DEFINING ENERGY TECHNOLOGIES AND SERVICES

Energy

EFFICIENCY

TECHNOLOGY

CONSERVATION

environment

SYSTEMS

ADVANCED TECHNOLOGY ENVIRONMENTAL AND ENERGY CENTER

Technician

A report from a forum sponsored by the Advanced Technological Education Program of the National Science Foundation and by the Advanced Technology Environmental and Energy Center

This material is based on work supported by the National Science Foundation under Grant No. DUE-0702439.

•

Eastern Iowa Community College District

•

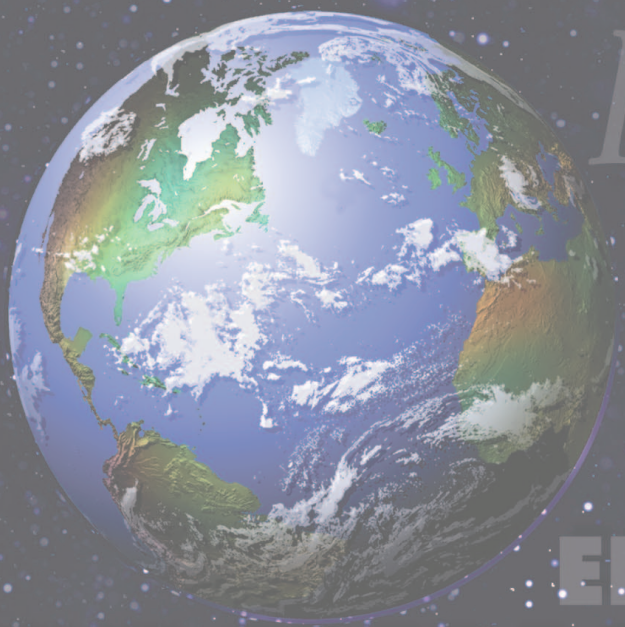
Partnership for Environmental Technology Education

•

University of Northern Iowa

This project was supported, in part, by the Advanced Technological Education Program at the National Science Foundation (NSF).
The opinions expressed in this report are those of the authors and do not necessarily represent NSF policy.

DEFINING ENERGY TECHNOLOGIES AND SERVICES



Energy

EFFICIENCY

TECHNOLOGY

CONSERVATION

environment

SYSTEMS

ADVANCED TECHNOLOGY ENVIRONMENTAL AND ENERGY CENTER

Technician

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 technologies and services career field. Their professional insights are critical to developing energy technology education and training programs that will meet workforce needs. The forum participants and external reviewers are listed at the back of this report.

Forum Coordination and Report Production

Ellen Kabat Lensch
Principal Investigator
Executive Director, ATEEC

Todd Trammell
Facilitator
Director, ATEEC

Melonee Docherty
Lead Facilitator/Report Editor
Instructional Designer, ATEEC

Heidi Hilbert
Facilitator
Project Coordinator, ATEEC

Tim Hunter
Facilitator
Instructional Designer, ATEEC

Lora Kaisler
Facilitator
Instructional Designer, ATEEC

Mercedes Luna-Rivero
Facilitator
Instructional Designer, ATEEC

TABLE OF CONTENTS

CONTENTS

INTRODUCTION

On December 12th and 13th in 2007, the Advanced Technology Environmental and Energy Center (ATEEC) conducted a national forum for defining energy technology. The forum goal was to validate and update occupational information from a 2000 report from the Partnership for Environmental Technology Education (PETE) titled *Energy Services Careers*. The energy technology industry has grown by leaps and bounds since the original report and continues to do so. The advent of new technology, the increased role of energy in national security issues, changes in national and regional regulatory compliance requirements, and the changing demands of industry call for a realignment of academia, industry, business, and government. New energy technology career categories are emerging at an unprecedented pace, and skill sets traditionally associated with energy technology are cutting across both traditional and emerging industries.

The 2007 forum's objectives included validating, revising, and/or updating the following:

- 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 collaborated with the Partnership for Environmental Technology Education (PETE) to select participants for the forum. ATEEC invited experienced practitioners and educators in environmental technology with a broad perspective of the various occupational areas included in this field. The participants who attended the workshop included business, industry, and government agency representatives, as well as two- and four-year college environmental technology educators. ATEEC attempted to gather as broad a regional representation of the country as possible, 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 two-year colleges and high schools;
- 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.

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 curriculum that prepares students for energy technology careers.

> Energy Technologies and Services is a career field that applies the principles of science, engineering, communication, economics, management, and law to optimize the sustainable production, delivery, and use of energy resources.

The report is also being used to provide direction for ATEEC, a Center of Excellence partially funded through a grant from the National Science Foundation. The Center brings together institutions from across the

nation to promote and assist environmental technology programs. ATEEC's core partners are PETE, the University of Northern Iowa, the National Renewable Energy Laboratory, and the National Science Foundation (NSF).

