (e.g., air emissions, effluents).
- Identify and explain basic wiring techniques for line voltage and low voltage systems.
- Explain basic water quality and chemistry concepts.
- Identify and apply trade union rules.
- Explain basic specification of parts procurement.
- Explain basic controls theory and application.

Building Systems Automation Technician*

- Collect field data on automation system for comparison to Supervisory Control and Data Acquisition (SCADA) database and program.
- Install/maintain automation system components.
- Test components for safety and operation.
- Tune (adjust and balance) operations to design specifications.

Direct Digital Control (DDC) Programmer

- Assemble DDC operations program in format needed for equipment.
- Maintain programming and testing equipment.
- Upload and verify program operations in controller(s).

Energy Cost Analyst

- Analyze energy and water bills and compare bills to actual consumption.
- Write technical reports.
- Verify consumption.

- Verify rate schedules.
- Develop energy budgets.
- Negotiate with provider/utility on billing discrepancies.

Energy Manager/Specialist/Consultant

- Perform the duties of an energy auditor.
- Perform complex energy analysis of HVAC, lighting, and building systems.
- Perform complex energy and productivity analysis of industrial processes and systems.
- Calculate loads for the systems: heating/cooling (i.e., thermodynamics), electrical, lighting, equipment, and resistance.
- Calculate the point when one energy source is more cost effective to use than another.
- Provide customer service in the areas of rate and bill analysis, problem resolution, and education.
- Audit energy bills for overcharges and negotiate refunds with utility.
- Formulate recommendations for energy efficiency and productivity improvements based upon energy analysis findings.
- Explain findings and recommendations to promote adoption by the client.
- Prepare technical reports including energy audits, assessments, and recommendations for energy cost savings.
- Research and apply codes, standards, and guidelines.
- Prepare or review cost estimates.
- Perform economic analysis:
 - Determine and estimate operating costs, maintenance costs, and capital costs.
 - Conduct life-cycle costing.
 - Determine present worth and value.
 - Calculate cost-benefit ratio, payback period, and return on investment.
- Research, evaluate, and apply new energy technologies, including renewable energies.
- Work with customers, project managers, engineers, contractors, and others to implement energy efficiency projects.
- Set up and maintain a system for monitoring energy performance (i.e., energy management system).

*Indicates an emerging occupation, existing but not yet fully defined.

FACILITIES OPERATIONS AND MAINTENANCE

Industrial Process Equipment Maintenance and Operations Specialist

- Coordinate and schedule labor and maintenance for production.
- Plan production for optimum energy rate (i.e., “time of use”).
- Inspect machines, equipment, and procedures for efficiency of labor, material, and energy.
- Perform preventative maintenance on machines/equipment.
- Compare actual energy use to planned (budgeted) use.
- Chart use patterns of labor, material, and energy.
- Assess energy as resource in unit of production.
- Study operation to set standards of labor, material, and energy.
- Investigate and recommend alternative methods to reduce costs and environmental impact.
- Recommend waste management practices.
- Assist in economic analysis.
- Prepare verbal and written reports on production activities and energy plans.
- Install, test, and debug new equipment, as needed.
- Identify and explain reduce, recycle, and reuse practices related to the types of material and processes commonly encountered in various facilities such as schools, hospitals, and other institutional settings.
- Identify and explain the ecological footprint and other environmental impact tools.

Lighting Specialist

Maintenance Technician

- Implement preventative maintenance program.
- Troubleshoot problems.
- Lockout and tagout system, as needed.
- Repair equipment/systems.
- Test operation of equipment.
- Respond to Energy Management System alarms.
- Possess diagnostic skills.
- Possess trades skills (e.g., mechanical, electrical).
- Identify and explain the basics of:
 - Metering and instrumentation.
 - Control systems.

- Distributing systems.
- Air quality standards and guidelines.
- Operating codes and standards.
- Energy use, efficiency, and optimization.

Performance Monitoring/Continuous Commissioning Technician

Program/Project Coordinator

- Coordinate implementation process.
- Prepare project schedule.
- Schedule programs/projects.
- Monitor progress toward completion.
- Develop and monitor budget.
- Communicate with contractors and subcontractors.
- Report to manager.

Renewable Energy Maintenance Technician

- Complete startup re-commissioning and perform system operation confirmation tests.
- Construct assemble components of the system as designed.
- Place/install system components and support structures following fire prevention and occupational safety/health codes.
- Receive and/or verify equipment for the system maintenance is ready for assembly, construction, or installation.
- Restart utility or components systems and controls systems.
- Safely shutdown system utilities and/or components for replacement/repair.
- Verify operations of energy system to diagnose problems and develop solutions.

Resource Conservation/Efficiency Manager

- Identify areas of waste and optimize energy and resource efficiency.
- Monitor resource and energy use and cost.
- Plan and recommend resource efficiency and conservation projects.
- Develop financial plans for recommended projects.
- Analyze energy cost.

