

Green Career Pathways Statewide Roadmap Project

Environmental Scan of Resources

Prepared for the
Oregon Career Pathways Initiative
by
Key Links Inc.

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Definition of a Green Job in Oregon

A Green Job works to do at least one of the following:

- Increase energy efficiency
- Produce renewable energy
- Prevent, reduce or mitigate environmental degradation
- Clean up and restore the natural environment
- Educate, consult and provide other services that support the above.

www.QualityInfo.org/Green

I. OVERVIEW

Purpose: The purpose of this paper is to inform the process of developing “green” statewide career pathway roadmaps in Oregon and to provide resources, national in scope, to inform development of green career pathways at Oregon community colleges. Specifically the paper focuses on informational resources that can help inform the development of five to seven statewide green career pathways. Two prototypes will be developed in summer 2010: one will be in a “traditional” occupation that requires enhanced skill sets to function effectively in the green economy: Heating, Ventilation, Air Conditioning and Refrigeration Mechanics and Installers. The second prototype will be in an emerging area of the green economy: Solar. To that end, the paper focuses on green career pathways (not pathways in general) and on the two initial targeted occupations. Roadmaps for up to three additional occupation/industries will be selected for development once the prototypes are completed.

Background: The Green Career Pathways Statewide Roadmap Project is part of a Labor Market Information (LMI) grant awarded through the American Recovery and Reinvestment Act (ARRA) to the Oregon Employment Department (OED). Through a subcontract with the Oregon Department of Community Colleges and Workforce Development (CCWD), the project will develop statewide career pathway roadmaps in 5-7 occupations by May 2011, including several emerging green occupations as well as several existing occupations requiring new skill sets of workers to function effectively in Oregon’s growing green economy. The goal of the Green Statewide Career Pathways Project is to provide Oregonians—students, parents, “swirlers” and “retoolers”---as well as high school and community college advisors and counselors with roadmaps that chart where education and training is available statewide through community colleges and apprenticeship programs in selected occupations/industries and including labor market information. Completed statewide roadmaps will be available on www.MyPathCareers.org, Oregon Career Information System, as well as community college websites.

Current Efforts: Oregon has a decade-long commitment to career pathways- building series of connected education and training programs and support services that enable individuals to secure a job or advance in a high-growth demand industry or high-demand occupation. These “stepping stones” help articulate and ease transitions from high school to community college; from pre-college (ABE/GED/ESL) to credit post-secondary; and from community college to university or a job. Oregon education partners have developed over 250 career pathway roadmaps and 150 Career Pathway Certificates, which are posted on www.MyPathCareers.org/cp and www.oregonpathways.org, respectively.

Statewide Focus: What is different about the Green Career Pathways project is that it is **statewide** in scope. As opposed to representing a single program of study within a given community college and the linkages among educational institutions in a local or regional community (essentially a 1-1 relationship), this effort will map statewide programs of study and link to multiple state and national level resources. As such, the pathway visual will not be two-

dimensional, but rather multi-dimensional with multiple “layers” of information and detail to explore.

Format of Prototypes: An Advisor Team has been formed that will provide input and guidance on the design and development of the statewide green career pathway prototypes. It is expected that a variety of options will be explored and discussed, which will then be evaluated against a set of criteria - including feasibility, ease of use, ability to replicate, etc. - and an initial design determined for development of the prototype(s). The Advisor Team includes:

- Kate Dins, Dean, Cascade Campus of Portland Community College
- Shalee Hodgson, Educational Specialist and “green” lead, CCWD
- Dave Krumbein, Pathways and Perkins Coordinator, Blue Mountain Community College
- Serena St. Clair, Pathways and Articulation Coordinator, Rogue Community College
- Tom Thompson, Perkins and Green-Focused Programs of Study, ODE
- Rosa Lopez, Pathways Coordinator, Lane Community College
- Mark Williams, CTE Dean, Umpqua Community College

Mimi Maduro, Pathways Initiative Statewide Director, serves as the lead for the Green Career Pathways Statewide Roadmap Project and staffs the committee. Audrey Theis, Project Consultant, President of Key Links Inc., provides consulting services for project implementation

Note to Reader: Imbedded throughout this report are text boxes that contain excerpts or examples of information or material contained in the document or database referenced on that page. They are included to give the reader an example of the kind of information available and also to entice them into exploring some of the many links included in this report.