The Forum

The 2007 Defining Forum participants reviewed the 2000 report, Energy Services Careers, prior to the workshop and considered these questions:

- Does the "energy 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 occupational category?
- What are the emerging employment trends in the environmental field?
- What is the role of community colleges in technician education and training?

The forum began on December 12th at the O'Hare Hilton 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 2000 report's definition of "energy services." The participants decided to redefine the field as "Energy Technologies and Services." Additionally, the participants decided to make minor revisions to the definition of "technician" from the 2000 report. It was noted that the educational background for technicians can range from a high school diploma plus on-the-job training to a bachelor's degree. Typically, technicians complete a two-year associate degree in an applied technology program.

Next, the participants worked to validate or revise each of the energy technologies and services occupational categories listed in the 2000 report. Consensus was reached on the following occupational categories.

- Buying & Selling of Energy
- Energy Assessment
- Energy Efficient Building Construction, Project Engineering, & Implementation
- Exploration
- Generation (Alternative) & Utility-Scale Construction
- Operations & Maintenance
- Regulatory Affairs
- Transmission & Distribution
- Transportation (Mobile) Sources

A technician applies knowledge, skills, and abilities to perform scientific, technical, communication, and regulatory tasks.to optimize the sustainable

The participants then worked in small groups, in the areas where they felt their specific expertise would be of most value. Again, the 2000 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. Many of the occupations added at this time were well-established and well-defined jobs that are incorporating energy technologies and services as part of the traditional, existing job. Rather than recreating job functions for these types of jobs,

ATEEC's mission is the advancement of environmental and energy technology education through curriculum, professional, and program development and improvement.

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

participants felt their time would be best spent addressing new occupations that are emerging in the field or those occupations whose functions needed to be revised significantly due to changes in the energy field.

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. An asterisk also 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. The small groups then shared and discussed their specific results with the large group, reaching a forum consensus on the areas covered in this report.

Additionally, during the large-group discussion, the participants identified "cross-cutting" areas—functional areas that cut across most environmental technology occupational categories. For example, many energy technology jobs require a background in geospatial sciences, so that technicians can collect, manage, and integrate spatial and attribute data using geographic information systems (GIS). 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 held online discussions to spend further time refining the materials they had developed. Additional experts in the field from business, education, and government organizations were then 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. 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, and a listing of community college responsibilities developed during a similar forum on defining environmental technology.

*Throughout this report, the asterisk indicates an emerging occupational field, which currently exists but may not yet be fully defined.

Cross-Cutting Knowledge & Skills

- Agricultural technology
- Computer applications
- Conservation
- Energy independence
- Environmental stewardship
- Geospatial
- Health and safety
- Homeland security
- Logistics
- Policy analysis
- Problem-solving/communication/teamwork/ethics
- Project management
- Public outreach/education
- Regulatory compliance
- Research and development
- Sales and marketing
- Storage
- Sustainability

DEFINING *En*

What is the Energy Technologies and Services field?

Energy Technologies and Services is a career field that applies the principles of science, engineering, communication, economics, management, and law to optimize the sustainable production, delivery, and use of energy resources.

OCCUPATIONAL CATEGORIES

BUYING & SELLING ENERGY

- Alternative financing specialist (government incentives)
- Billing analyst / rate analyst
- Carbon trading analyst*
- Customer service representative / account executive
- Energy broker / trader
- Energy contracting specialist (state & federal)
- Purchasing agent (utility & private)
- Salesperson
- Sales representative (utility & private)

ENERGY ASSESSMENT

- Energy analyst
- Energy auditor
- Energy portfolio planner*
- Industrial process specialist
- Measurement & verification tech*
- Renewable energy site assessment tech*, including:
  - Geothermal site assessment specialist*
  - Hydropower site assessment specialist*
  - Ocean energy site assessment specialist*
  - Solar resource site assessment specialist*
  - Windfield site assessment specialist*

ENERGY EFFICIENT BUILDING CONSTRUCTION, PROJECT ENGINEERING, & IMPLEMENTATION

- Architecture tech
- Commissioning tech, including:
  - Verify systems operation & interoperations
  - Measurement & verification
- Energy efficient construction tradesperson / site foreman*
- Energy project developer / manager, including:
  - Scheduler
  - Engineering technician
  - CAD / CAM tech / draftsperson
  - GIS tech
- Renewable energy systems installer*
- Site & building exterior manager, including:
  - Xeri-scaping
  - Shading
- Testing, Adjusting, Balancing (TAB) tech
- Testing / commission tech

EXPLORATION

- Crop yield / biomass analyst (agriculture, aquaculture, & silviculture)
- Geology tech
- Geospatial tech
- Oil & gas exploration tech
- Solar resource assessor
- Surveyor /site assessor
- Uranium prospector
- Wind resource assessor