FACILITIES OPERATIONS AND MAINTENANCE

- Develop operational plans and budgets.
- Manage projects.
- Analyze utility rates and recommend energy procurement strategy.
- Identify and explain system commissioning.
- Maintain records and logs.
- Explain basic water quality and chemistry concepts.
- Identify and apply trade union rules.
- Identify and explain basic energy efficiency issues.
- Explain basic specification of parts procurement.
- Perform the duties of an energy auditor.
- Analyze energy bills (including utility rates and tariffs) for historical energy usage data.
- Measure and analyze energy and waste streams.
- Investigate/analyze opportunities for energy savings and pollution reduction in the following areas: HVAC, lighting, motors and other building equipment (including power factor and peak demand charge), the building envelope, maintenance procedures and operations, and industrial processes.
- Perform economic analysis:
 - Determine and estimate operating costs, maintenance costs, and capital costs.
 - Conduct life-cycle costing.
 - Determine present worth and value.
 - Calculate cost-benefit ratio, payback period, and return on investment.
- Prepare presentations and/or reports that provide energy and waste stream analysis and recommendations for improvements.
- Network, team-build, and be the champion for energy cost reductions.
- Coordinate work with trades workers.
- Manage the Hazard Communication Right-to-Know program, including Safety Data Sheets (SDS).
- Identify and explain energy, environmental, health, and safety regulations and issues.
- Demonstrate persuasive communication skills.
- Possess personnel and project managerial skills (e.g., scheduling, critical path, project management software).
- Explain the basics of building monitoring/system control measurement and verification skills.

- Explain the basics of system relationships (i.e., mapping process systems).
- Explain the basics of pollution prevention (i.e., source reduction, conservation, recycling).

Sustainability Coordinator*

- Analyze waste streams within an organization (water, electricity, trash, recycling).
- Arrange for proper recycling of materials locally accepted.
- Identify and apply basics of LEED and other green building standards.
- Provide education and outreach on corporate sustainability plan to management and employees.
- Calculate life-cycle costs for new purchases.
- Develop a green procurement plan.
- Plan and apply xeriscaping techniques.
- Plan and apply shading techniques.
- Plan and apply applicable roofing techniques.

Waste Management/Recycling Technician

- Evaluate and analyze processes and waste streams for waste minimization, recovery, or recycling.
- Analyze cradle-to-grave product usage, utilizing tools such as ecological footprint, to calculate environmental impact.
- Establish standards and procedures for waste minimization, recovery, or recycling.
- Work effectively with regulatory agencies.
- Prepare reports, permit applications, and proposals.
- Operate measurement and monitoring equipment.
- Negotiate and administer contracts.
- Evaluate and interpret tariffs and fees.
- Work with potentially hazardous materials and analyze opportunities for less toxic alternatives.
- Interpret complex technical literature.
- Prepare, administer, and perform emergency actions.
- Assist in monitoring environmental, health, and safety conditions.
- Participate in product redesign team to make organization more productive and environmentally sound or benign.

*Indicates an emerging occupation, existing but not yet fully defined.

UTILITY-SCALE GENERATION OPERATIONS AND MAINTENANCE

Occupational Titles

- Boiler Technician
- Coal Gasification Technician
- Electrical Maintenance Technician
- Energy Storage Technician*
- Fuel Storage Technician
- Instrument/Control Technician
- Mechanical Maintenance Technician
- Nuclear Radiation Protection Technician
- Ocean Power Technician*
- Power Plant Operator/Technician
- Solar Photovoltaic Technician
- Turbine Generator Technician
- Wind Turbine Technician

Boiler Technician

Coal Gasification Technician

Electrical Maintenance Technician

Energy Storage Technician*

Fuel Storage Technician

Instrument/Control Technician

- Monitor and regulate energy production processes.
- Anticipate and adjust system to meet load and distribution demands.
- Develop and implement preventive maintenance practices and programs.
- Collect and analyze data to maintain proper conditions.
- Optimize operational efficiencies.
- Operate plant equipment and controls, including monitoring and testing equipment.
- Calibrate and operate instruments.

- Identify and practice standard environmental, health, safety, and spill practices and procedures.
- Develop a critical path outage plan.
- Analyze and respond to alarm conditions.

Mechanical Maintenance Technician

Nuclear Radiation Protection Technician

Ocean Power Technician*

- Measure ocean power source quality and quantity to ensure it meets required characteristics for conversion equipment operations.
- Monitor equipment operating efficiency, output, and safe operation.
- Rebuild and/or repair components, if acceptable practice.
- Remove and replace components as determined by preventive maintenance plan.
- Test operation of reconditioned components before reusing.

Power Plant Operator/Technician, including: Cogeneration, Fossil Fuel, Geothermal, Hydropower, Nuclear (usually above technician level), Solar thermal, Waste-to-Energy/Biomass-to-Energy

Solar Photovoltaic Technician

Turbine Generator Technician

Wind Turbine Technician

- Functionally test electrical circuits working with 24 to 600 V DC/AC.
- Troubleshoot and repair integrated systems.
- Troubleshoot complicated mechanical and hydraulic problems on turbines.
- Perform all mechanical, hydraulic, and electrical component maintenance, repair, or replacement of parts to correct malfunctions.
- Perform start-up procedures and equipment function tests.