FINDINGS AND RECOMMENDATIONS

A review of the various documents and other resources highlighted in this report suggests the following findings and observations:

- **Groundbreaking Effort.** The effort to develop statewide career pathway roadmaps, and to further transfer that information to an online career pathways tool, is a groundbreaking effort. This research did not uncover a similar effort anywhere in the country (although such effort might be underway and under the radar).
- **Generic Green Pathways:** The few green career pathways visuals identified in this research were (a) at a very high, industry level (e.g., the Center for Energy Workforce Development (CEWD) Energy Career Pathways for Skilled Utility Technicians) or representing broad program designs (e.g., the Wisconsin Regional Training Partnership (WRTP) Big Step Program Career Pathways visual in Greener Skills, p.25) and not occupationally-specific programs.
- **Green Programs are New:** Generally speaking, green programs at most colleges nationally have been developed within the past five years (although some in Oregon are clearly the exception). As a result, effort has been focused on standing up the new programs, and not so much on the interrelationships between and among them, which is a critical component of pathway development.
- **Green Program Roll-out:** The first wave of program development at many colleges has focused on emerging areas of technology, where the hierarchy of positions and skills is still very much in flux. In recognition that many green jobs are traditional jobs with enhanced skill sets, colleges are beginning to move into “greening” of existing programs and building principles of sustainability across the curriculum, although this effort is still very much in its infancy.
- **Job Requirements:** Many of the studies in this report suggest that the majority of green jobs require increasingly complex skill sets, and that most of which will require some form of post-secondary credential. A consistent theme is the growing importance of applied academic and workplace skills such as critical thinking, problem solving, creativity, innovation, systems-orientation, and cross-disciplinary/integrated approaches.
- **Skills Gap:** The studies also point to the growing gap that is surfacing between green job requirements and the skills of unemployed, undereducated workers, suggesting that greater efforts need to be made to prepare disadvantaged individuals for participation in the new green economy. The need for systems of long-term, comprehensive career pathways is gaining momentum as a critical vehicle for addressing access and opportunity to green, middle-class jobs.
- **Green Industry Standards and Certifications:** Because green industries and their skill requirements are emerging, the development of industry standards and industry-

recognized certifications is very much in flux. While a few national organizations offer widely recognized certifications in some sectors, such as renewable energy and energy efficiency, not all have reached that point of congruence as of yet. This makes designing and aligning programs with industry-based standards and certification at this point in time a bit of a challenge and why input from local and regional employers is critical.

- **Entrepreneurial Opportunity:** The emerging nature of the green economy provides an opportunity for those willing and able to start their own companies. This dimension suggests the need for business management skills to be incorporated into green training programs.

Based on these findings, a number of general recommendations regarding the overall approach to green pathways development follow logically:

- **Adopt a continuous improvement mentality:** The prototype(s) will likely go through various stages of development, as will the final product as the green economy morphs. This will be an iterative process and it will be important that everyone involved in the development be committed to a continuous improvement process in terms of design, content, ease of use, etc.
- **Layer Information:** Because of the complexity of the task, and the fact that the design tool limits the view to a single page at a time, there will need to be multiple layers of information that the user can essentially “peel” through. The question/ challenge will be defining the level of appropriate detail necessary to support informed decision making.
- **Emphasize Links:** More than the current career pathways, which reflect a single program of study at a single college in an existing occupation or occupational family, the statewide green pathways should reflect various linkages:
 - across colleges
 - between existing programs that may be adding new skill sets (e.g., construction) and new programs that reflect emerging occupations (e.g., solar)
 - with state and national databases regarding a variety of informational resources, including but not limited to skills, certifications, etc.

I. National Reports/Frameworks

A. Greening of the World of Work. Erich C. Dierdorff, Jennifer J. Norton, Donald W. Drewes, Christina M. Kroustalis *North Carolina State University* ; David Rivkin and Phil Lewis, National Center for O*NET Development. February 2009. www.onetcenter.org/dl_files/Green.pdf

This report helped to establish a national framework for thinking about and categorizing “green” occupations. It summarizes research focused on the impact of green economy activities and technologies on occupational requirements and identifies new and emerging occupations that may be considered as potential candidates for inclusion in the national occupational database system. Section I describes the occupational implications of the green economy and its associated activities and technologies. Section II focuses on important occupational staffing implications within different sectors of the green economy. Section III describes the methodology and results of this research, including identification of current occupations impacted by the green economy and specific green economy new and emerging occupational candidates.