GENERATION & UTILITY-SCALE CONSTRUCTION

- Biofuels processing tech*
- Boiler tech
- Carbon sequestration tech
- Coal gasification tech
- Coal miner
- Cogeneration tech
- Combustion tech
- Energy crop farmers
- Energy specialist
- Fuel cell tech*
- Generator tech
- Geothermal tech
- Green power tech*
- Hydropower tech
- Infrastructure / construction tech (installation)
- Instrument / control tech & process operator
- Nuclear fuel enrichment & reprocessing tech
- Nuclear reactor tech
- Ocean power tech*
- Oil & gas field tech
- Oil & shale & tar sand processing tech
- Oil refinery / process tech
- Solar photovoltaic tech
- Solar thermal tech
- Utility-scale renewable energy installation tech
- Waste-to-energy tech
- Wind turbine tech

nergy Technologies & Services

What is a technician?

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

OCCUPATIONAL TITLES

OPERATIONS & MAINTENANCE

- Building control operator
- Building control systems tech
- Building operator
- Building systems automation tech*
- Direct Digital Control (DDC) programmer
- Energy cost analyst
- Energy manager / specialist / consultant
- Industrial process equipment maintenance & operations specialist
- Lighting specialist
- Maintenance tech
- Performance monitoring / continuous commissioning tech
- Program / project coordinator
- Renewable energy maintenance tech
- Resource conservation / efficiency manager
- Sustainability coordinator*
- Waste management / recycling tech

REGULATORY AFFAIRS

- Code inspector (municipal, county, & state)
- Compliance specialist (municipal, county, state, & federal)
- Energy regulation specialist
- Energy technology program specialist (state & federal)
- Fuel testing / verification tech
- Incentive auditing (verification)
- Legislative aide
- Permit specialist
- Plan reviewer / checker
- Surveyor / site assessor

TRANSMISSION & DISTRIBUTION

- Electrical energy storage / distribution tech*
- Emergency response
- Environmental safety & health
- Equipment operator / controls operator
- Fuel storage tech
- Infrastructure / construction tech
- Outage reporting
- Utilities tech

TRANSPORTATION (MOBILE) SERVICES

- Alternative Fuel Vehicle (AFV) repair / maintenance tech
- Emissions testing & repair tech
- Fleet manager
- Transportation, warehousing, & logistics tech (geospatial, planning, public transportation, multi-modal transportation, expediting)

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

Note: See reverse for additional information.

JOB FUNCTIONS

BUYING AND SELLING OF ENERGY

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

Billing analyst/rate analyst
- Read/understand rate schedules and contracts.
- Review/analyze customer bills and utility rate schedules.
- Select optimal rate structures.
- Prepare bill/rate schedule analysis reports.
- Identify and apply peak demand and power factor issues.
- Identify required supply to purchase.
- Identify and apply basics of electrical/gas units.
- Identify and apply regulatory structures and opportunities for change.

Carbon 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.

Customer service representative/ account executive
- Acquire product knowledge of basic systems, equipment, and services.
- Keep pace with the changing renewable markets and portfolios.
- Effectively use the telephone and personal contact to interact with customers and others.
- Use customer care software systems.
- Demonstrate good oral and written communication skills.
- Deal constructively with a variety of customer situations and emotions.
- Identify and apply energy company/energy supplier rates.
- Market products and services.
- Prepare and conduct presentations.
- Coordinate overall service with customer.
- Maintain quality of service.
- Develop and propose energy improvement or retrofit projects.
- Propose renewable energy systems (i.e., solar, wind, biomass).
- Analyze energy costs.
- Estimate preliminary costs.
- Write proposals and contracts.
- 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.

*Throughout this report, the asterisk indicates an emerging occupational field, which currently exists but may not yet be fully defined.

BUYING AND SELLING OF ENERGY (CONT)

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 on-going customer service.
- Provide reports on the status of markets and clients.
- Interact with multiple levels within the power selling chain.
- Solicit new clients.

Energy contracting specialist (state and federal)

- Apply the basics of federal/state government requirements for federal/state agencies (e.g., federal Energy Policy Acts 2005 and 2007).
- Apply the basics of federal Executive Orders that require federal agencies to meet or exceed requirements set by the President.
- Apply the basics of alternative financing by federal/state agencies to completed installation of energy efficiency and renewable energy technologies.

Purchasing agent (utility/private)

- Describe the basics of the energy industry and trading.
- Describe the basic regulatory structure of the Public Service/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 (utility/private)

- Acquire product knowledge of basic systems, equipment, and services.
- Keep pace with the changing renewable markets and portfolios.
- Cultivate new customers.
- Develop and maintain rapport with customers.
- Acquire information from prospects/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.
- Develop and deliver proposals/presentations to diverse audiences.
- Apply basic knowledge of building systems for residential, commercial, and industrial facilities.