UTILITY-SCALE GENERATION OPERATIONS AND MAINTENANCE

- Perform maintenance on turbine equipment per the commissioning manual.
- Collect turbine data for research and/or analysis.
- Report turbine conditions and complete reports and paperwork as required.
- Provide technical assistance to other technicians.
- Adhere to OSHA-compliant health and safety programs.
- Coordinate with engineering on technical issues and documentation.
- Prepare wind turbine generators for commercial operation.
- Travel and work overtime as required.
- Evaluate product conditions and quality to verify that systems have been assembled and wired correctly to meet product standards.
- Ensure that less experienced colleagues and subcontractors adhere to all best practices and work instructions, and provide quality workmanship combined with good housekeeping practices.
- Document all work performed using computer-based service reporting procedures.
- Possess a valid driver's license.



Occupational Titles

- Compliance Specialist
- Critical Infrastructure Protection (CIP) Specialist
- Cybersecurity Specialist
- Environmental, Health, and Safety (EHS) Specialist
- Inspector
- Laboratory/Field Technician
- Paralegal
- Permit Coordinator/Reviewer
- Training Coordinator

Compliance Specialist, including: Codes/Standards, Warranty, Regulatory, Internal Auditor, Voluntary Programs, Insurance, Incentives

- Review permit applications for accuracy and/or prepare them.
- Maintain knowledge of and apply current municipal, state, and federal regulations (environmental, health, safety, utility codes, internal).
- Identify and explain monitoring equipment and terminology.
- Assist in developing policies and procedures.
- Evaluate internal compliance.
- Interact with regulatory authorities.
- Conduct ongoing employee training (e.g., OSHA, EPA, corporate policy).
- Certify for LEED attributes and other voluntary programs.
- Identify, track, and comply with warranty, insurance, and incentives requirements.

Critical Infrastructure Protection (CIP) Specialist

- Plan for emergencies.
- Prevent incidents.
- Manage disasters (e.g., natural, technological, malicious events).

Cybersecurity Specialist

- Implement security as risk management.
- Monitor systems for cyber attacks.
- Collect business-oriented security metrics and methods.
- Detect, prevent, and resolve security threats to computer networks.
- Maintain integrity and confidentiality of data and information systems.

Environmental, Health, and Safety (EHS) Specialist

- Implement programs, policies, and assessments to ensure compliance with regulations.
- Develop and provide employee training.
- Identify and eliminate hazards.

Inspector (Insurance, Finance/Rebate, Municipal/County/State, Utility, Plan Review)

- Conduct site visits and coordinate with owners.
- Identify and apply regulatory codes and maintain updated code reference data.
- Report code violations or recommended regulatory actions to agencies and/or owners.
- Review and/or test systems and process physical locations to assess compliance with codes.
- Audit for municipal, county, and state codes and regulations.
- Verify adherence to insurance, finance, rebate, or other requirements.

Laboratory/Field Technician

- Collect and analyze samples for compliance and quality control purposes.
- Perform data acquisition and analysis.
- Prepare reports.
- Follow standard operating procedures.
- Develop lab and field procedures.
- Maintain equipment and supplies.

Paralegal

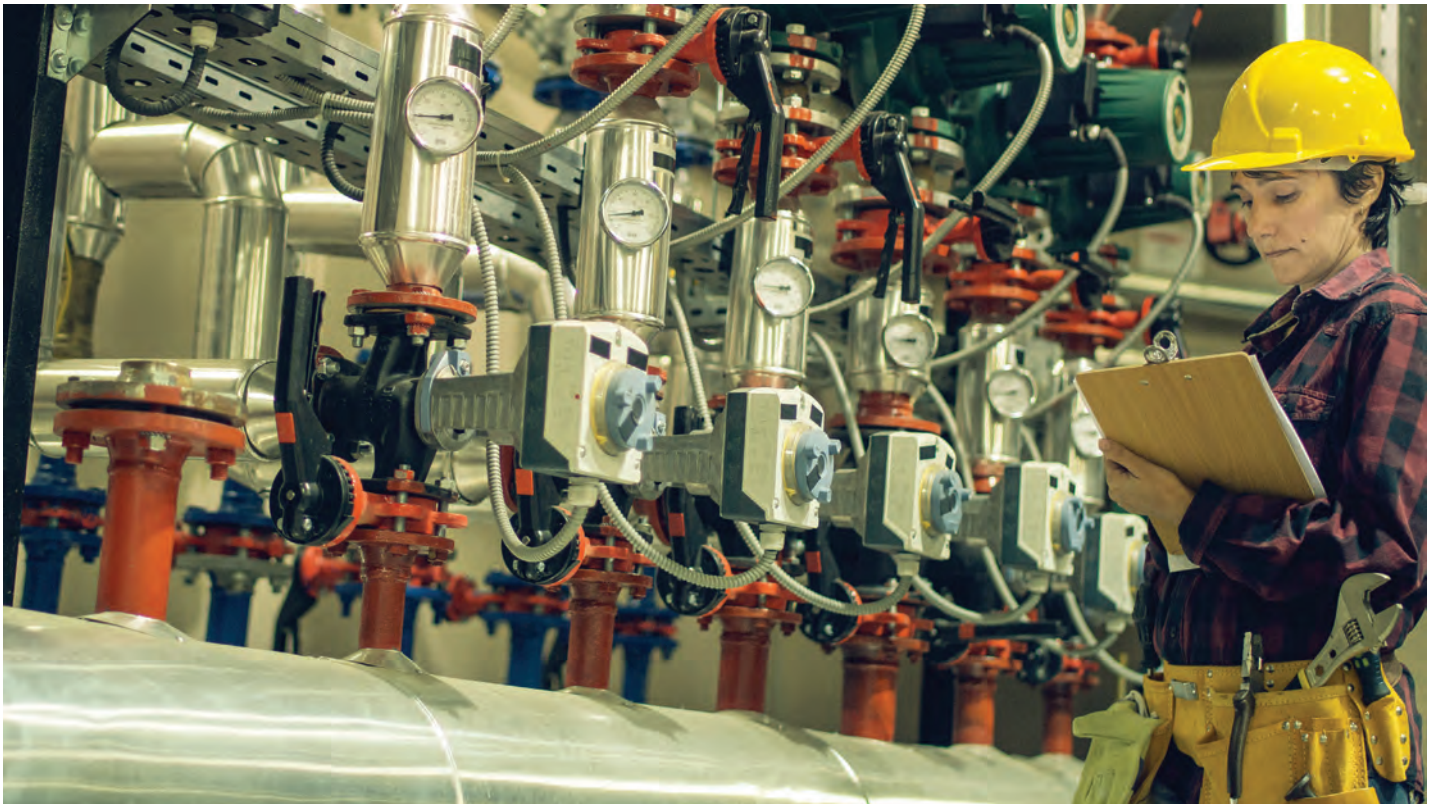
- Research regulatory requirements.
- Monitor and report legislative activity.
- Prepare/review contracts.