Excerpts from the Executive Summary: The term “green” is widely applied to a substantial variety of products, services, and even lifestyle or consumer choices in the current economy. However, many of these applications are either not relevant or practical for occupational analysis or workforce development efforts. To focus on the implications of the green economy for occupations, an important initial priority was to define the green economy. *The green economy encompasses the economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy.*

It was also important to establish conceptual and definitional boundaries for “green employment” or work in so-called “green jobs.” The appropriate level of analysis for the current research was at the occupational level. In this report occupations are viewed as groupings of work roles that span multiple organizations but share common purposes and common requirements of incumbents. According to the U.S. Department of Labor, an occupation is defined as follows: *Group of jobs, found at more than one establishment, in which a common set of tasks are performed or are related in terms of similar objectives, methodologies, materials, products, worker actions, or worker characteristics.*

Green economy activities and technologies may have different effects on different occupations. Accordingly, some experts have argued that it is essential to move beyond simply applying a broad label such as “green.” Thus, a more prudent approach is to focus on the “greening” of occupations, which is defined in this report as follows: *The “greening” of occupations refers to the extent to which green economy activities and technologies increase the demand for existing occupations, shape the work and worker requirements needed for occupational performance, or generate unique work and worker requirements.* This definition lends itself to three general occupational categories, each describing the differential consequences of green economy activities and technologies on occupational performance: (1) Green Increased Demand Occupations; (2) Green Enhanced Skills Occupations; and (3) Green New and Emerging Occupations.

B. O*NET Online Resource Center

Sponsored by the U.S. Department of Labor, O*NET is the nation's primary source of occupational information. Central to the project is the O*NET database, containing information on hundreds of standardized and occupation-specific descriptors on thousands of occupations. The database, which is available to the public at no cost, is continually updated by surveying a broad range of workers from each occupation. Information from this database forms the heart of O*NET OnLine, an interactive application for exploring and searching occupations. See: www.onetcenter.org

As part of its efforts to keep up with the changing world of work, the National Center for O*NET Development investigated the impact of green economy activities and technologies on occupational requirements and the development of new and emerging occupations (see *Greening of the World of Work* referenced above). As a result, O*NET has developed a special section of its database to focus on green occupations. See: www.onetcenter.org/green.html

Green Sectors: To determine the potential occupational implications of green technology, workplace activities were categorized under different green economy sectors:

- Renewable Energy Generation
- Transportation
- Energy Efficiency
- Green Construction
- Energy Trading
- Energy/Carbon Capture and Storage
- Research, Design and Consulting Services
- Environmental Protection
- Agricultural and Forestry
- Manufacturing
- Recycling and Waste Reduction
- Governmental and Regulatory Administration

“Greening” of Occupations: Three categories, each describing different consequences of green economy activities and technologies on occupational performance.

- **Green Increased Demand Occupations:** The impact of green economy activities and technologies results in an increase in the employment demand for an existing occupation. However, this impact does not entail significant changes in the work or worker requirements of the occupation. The work context may change, but the tasks themselves do not. Sixty-four (64) occupations identified: www.onetcenter.org/green/demand.html?d=1
- **Green Enhanced Skills Occupations:** The impact of green economy activities and technologies result in a significant change in the work and worker requirements. This impact may or may not result in an increase in employment demand for the occupation. The essential purposes of the occupation remain the same, but tasks, skills, knowledge and external elements, such as credentials, have been altered. Sixty (60) occupations identified: www.onetcenter.org/green/skills.html?d=1
- **Green New and Emerging Occupations:** The impact of green economy activities and technologies is sufficient to create the need for unique work and worker requirements, which result in the generation of a new occupation. This new occupation could be entirely novel or “born” from an existing occupation. Ninety-one (91) occupations identified: www.onetcenter.org/green/emerging.html?d=1

B1. Green New and Emerging Occupations: Solar

Solar occupations are classified by O*NET in the new and emerging category, given that the impact of green economy activities and technologies has created the need for unique work and worker requirements and resulted in the emergence of new occupations. The O*NET classification system has added seven solar-related occupations as of July 2010. Five are outlined below; the other two are under development (Solar Power Plant Technician and Solar Thermoelectric Pant Operator)