Occupational Titles

Alternative financing specialist (government incentives)

Billing analyst / rate analyst

Carbon trading analyst*

Customer service representative / account executive

Energy broker / trader

Energy contracting specialist (state & federal)

Purchasing agent (utility & private)

Sales representative (utility & private)

JOB FUNCTIONS

ENERGY ASSESSMENT

Energy analyst

- Perform or be able to perform duties of an energy auditor.
- 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.
- Identify and explain the costs and environmental impact of using different types of energy.
- Evaluate potential for special contracts.
- Educate consumers on energy consumption and energy conservation.
- Compare energy company tariffs and energy market prices and make recommendations.
- Maintain library of tariffs, rules and regulations, codes, Public Utility Act, etc.
- Monitor daily findings (i.e., follow dockets).
- Testify at Public Service Commission hearings.
- Participate in association activities to lobby for more effective rates.
- 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, renewable energy applications.

Occupational Titles

Energy analyst

Energy auditor

Energy portfolio planner*

Industrial process specialist

Measurement & verification technician*

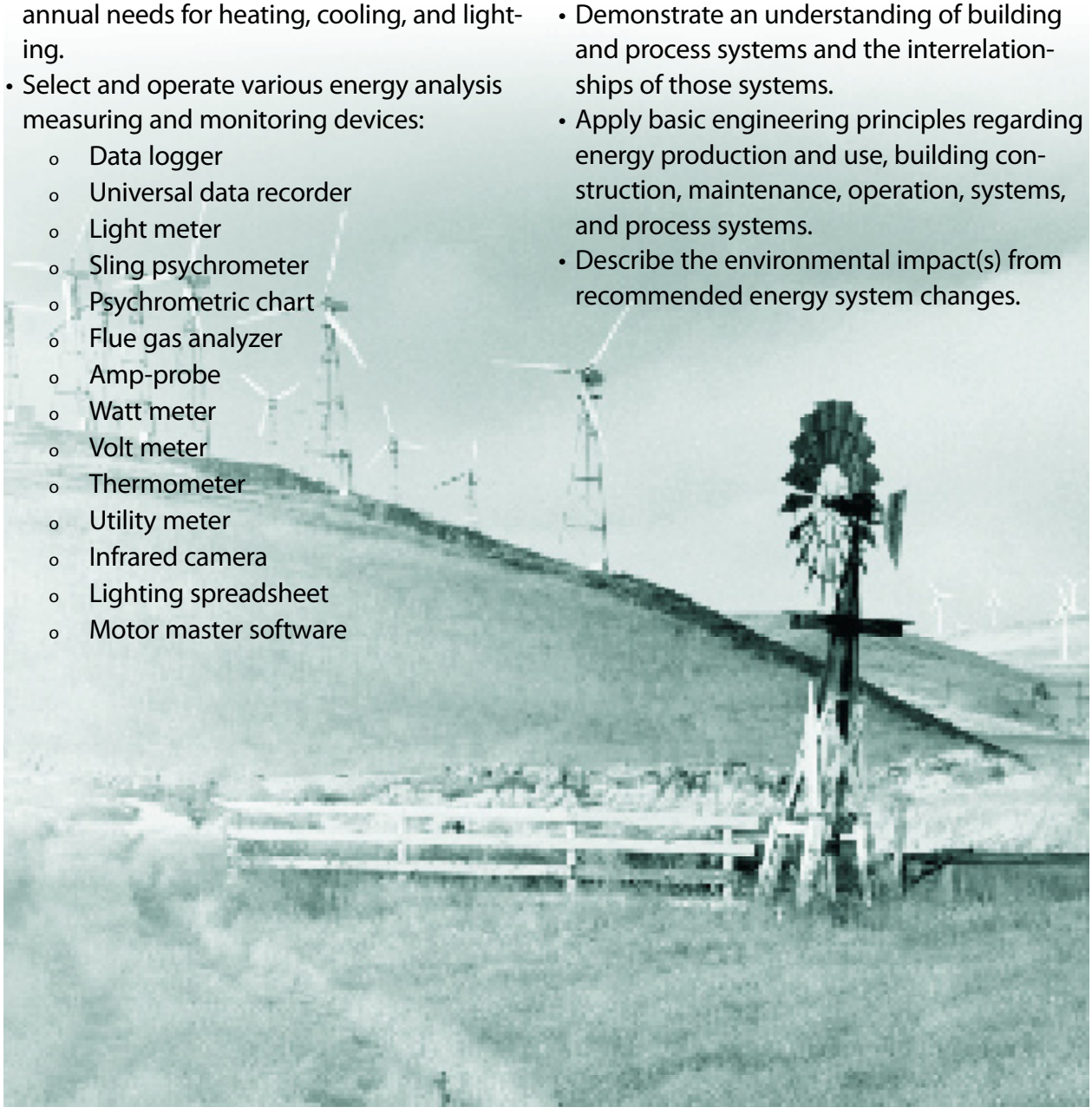
Renewable energy site assessment tech*

- 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.
- Analyze energy audit reports and provide recommendations for energy cost savings.
- Present energy analysis findings and energy cost savings recommendations to promote adoption by client.
- Describe the environmental impact(s) from recommended energy system changes.