Permit Coordinator/Reviewer

- Identify permitting requirements.
- Prepare permits for submission.
- Modify permits.
- Ensure accuracy and completeness of permits.

Training Coordinator

- Develop and deliver training.
- Identify training needs.
- Maintain employee training records.
- Ensure training meets regulatory requirements.
- Coordinate and schedule training.



TRANSMISSION AND DISTRIBUTION

Occupational Titles

- Distribution Systems Controller
- Distribution Technician
- Gas Technician
- Line Mechanic (Lineman)
- Meter and Control Technician
- Pipeline Technician
- Smart Grid Technician*
- Substation (Relay) Technician
- Systems Analysis Technician

Distribution Systems Controller

- Assist with operation and maintenance of fuel storage and distribution systems (e.g., bulk storage, supplemental storage, generator distribution systems).

Distribution Technician

- Coordinate, regulate, and distribute electricity, gas, and/or steam.

Gas Technician

- Install, service, maintain, troubleshoot, and repair gas pipeline delivery systems and commercial/residential appliances.

Line Mechanic (Lineman)

- Maintain and repair overhead distribution/transmission lines.
- String new wire.
- Install and maintain insulators, transformers, and other equipment.
- Set up towers and poles, and trim trees.

Meter And Control Technician

- Install, repair, and maintain mechanical regulating and controlling devices (e.g., electricity meters, gas regulators, thermostats, valves, governors).

Pipeline Technician

- Operate and maintain oil/gas pipeline system.
- Troubleshoot, test, and repair pipeline and equipment.

Smart Grid Technician*

- Maintain technology for electric grid control.
- Install communication networks and control systems.
- Troubleshoot hardware and communication systems failures.

Substation (Relay) Technician, Assistant

- Apply electrical safety principles (including human performance).
- Perform electrical lockout/tagout procedures.
- Explain and apply basic electricity principles (e.g., DC electrical circuits, OHM's law, progressing into 3-phase AC power, and impedance principles).
- Read and interpret electrical prints (including single line, AC 3-line, DC elementary, panel wiring prints, schematic and connection diagrams, and zones of protection drawings).
- Manage and control electrical documentation.
- Implement electric utility governmental regulations.
- Describe and apply protective relaying principles, theory, and philosophy.
- Install, test, and commission electro-mechanical relays.
- Commission substation using numerical relays.
- Program and troubleshoot programmable logic controls (PLCs).
- Maintain high-voltage power transformer systems.
- Troubleshoot high-voltage power circuit breaker.
- Construct, operate, and maintain electrical substation/protective relays.
- Design, construct, test, and electrically commission a distribution feeder protection terminal.

TRANSMISSION AND DISTRIBUTION

Substation (Relay) Technician, Journeyman

- Review construction prints, make corrections as needed, and confirm schemes will function properly.
- Assist in resolving any problems with protection and control schemes.
- Perform overlapping project management duties (including setting dates and priorities of most large electrical projects).
- Review protective relay settings as issued; assist in resolving any problems with logic and protection relay settings.
- Review Supervisory Control and Data Acquisition (SCADA) point assignment sheet and assist in resolving any conflicts between relay logic settings and remote terminal unit (RTU) settings and any other supervisory control issues.
- Oversee inventory of relay material issued to the project; order missing items.
- Direct and oversee all aspects of substation/power plant construction (including mounting and wiring of protective relays, cabling from panel to panel, and terminating cables by electricians).
- Assist in resolving any construction quality control issues.
- Provide on-site support to other departments (e.g., proper direction and placement of high voltage circuit breakers).
- Review and correct as needed, substation operating instructions.
- Coordinate, schedule, and sequence each phase of the project, providing protection to equipment throughout the duration of the project.
- Test high voltage equipment for ratio, polarity, saturation, and meggar.
- Apply settings and calibrate protective and control relays.
- Create and install proper labeling to panels; order labels for exterior junction boxes and switch handles.
- Verify proper wiring of potential and current circuits from instrument transformer to end element device.