Solar Photovoltaic Installer (O*NET Code 47.4099.1)
Description: Assemble, install, or maintain solar photovoltaic (PV) systems on roofs or other structures in compliance with site assessment and schematics. May include measuring, cutting, assembling, and bolting structural framing and solar modules. May perform minor electrical work such as current checks.
Median National Wages (2009): \$16.34 hourly; \$33,980 annual / Projected Growth (2008-2018): 7% to 13%
Classification of Instructional Programs (CIP): Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (47.0201)
<p>Tasks:</p> <ul style="list-style-type: none"> ▪ Assemble solar modules, panels, or support structures, as specified. ▪ Install active solar systems, including solar collectors, concentrators, pumps, or fans. ▪ Install photovoltaic (PV) systems in accordance with codes and standards using drawings, schematics, and instructions. ▪ Perform routine photovoltaic (PV) system maintenance on modules, arrays, batteries, power conditioning equipment, safety systems, structural systems, weather sealing, or balance of systems equipment. ▪ Activate photovoltaic (PV) systems to verify system functionality and conformity to performance expectations. ▪ Apply weather sealing to array, building, or support mechanisms. ▪ Check electrical installation for proper wiring, polarity, grounding, or integrity of terminations. ▪ Determine appropriate sizes, ratings, and locations for all system over current devices, disconnect devices, grounding equipment, and surge suppression equipment. ▪ Determine connection interfaces for additional subpanels or for connecting photovoltaic (PV) systems with utility services or other power generation sources. ▪ Determine photovoltaic (PV) system designs or configurations based on factors such as customer needs, expectations, and site conditions. ▪ Diagram layouts and locations PV arrays and equipment, including existing building or site features. ▪ Examine designs to determine current requirements for all parts of the PV system electrical circuit. ▪ Identify and resolve any deficiencies in photovoltaic (PV) system installation or materials. ▪ Identify electrical, environmental, and safety hazards associated with photovoltaic (PV) installations. ▪ Identify installation locations with proper orientation, area, solar access, or structural integrity for PV arrays. ▪ Identify methods for laying out, orienting, and mounting modules or arrays to ensure efficient installation, electrical configuration, or system maintenance. ▪ Install module array interconnect wiring, implementing measures to disable arrays during installation. ▪ Install required labels on solar system components and hardware. ▪ Measure and analyze system performance and operating parameters to assess operating condition of systems or equipment. ▪ Program, adjust, or configure inverters and controls for desired set points and operating modes. ▪ Select mechanical designs, installation equipment, or installation plans that conform to environmental, architectural, structural, site, and code requirements. ▪ Test operating voltages to ensure operation within acceptable limits for power conditioning equipment, such as inverters and controllers. ▪ Visually inspect and test photovoltaic (PV) modules or systems. ▪ Compile or maintain records of system operation, performance, and maintenance. ▪ Demonstrate system functionality and performance, including start-up, shut-down, normal operation, and emergency or bypass operations. ▪ Determine materials, equipment, and installation sequences necessary to maximize installation efficiency.

Solar Thermal Installers and Technicians (O*NET Code 47.4099.02)
Description: Install or repair solar energy systems designed to collect, store, and circulate solar-heated water for residential, commercial or industrial use.
Median National Wages (2009): \$16.34 hourly; \$33,980 annual / Projected Growth (2008-2018): 7% to 13%
Classification of Instructional Programs (CIP): Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (47.0201)
<p>Tasks:</p> <ul style="list-style-type: none"> ▪ Design active direct or indirect, passive direct or indirect, or pool solar systems. ▪ Perform routine maintenance or repairs to restore solar thermal systems to baseline operating conditions. ▪ Apply operation or identification tags or labels to system components, as required. ▪ Assess collector sites to ensure structural integrity of potential mounting surfaces or the best orientation and tilt for solar collectors. ▪ Connect water heaters and storage tanks to power and water sources. ▪ Determine locations for installing solar subsystem components, including piping, water heaters, valves, and ancillary equipment. ▪ Fill water tanks and check tanks, pipes, and fittings for leaks. ▪ Identify plumbing, electrical, environmental, or safety hazards associated with solar thermal installations. ▪ Install circulating pumps using pipe, fittings, soldering equipment, electrical supplies, and hand tools. ▪ Install copper or plastic plumbing using pipes, fittings, pipe cutters, acetylene torches, solder, wire brushes, sand cloths, flux, plastic pipe cleaners, or plastic glue. ▪ Install flat-plate, evacuated glass, or concentrating solar collectors on mounting devices, using brackets or struts. ▪ Install heat exchangers and heat exchanger fluids according to installation manuals and schematics. ▪ Install monitoring system components, such as flow meters, temperature gauges, and pressure gauges, according to system design and manufacturer specifications. ▪ Install plumbing, such as dip tubes, port fittings, drain tank valves, pressure temperature relief valves, or tanks, according to manufacturer specifications and building codes. ▪ Install solar collector mounting devices on tile, asphalt, shingle, or built-up gravel roofs, using appropriate materials and penetration methods. ▪ Install solar thermal system controllers and sensors. ▪ Test operation or functionality of mechanical, plumbing, electrical, and control systems. ▪ Apply ultraviolet radiation protection to prevent degradation of plumbing. ▪ Apply weather seal, such as pipe flashings and sealants, to roof penetrations and structural devices. ▪ Cut, miter, and glue piping insulation to insulate plumbing pipes and fittings. ▪ Demonstrate start-up, shut-down, maintenance, diagnostic, and safety procedures to thermal system owners.