ENERGY ASSESSMENT (CONT)

Energy auditor

- Assess customer's wants and needs.
- Establish/follow interview protocols for assessing customer's 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:
    - Data logger
    - Universal data recorder
    - Light meter
    - Sling psychrometer
    - Psychrometric chart
    - Flue gas analyzer
    - Amp-probe
    - Watt meter
    - Volt meter
    - Thermometer
    - Utility meter
    - Infrared camera
    - Lighting spreadsheet
    - Motor master software
- 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.



JOB FUNCTIONS

ENERGY ASSESSMENT (CONT)

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 application.
- 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 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.
- 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.

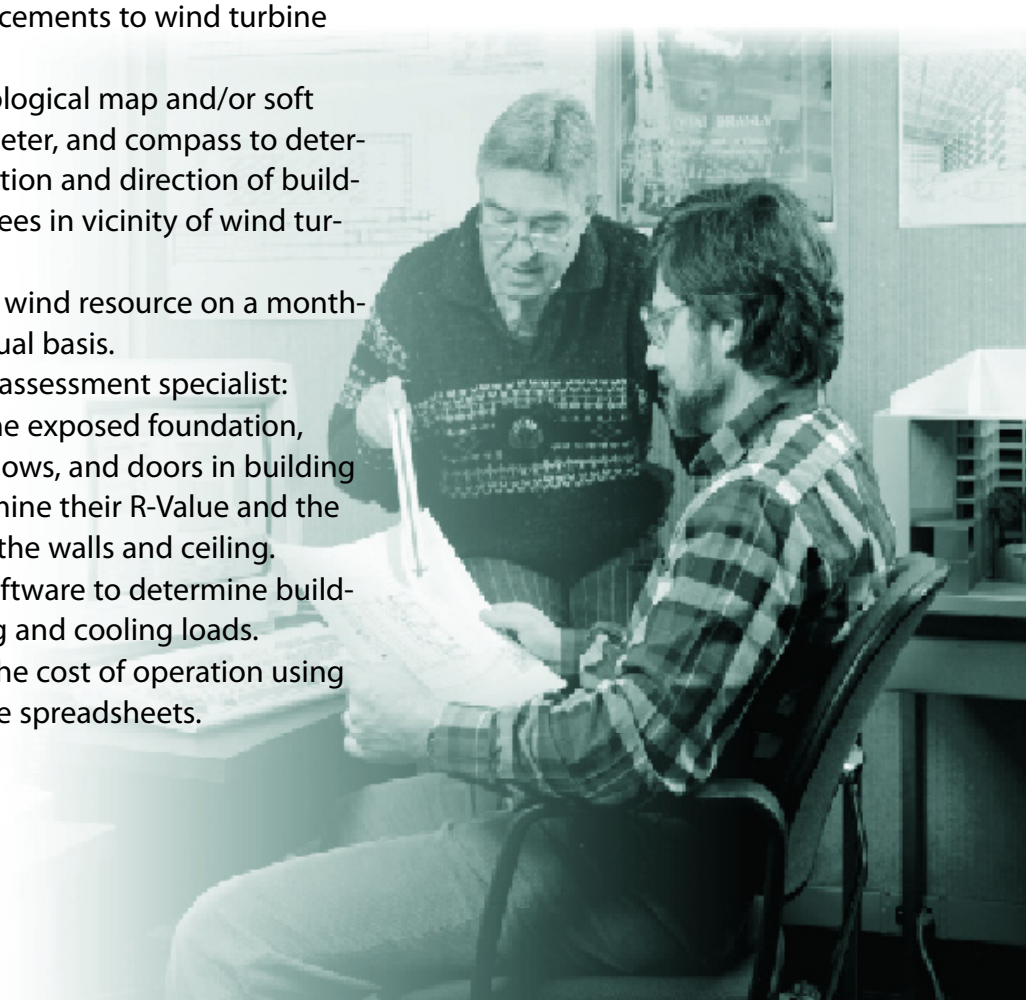
Measurement and verification technician*

- 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 ASSESSMENT (CONT)

Renewable energy site assessment technician*, including:

- Solar site assessment specialist:
  - Operate appropriate equipment (e.g., Solar Path Finder, 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.
- Windfield site assessment specialist:
  - Observe landscape within two to five miles of site and identify obstructions and enhancements to wind turbine operation.
  - Read a geological map and/or soft ware, 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.
- Geothermal site assessment specialist:
  - 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 assessment specialist:
  - 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 assessment specialist:
  - Find and assess thermal gradients in ocean.
  - Analyze data and provide estimated potential production from gradient.