- Test electrical apparatus/schemes (e.g., transformer sudden pressure, line tuner, wave traps, generator protection, and transmission line protection).
- Verify transformer and breaker alarms function properly from the equipment terminal blocks into control house and dispatch center.
- Perform functional test for relay and control circuits to verify proper operation during simulated fault conditions.
- Confirm proper operation of new equipment through SCADA.
- Write functional guidelines.
- Coordinate and schedule with others to energize new equipment.
- Perform or confirm phasing of newly energized lines or equipment.
- Take electrical in-service readings of new equipment as load is first applied (electrical commissioning).
- Leave a complete corrected set of relay drawings at substation and submit copy of same for redrafting.
- Sign and submit documentation (e.g., settings, in-service sheets, CTR sheets, substation operating instructions, point assignment sheets) to appropriate person.
- Schedule a meeting with maintenance personnel to inform them of new equipment and schemes, and answer any questions they may have.
- Schedule and conduct meeting with project engineers, if needed, to go over lessons learned.
- Oversee documentation of excess items and schedule a pick-up of excess material.

Systems Analysis Technician

- Collect and analyze data for proper system operation.
- Identify failure and fault condition and recommend system adjustment/improvement.

ALTERNATIVE FUEL VEHICLES (AFVs) AND INFRASTRUCTURE*

Occupational Titles

- AFV Infrastructure Technician
- AFV Mechanic
- Battery Repair and Maintenance Technician*
- Biofuels Processing Technician*
- Fleet Manager
- Life Cycle/Recycling Specialist

AFV Infrastructure Technician*

- Install, maintain, and repair AFV stations, including electric vehicle charging station, natural gas fueling station, and hydrogen fueling station.

AFV Mechanic

- Diagnose, troubleshoot, maintain and repair AFVs, according to manufacturing specs, using complex diagnostics tools.
- Apply specialized knowledge of AFV systems (e.g., electric, hybrid, propane, natural gas, hydrogen).
- Apply specialized knowledge of electric power train drive.

Battery Repair and Maintenance Technician*

- Apply basic knowledge of DC power systems.
- Analyze and troubleshoot high voltage DC battery systems.
- Adhere to stringent safety procedures.
- Perform repair and replacement of battery systems.
- Adhere to appropriate recycling and disposal procedures.
- Interact with computerized power management systems.

Biofuels Processing Technician*


- Calculate, measure, load, mix, and process refined feedstock with additives in fermentation/reaction process vessels and monitor production process.
- Clean, maintain, and prepare processing equipment.
- Extract fuel product, measure quality, and monitor storage until transferred to user.
- Extract secondary by-product or reusable fraction and monitor in storage until reused or transferred to user.
- Measure and monitor raw biofuels feedstock as well as processing additives quality and quantity prior to preprocessing.
- Preprocess feedstock in preparation for physical/chemical/biological fuel production process.
- Rebuild and/or repair components, if acceptable practice.
- Replace process components as determined by preventive maintenance plan.
- Test operation of reconditioned components before reusing.

Fleet Manager

- Monitor fleet needs.
- Manage fleet maintenance programs.
- Perform inventory control, warranty/vendor issues, and fueling requirements.

Life Cycle/Recycling Specialist





CROSS-CUTTING KNOWLEDGE AND SKILLS

In addition to the specific technical skills listed on the preceding chart, the following list of knowledge and skills has been identified as cutting across many of the technician jobs identified in this report.

- Safety and health
- Marketing
- Environmental compliance
- Data acquisition and analysis
- Systems analysis and integration

EMERGING AREAS AND FUTURE TRENDS

- Drone/unmanned aerial system (UAS)
- Autonomous vehicles
- Battery storage
- Battery chemistries
- Localized generation sources
- Cogeneration
- Off-shore wind
- Fault detection and diagnostics
- Big data
- Advanced grid technology (vehicle-to-grid)
- Cybersecurity
- Ocean wave technology
- Robotics/automation
- Artificial Intelligence (AI)
- Internet of Things (IOT)
- Cloud
- Energy harvesting technology (e.g., wearables, remote sensors)
- Wireless energy
- Environmental stewardship and protection





COMMUNITY COLLEGE RESPONSIBILITIES

- Develop student skills in the areas of critical thinking, communication, problem solving, and employability (e.g., integrity, interviewing, teamwork, punctuality).
- Provide faster response and agility in program development to meet rapid changes in business needs.
- Perform appropriate front-end analysis and needs assessment, to ensure the institution is serving real-world needs in the community.
- Provide real-world learning experiences in the classroom and through internships.
- Perform career aptitude and capabilities assessment.
- Provide career guidance.
- Actively pursue and foster industry partnerships.
- Develop mentorship programs.
- Provide the curricula for and promote certification and stackable credentials, as applicable.
- Incorporate industry-recognized occupational testing where applicable (e.g., MASS, POSS, SASS tests from Edison Electric Institute or the National Career Readiness Certificate test from ACT).
- Integrate capstone projects in the curricula to build and demonstrate critical thinking, problem solving, and time management skills.
- Collaborate with industry, government, and military partners to enhance students' portfolio assessment (e.g., Solar SunShot program).
- Provide instructors with training and administrative support to actively solicit industry for advisory committees and to use them appropriately.
- Incorporate classroom sessions with business and industry representatives as guest speakers.
- Solicit case studies from business and industry for integration into the curriculum.
- Foster industry relationships through contacts with student hires, salespersons, and press secretaries.
- Plug in to community organizations.

INDUSTRY COLLABORATION

- Externships (short-term or ongoing) for instructors
- Job shadowing
- Business plan training
- Advisory committees
- Company informational webinars connected to classroom (record and make available)
- Appropriate, field-specific point of contact person
- Local industry—guest lecture and career fairs
- Equipment and tools donations applicable to specific jobs
- Financial incentives and scholarships for students
- Laboratory use and/or joint training lab
- Adjunct relationships
- Interactive seminars
- Access to previous program student hires, salespersons, press secretaries

ACKNOWLEDGMENTS

CONTRIBUTORS

Kathy Alfano

Director
NSF ATE Center
Santa Clarita, CA

Marilyn Barger

FLATE, NSF-ATE Center
Tampa, FL

James Coates

International Union of Operating
Engineers
Local 399
Chicago, IL

Steve Factor

SolarCity Corp
Los Angeles, CA

Chuck Frost

BEST, NSF-ATE Center
Oakland, CA

Jacob Henderson

Spiers New Technology
Oklahoma City, OK

Eric Holland

SolarCity
Redwood, CA

Cynthia Howell

Colorado Energy Research
Institute
Colorado School of Mines
Golden, CO

Ann Johnson

GeoTech Center, NSF-ATE Center
Salmon, ID

Joseph Konrade

Federal Energy Management
Program
Department of Energy
Washington, DC

Kirk Laflin

Partnership for Environmental
Technology Education
South Portland, ME

Richard Lawrence

North American Board of Certified
Energy Practitioners (NABCEP)
Clifton Park, NY

Andrew McMahan

McMahan Hydropower
Pittsboro, NC

Jeff Melvin

Exelon Generation
Cordova, IL

Julie Plummer

Iowa Waste Exchange
Davenport, IA

Mike Schmidt

MD&A Renewables Services
Fort Collins, CO

Mike Tuttle

MidAmerican Energy Company
Council Bluffs, IA

Troy Wanek

Solar Energy Environments, LLC
Lakewood, CO

EFFICIENCY

systems



Advanced Technology

**Environmental and
Energy Center**

201 North Harrison Street, Suite 101
Davenport, IA 52801

563.441.4081 • 866.419.6761
fax: 563.441.4080 • www.ateec.org



GRID

 EASTERN IOWA COMMUNITY COLLEGES
CLINTON ♦ MUSCATINE ♦ SCOTT

generation

POWER

storage

CONSERVATION



Cover design by Maxim Marketing & Graphic Services, Bettendorf, IA

Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International Public License CC BY-NC-SA

By exercising the Licensed Rights (defined below), You accept and agree to be bound by the terms and conditions of this Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International Public License ("Public License"). To the extent this Public License may be interpreted as a contract, You are granted the Licensed Rights in consideration of Your acceptance of these terms and conditions, and the Licensor grants You such rights in consideration of benefits the Licensor receives from making the Licensed Material available under these terms and conditions.

Section 1 – Definitions.

- a. **Adapted Material** means material subject to Copyright and Similar Rights that is derived from or based upon the Licensed Material and in which the Licensed Material is translated, altered, arranged, transformed, or otherwise modified in a manner requiring permission under the Copyright and Similar Rights held by the Licensor. For purposes of this Public License, where the Licensed Material is a musical work, performance, or sound recording, Adapted Material is always produced where the Licensed Material is synched in timed relation with a moving image.
- b. **Adapter's License** means the license You apply to Your Copyright and Similar Rights in Your contributions to Adapted Material in accordance with the terms and conditions of this Public License.
- c. **BY-NC-SA Compatible License** means a license listed at creativecommons.org/compatiblelicenses, approved by Creative Commons as essentially the equivalent of this Public License.
- d. **Copyright and Similar Rights** means copyright and/or similar rights closely related to copyright including, without limitation, performance, broadcast, sound recording, and Sui Generis Database Rights, without regard to how the rights are labeled or categorized. For purposes of this Public License, the rights specified in Section [2\(b\)\(1\)-\(2\)](#) are not Copyright and Similar Rights.
- e. **Effective Technological Measures** means those measures that, in the absence of proper authority, may not be circumvented under laws fulfilling obligations under Article 11 of the WIPO Copyright Treaty adopted on December 20, 1996, and/or similar international agreements.
- f. **Exceptions and Limitations** means fair use, fair dealing, and/or any other exception or limitation to Copyright and Similar Rights that applies to Your use of the Licensed Material.
- g. **License Elements** means the license attributes listed in the name of a Creative Commons Public License. The License Elements of this Public License are Attribution, NonCommercial, and ShareAlike.
- h. **Licensed Material** means the artistic or literary work, database, or other material to which the Licensor applied this Public License.
- i. **Licensed Rights** means the rights granted to You subject to the terms and conditions of this Public License, which are limited to all Copyright and Similar Rights that apply to Your use of the Licensed Material and that the Licensor has authority to license.
- j. **Licensor** means the individual(s) or entity(ies) granting rights under this Public License.
- k. **NonCommercial** means not primarily intended for or directed towards commercial advantage or monetary compensation. For purposes of this Public License, the exchange of the Licensed Material for other material subject to Copyright and Similar Rights by digital file-sharing or similar means is NonCommercial provided there is no payment of monetary compensation in connection with the exchange.
- l. **Share** means to provide material to the public by any means or process that requires permission under the Licensed Rights, such as reproduction, public display, public performance, distribution, dissemination, communication, or importation, and to make material available to the public including in ways that members of the public may access the material from a place and at a time individually chosen by them.
- m. **Sui Generis Database Rights** means rights other than copyright resulting from Directive 96/9/EC of the European Parliament and of the Council of 11 March 1996 on the legal protection of databases, as amended and/or succeeded, as well as other essentially equivalent rights anywhere in the world.
- n. **You** means the individual or entity exercising the Licensed Rights under this Public License. **Your** has a corresponding meaning.