JOB FUNCTIONS

JOB FUNCTIONS

ENERGY EFFICIENT BUILDING CONSTRUCTION, PROJECT ENGINEERING, AND IMPLEMENTATION

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 systems operation.
- Program the building's energy management system, including control strategies.
- Test and troubleshoot building and process systems.
- Verify field data.
- Train on-site 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 equipment in the building.
- 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).
- Work well with trades personnel.

Energy efficient construction tradesperson/site foreman*

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

Energy project developer/manager

- Perform scheduling tasks.
- Perform engineering technician tasks.
- Perform CAD/CAM and drafting tasks.
- Apply GIS technology to project.

Renewable 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.

ENERGY EFFICIENT BUILDING CONSTRUCTION, PROJECT ENGINEERING, AND IMPLEMENTATION (CONT)

Site and building exterior manager, including:

- Plan and apply xeri-scaping techniques.
- Plan and apply shading techniques.
- Plan and apply applicable roofing techniques.

Testing, adjusting, balancing (TAB) technician

- 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.

Testing/commissioning technician

- Ensure proper operation of the energy system by verifying system is working properly and teaching operators how to use the system.
- Ensure energy system is working properly during startup.
- Educate users about proper system operation and when to call a technician to fix problems.

JOB FUNCTIONS

JOB FUNCTIONS

EXPLORATION

Geospatial technician

- Collect, manage, and integrate spatial and attribute data using geographic information systems (GIS).

Occupational Titles

Crop yield/biomass analyst (agriculture, aquaculture, & silviculture)
Geology technician
Geospatial technician
Oil & gas exploration technician
Solar resource assessor
Surveyor/site resource assessor
Uranium prospector
Wind resource assessor

GENERATION AND UTILITY-SCALE CONSTRUCTION

Biofuels (liquid) 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.

GENERATION AND UTILITY-SCALE CONSTRUCTION (CONT)

Energy specialist

- Perform duties of an energy auditor.
- Calculate the environmental impact of energy usage.
- Prepare commissioning plans.
- Calculate savings, cost, and return on investment for energy efficiency opportunities.
- Interpret technical literature.
- Prepare presentations and/or reports on energy bill analysis, energy audits, commissioning plans, and measurement and verification plans.
- Present prioritized energy efficiency opportunities to purchasing department/building owner.

Fuel cell technician*

- Monitor quality and quantity of fuel cell components.
- Diagnose fuel cell operating characteristics and compare to specified parameters.
- Remove fuel cell or components from the energy transfer device.
- Replace fuel cell components as determined by preventive maintenance plan.
- Rebuild and/or repair fuel cell components if acceptable practice.
- Test operation of reconditioned components before reusing.
- Test operation of energy transfer device.

Green power technician*

- Assist with design of renewable energy system.
- Install renewable energy system.
- Operate and maintain renewable energy systems.

Occupational Titles

Biofuels processing technician*
Boiler technician
Carbon sequestration technician
Coal gasification technician
Coal miner
Cogeneration technician
Combustion technician
Energy crop farmers
Energy specialist
Fuel cell technician*
Generator technician
Geothermal technician
Green power technician*
Hydropower technician
Infrastructure / construction technician (installation)
Instrument/control technician & process operator
Nuclear fuel enrichment & reprocessing technician
Nuclear reactor technician
Ocean power technician*
Oil & gas field technician
Oil & shale & tar sand processing technician
Oil refinery / process technician
Solar photovoltaic technician
Solar thermal technician
Utility-scale renewable energy installation technician
Waste-to-energy technician
Wind turbine technician

JOB FUNCTIONS

GENERATION AND UTILITY-SCALE CONSTRUCTION (CONT)

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.

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.

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.
- 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.
- Responsible for adherence 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.

OPERATIONS AND MAINTENANCE

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).

OPERATIONS AND MAINTENANCE (CONT)

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.
- Identify and explain usage of other equipment (e.g., office equipment, kitchen equipment) in the building.
- Identify and apply instrumentation theory and application.
- Possess troubleshooting and diagnostic skills.
- 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.

OPERATIONS AND MAINTENANCE (CONT)

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, 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).

JOB FUNCTIONS

OPERATIONS AND MAINTENANCE (CONT)

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.

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

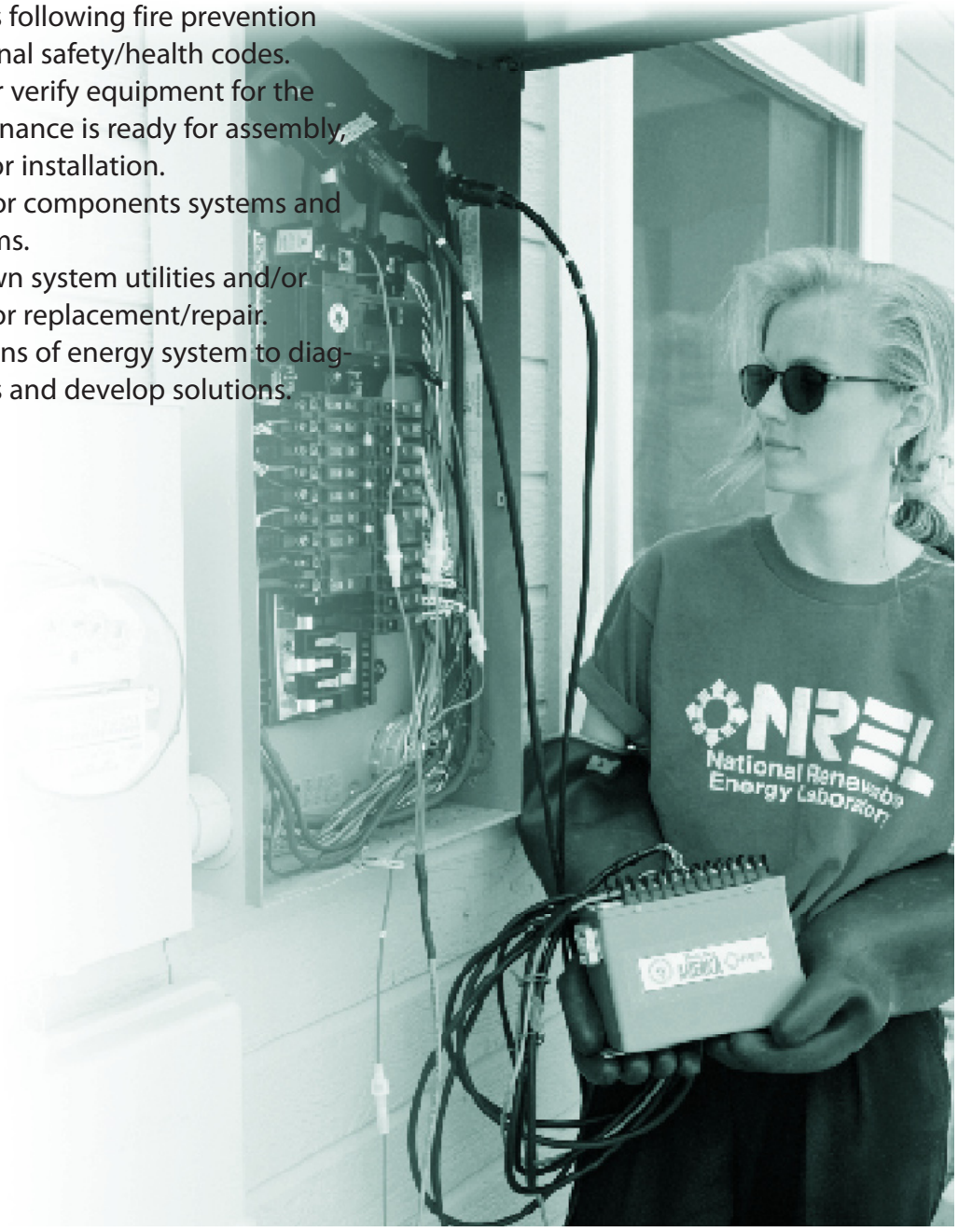
Program/project coordinator

- 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.

OPERATIONS AND MAINTENANCE (CONT)

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.



JOB FUNCTIONS

OPERATIONS AND MAINTENANCE (CONT)

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.
- 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 Material Safety Data Sheets (MSDS).
- 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).

OPERATIONS AND MAINTENANCE (CONT)

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.

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.

REGULATORY AFFAIRS

Code inspector (municipal, county, and state)

- Conduct energy 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 energy system and process physical locations to assess compliance with codes.

Compliance specialist (municipal, county, state, and federal)

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

Energy regulation specialist

- Ensure OSHA compliance.
- Advocate for voluntary and mandatory energy standards.

Energy technology program specialist (state and federal)

- Apply the basics of federal/state government requirements for federal/state agencies (e.g., federal Energy Policy Acts 2005 and 2007).
- Apply the basics of federal Executive Orders that require federal agencies to meet or exceed requirements set by the President.
- Apply the basics of alternative financing by federal/state agencies to completed installation of energy efficiency and renewable energy technologies.

Occupational Titles

Code inspector
Compliance specialist
Energy regulation specialist
Energy technology program specialist
Fuel testing/verification technician
Incentive auditing (verification)
Legislative aide
Permit specialist
Plan reviewer/checker
Surveyor/site assessor

TRANSMISSION AND DISTRIBUTION

Electrical energy storage/distribution technician*

- Measure energy source input quality and quantity to ensure it meets required characteristics for storage/transmission.
- Monitor and record storage and distribution frequency ratios and determine excess or available capacity within safety limits.
- Monitor storage/transmission equipment operating efficiency and safe operations.
- Rebuild and/or repair components, if acceptable practice.
- Remove and replace storage components as determined by preventive maintenance plan.
- Test operation of reconditioned components before reusing.