Section 2 – Scope.

a. License grant.

1. Subject to the terms and conditions of this Public License, the Licensor hereby grants You a worldwide, royalty-free, non-sublicensable, non-exclusive, irrevocable license to exercise the Licensed Rights in the Licensed Material to:
 - A. reproduce and Share the Licensed Material, in whole or in part, for NonCommercial purposes only; and
 - B. produce, reproduce, and Share Adapted Material for NonCommercial purposes only.
2. Exceptions and Limitations. For the avoidance of doubt, where Exceptions and Limitations apply to Your use, this Public License does not apply, and You do not need to comply with its terms and conditions.
3. Term. The term of this Public License is specified in Section [6\(a\)](#).
4. Media and formats; technical modifications allowed. The Licensor authorizes You to exercise the Licensed Rights in all media and formats whether now known or hereafter created, and to make technical modifications necessary to do so. The Licensor waives and/or agrees not to assert any right or authority to forbid You from making technical modifications necessary to exercise the Licensed Rights, including technical modifications necessary to circumvent Effective Technological Measures. For purposes of this Public License, simply making modifications authorized by this Section [2\(a\)\(4\)](#) never produces Adapted Material.
5. Downstream recipients.
 - A. Offer from the Licensor – Licensed Material. Every recipient of the Licensed Material automatically receives an offer from the Licensor to exercise the Licensed Rights under the terms and conditions of this Public License.
 - B. Additional offer from the Licensor – Adapted Material. Every recipient of Adapted Material from You automatically receives an offer from the Licensor to exercise the Licensed Rights in the Adapted Material under the conditions of the Adapter’s License You apply.
 - C. No downstream restrictions. You may not offer or impose any additional or different terms or conditions on, or apply any Effective Technological Measures to, the Licensed Material if doing so restricts exercise of the Licensed Rights by any recipient of the Licensed Material.
6. No endorsement. Nothing in this Public License constitutes or may be construed as permission to assert or imply that You are, or that Your use of the Licensed Material is, connected with, or sponsored, endorsed, or granted official status by, the Licensor or others designated to receive attribution as provided in Section [3\(a\)\(1\)\(A\)\(i\)](#).

b. Other rights.

1. Moral rights, such as the right of integrity, are not licensed under this Public License, nor are publicity, privacy, and/or other similar personality rights; however, to the extent possible, the Licensor waives and/or agrees not to assert any such rights held by the Licensor to the limited extent necessary to allow You to exercise the Licensed Rights, but not otherwise.
2. Patent and trademark rights are not licensed under this Public License.
3. To the extent possible, the Licensor waives any right to collect royalties from You for the exercise of the Licensed Rights, whether directly or through a collecting society under any voluntary or waivable statutory or compulsory licensing scheme. In all other cases the Licensor expressly reserves any right to collect such royalties, including when the Licensed Material is used other than for NonCommercial purposes.

Section 3 – License Conditions.

Your exercise of the Licensed Rights is expressly made subject to the following conditions.

a. Attribution.

1. If You Share the Licensed Material (including in modified form), You must:
 - A. retain the following if it is supplied by the Licensor with the Licensed Material:
 - i. identification of the creator(s) of the Licensed Material and any others designated to receive

attribution, in any reasonable manner requested by the Licensor (including by pseudonym if designated);

- ii. a copyright notice;
 - iii. a notice that refers to this Public License;
 - iv. a notice that refers to the disclaimer of warranties;
 - v. a URI or hyperlink to the Licensed Material to the extent reasonably practicable;
- B. indicate if You modified the Licensed Material and retain an indication of any previous modifications; and
- C. indicate the Licensed Material is licensed under this Public License, and include the text of, or the URI or hyperlink to, this Public License.
1. You may satisfy the conditions in Section [3\(a\)\(1\)](#) in any reasonable manner based on the medium, means, and context in which You Share the Licensed Material. For example, it may be reasonable to satisfy the conditions by providing a URI or hyperlink to a resource that includes the required information.
 2. If requested by the Licensor, You must remove any of the information required by Section [3\(a\)\(1\)\(A\)](#) to the extent reasonably practicable.

a. ShareAlike.

In addition to the conditions in Section [3\(a\)](#), if You Share Adapted Material You produce, the following conditions also apply.