Emergency response

See ATEEC's *Defining Environmental Technology* report.

Environmental health and safety

See ATEEC's *Defining Environmental Technology* report.

Equipment operator/controls operator

- Anticipate load demands and plan for proper load dispatching.
- Analyze and respond to alarm conditions.
- Establish and follow emergency response plans.
- Prepare to respond to weather conditions (i.e., storms) on short notice.
- Establish preventive maintenance program.
- Apply craft and code requirements.
- Calibrate and operate instruments.
- Evaluate a site and/or tower for communications equipment.
- Follow standard environmental, health, safety, and spill procedures.

TRANSPORTATION (MOBILE) SERVICES

Transportation, warehousing, and logistics technician

See *Logistics: Pathways to Hot! Careers* report, available from Eastern Iowa Community College District.

Transportation Services

Alternative fuel vehicle (AFV) repair/ maintenance technician

Emissions testing & repair technician

Fleet manager

Transportation, warehousing, & logistics technician (geospatial, planning, public transportation, multi-modal transportation, expediting)

Transmission/Distribution

Electrical energy storage/distribution technician*

Emergency response technician

Environmental safety & health technician

Equipment operator/controls operator

Fuel storage technician

Infrastructure/construction technician

Outage reporting technician

Utilities technician

JOB FUNCTIONS

EMERGING TRENDS

Cross-Cutting Knowledge and Skills

- Agricultural technology
- Computer applications
- Conservation
- Energy independence
- Environmental stewardship
- Geospatial
- Health and safety
- Homeland security
- Logistics
- Policy analysis
- Problem-solving/communication/teamwork/ethics
- Project management
- Public outreach/education
- Regulatory compliance
- Research and development
- Sales and marketing
- Storage
- Sustainability

Emerging Areas/Trends

- Biofuels processing technician
- Building systems automation technician
- Carbon trading analyst
- Electrical energy storage/distribution technician
- Energy efficient construction tradesperson/site foreman
- Energy portfolio planner
- Fuel cell technician
- Measurement and verification technician
- Ocean power technician
- Renewable energy site assessment technician

Community College Responsibilities and Contributions

Develop 2+2+2 articulation agreements with high schools and 4-year institutions.

Develop a program graduate survey tool to stay in touch with past graduates to assess changing job skills.

Develop active program advisory committees

Develop emerging trends programs.

Develop/foster relationships with local industry.

Develop shared program offerings with high schools for credit.

Include environmental/sustainability/energy as a capstone course and/or infuse in other program offerings on campus.

Integrate sustainability as a core competency throughout all programs.

Lead by example (e.g., practice what you preach, walk the talk).

Promote lifelong learning.

Promote professional development for all college staff in regards to emerging trends/technologies.

Provide community outreach on sustainability issues.

Provide energy and environmental re-careering

Provide inverse degrees.

Survey community and industry to assess emerging trends and business needs.

Train and retrain technicians.

Upgrade technician to professional status.

RESPONSIBILITIES

Forum Participants and Contributors

Barbara Anderegg
Madison Area Technical College
Madison, WI

Jim Coates
International Union of Operating Engineers, Local 399
Chicago, IL

Peter Crabtree
Peralta Community College District
Oakland, CA

Cynthia Howell
National Renewable Energy Laboratory, DOE
Golden, CO

David Inman
Wilbur Wright College
Chicago, IL

Ann Johnson
ESRI
St. Louis, MO

Paige Knutsen
Midwest Energy Efficiency Alliance
Chicago, IL

Joseph Konrade
Federal Energy Management Program, DOE
Washington, DC

Kirk Laflin
Partnership for Environmental Technology Education
South Portland, ME

Kent Peterson
American Society of Heating, Refrigerating and Air-Conditioning Engineers
Atlanta, GA

John Root
Muscatine Power and Water
Muscatine, IA

Mike Schmidt
Iowa Lakes Community College
Estherville, IA

Subodh Singh
Sinte Gleska University
Mission, SD

Jeffrey Steinfeld
Massachusetts Institute of Technology
Cambridge, MA

Amy Tapia
Sandia National Laboratory, DOE
Albuquerque, NM

Jane Weismann
Interstate Renewable Energy Council
Latham, NY

Triple Bottom Line of Sustainability

500 BELMONT ROAD
BETTENDORF, IOWA 52722
www.ateec.org
563-441-4091
fax:563-441-4080

ADVANCED TECHNOLOGY ENVIRONMENTAL AND ENERGY CENTER

Cover design by Maxim Marketing and Graphic Services, Bettendorf, Iowa
Printed with soy ink on recycled paper.