1. The Adapter's License You apply must be a Creative Commons license with the same License Elements, this version or later, or a BY-NC-SA Compatible License.
2. You must include the text of, or the URI or hyperlink to, the Adapter's License You apply. You may satisfy this condition in any reasonable manner based on the medium, means, and context in which You Share Adapted Material.
3. You may not offer or impose any additional or different terms or conditions on, or apply any Effective Technological Measures to, Adapted Material that restrict exercise of the rights granted under the Adapter's License You apply.

Section 4 – Sui Generis Database Rights.

Where the Licensed Rights include Sui Generis Database Rights that apply to Your use of the Licensed Material:

- a. for the avoidance of doubt, Section [2\(a\)\(1\)](#) grants You the right to extract, reuse, reproduce, and Share all or a substantial portion of the contents of the database for NonCommercial purposes only;
- b. if You include all or a substantial portion of the database contents in a database in which You have Sui Generis Database Rights, then the database in which You have Sui Generis Database Rights (but not its individual contents) is Adapted Material, including for purposes of Section [3\(b\)](#); and
- c. You must comply with the conditions in Section [3\(a\)](#) if You Share all or a substantial portion of the contents of the database.

For the avoidance of doubt, this Section [4](#) supplements and does not replace Your obligations under this Public License where the Licensed Rights include other Copyright and Similar Rights.

Section 5 – Disclaimer of Warranties and Limitation of Liability.

- a. **Unless otherwise separately undertaken by the Licensor, to the extent possible, the Licensor offers the Licensed Material as-is and as-available, and makes no representations or warranties of any kind concerning the Licensed Material, whether express, implied, statutory, or other. This includes, without limitation, warranties of title, merchantability, fitness for a particular purpose, non-infringement, absence of latent or other defects, accuracy, or the presence or absence of errors, whether or not known or discoverable. Where disclaimers of warranties are not allowed in full or in part, this disclaimer may not apply to You.**
- b. **To the extent possible, in no event will the Licensor be liable to You on any legal theory (including, without limitation, negligence) or otherwise for any direct, special, indirect, incidental, consequential, punitive, exemplary, or other losses, costs, expenses, or damages arising out of this Public License or use of the Licensed Material, even if the Licensor has been advised of the possibility of such losses, costs, expenses, or damages. Where a limitation of liability is not allowed in full or in part, this**

limitation may not apply to You.

- c. The disclaimer of warranties and limitation of liability provided above shall be interpreted in a manner that, to the extent possible, most closely approximates an absolute disclaimer and waiver of all liability.

Section 6 – Term and Termination.

- a. This Public License applies for the term of the Copyright and Similar Rights licensed here. However, if You fail to comply with this Public License, then Your rights under this Public License terminate automatically.
- b. Where Your right to use the Licensed Material has terminated under Section [6\(a\)](#), it reinstates:
 - 1. automatically as of the date the violation is cured, provided it is cured within 30 days of Your discovery of the violation; or
 - 2. upon express reinstatement by the Licensor.For the avoidance of doubt, this Section [6\(b\)](#) does not affect any right the Licensor may have to seek remedies for Your violations of this Public License.
- c. For the avoidance of doubt, the Licensor may also offer the Licensed Material under separate terms or conditions or stop distributing the Licensed Material at any time; however, doing so will not terminate this Public License.
- d. Sections [1](#), [5](#), [6](#), [7](#), and [8](#) survive termination of this Public License.

Section 7 – Other Terms and Conditions.

- a. The Licensor shall not be bound by any additional or different terms or conditions communicated by You unless expressly agreed.
- b. Any arrangements, understandings, or agreements regarding the Licensed Material not stated herein are separate from and independent of the terms and conditions of this Public License.

Section 8 – Interpretation.

- a. For the avoidance of doubt, this Public License does not, and shall not be interpreted to, reduce, limit, restrict, or impose conditions on any use of the Licensed Material that could lawfully be made without permission under this Public License.
- b. To the extent possible, if any provision of this Public License is deemed unenforceable, it shall be automatically reformed to the minimum extent necessary to make it enforceable. If the provision cannot be reformed, it shall be severed from this Public License without affecting the enforceability of the remaining terms and conditions.
- c. No term or condition of this Public License will be waived and no failure to comply consented to unless expressly agreed to by the Licensor.
- d. Nothing in this Public License constitutes or may be interpreted as a limitation upon, or waiver of, any privileges and immunities that apply to the Licensor or You, including from the legal processes of any jurisdiction or authority.

Creative Commons is not a party to its public licenses. Notwithstanding, Creative Commons may elect to apply one of its public licenses to material it publishes and in those instances will be considered the “Licensor.” The text of the Creative Commons public licenses is dedicated to the public domain under the [CC0 Public Domain Dedication](#). Except for the limited purpose of indicating that material is shared under a Creative Commons public license or as otherwise permitted by the Creative Commons policies published at creativecommons.org/policies, Creative Commons does not authorize the use of the trademark “Creative Commons” or any other trademark or logo of Creative Commons without its prior written consent including, without limitation, in connection with any unauthorized modifications to any of its public licenses or any other arrangements, understandings, or agreements concerning use of licensed material. For the avoidance of doubt, this paragraph does not form part of the public licenses.