Solar Energy Installation Managers (O*NET Code 47.1011.03)
Description: Direct work crews installing residential or commercial solar photovoltaic or thermal systems.
Median National Wages (2009): \$28.04 hourly; \$58,330 annual / Projected Growth (2008-2018): 14% to 19%
Classification of Instructional Programs (CIP): Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (47.0201); Solar Energy Technology/Technician (15.0505); Building/Construction Site Management/Manager (46.0412); Construction Management (52.201)
<p>Tasks:</p> <ul style="list-style-type: none"> ▪ Plan and coordinate installations of photovoltaic (PV) solar and solar thermal systems to ensure conformance to codes. ▪ Supervise solar installers, technicians, and subcontractors for solar installation projects to ensure compliance with safety standards. ▪ Assess potential solar installation sites to determine feasibility and design requirements. ▪ Assess system performance or functionality at the system, subsystem, and component levels. ▪ Coordinate or schedule building inspections for solar installation projects. ▪ Monitor work of contractors and subcontractors to ensure projects conform to plans, specifications, schedules, or budgets. ▪ Perform start-up of systems for testing or customer implementation.

- Provide technical assistance to installers, technicians, or other solar professionals in areas such as solar electric systems, solar thermal systems, electrical systems, and mechanical systems.
- Visit customer sites to determine solar system needs, requirements, or specifications.
- Develop and maintain system architecture, including all piping, instrumentation, or process flow diagrams.
- Estimate materials, equipment, and personnel needed for residential or commercial solar installation projects.
- Evaluate subcontractors or subcontractor bids for quality, cost, and reliability.
- Identify means to reduce costs, minimize risks, or increase efficiency of solar installation projects.
- Prepare solar installation project proposals, quotes, budgets, or schedules.
- Purchase or rent equipment for solar energy system installation.

Solar Energy Systems Engineer (O*NET Code 17-2199.11)

Description: Perform site-specific engineering analysis or evaluation of energy efficiency and solar projects involving residential, commercial, or industrial customers. Design solar domestic hot water and space heating systems for new and existing structures, applying knowledge of structural energy requirements, local climates, solar technology, and thermodynamics.

Median National Wages (2009): \$43.06 hourly; \$89,560 annual / **Projected Growth (2008-2018):** 7% to 13%

Classification of Instructional Programs (CIP): Electrical, Electronic and Communications Engineering (14.1001)

Tasks:

- Conduct engineering site audits to collect structural, electrical, and related site information for use in the design of residential or commercial solar power systems.
- Design or coordinate design of photovoltaic (PV) or solar thermal systems, including system components, for residential and commercial buildings.
- Create checklists for review or inspection of completed solar installation projects.
- Create electrical single-line diagrams, panel schedules, or connection diagrams for solar electric systems using computer-aided design (CAD) software.
- Create plans for solar energy system development, monitoring, and evaluation activities.
- Develop design specifications and functional requirements for residential, commercial, or industrial solar energy systems or components.
- Perform computer simulation of solar photovoltaic (PV) generation system performance or energy production to optimize efficiency.
- Provide technical direction or support to installation teams during installation, start-up, testing, system commissioning, or performance monitoring.
- Design or develop vacuum tube collector systems for solar applications.
- Develop standard operation procedures and quality or safety standards for solar installation work.
- Perform thermal, stress, or cost reduction analyses for solar systems.
- Review specifications and recommend engineering or manufacturing changes to achieve solar design objectives.
- Test or evaluate photovoltaic (PV) cells or modules.

Solar Sales Representatives and Assessors (O*NET Code 41-4011.7)

Description: Contact new or existing customers to determine their solar equipment needs, suggest systems of equipment, or estimate costs.

Median National Wages (2009): \$34.30 hourly; \$71,340 annual / **Projected Growth (2008-2018):** 7% to 13%

Classification of Instructional Programs (CIP): Solar Energy Technology/Technician (15.0505); Specialized Merchandising, Sales & Related Marketing Operations (52.1999)

Tasks:

- Generate solar energy customer leads to develop new accounts.
- Prepare proposals, quotes, contracts, or presentations for potential solar customers.
- Select solar energy products, systems, or services for customers based on electrical energy requirements, site conditions, price, or other factors.

- Assess sites to determine suitability for solar equipment, using equipment such as tape measures, compasses, and computer software.
- Calculate potential solar resources or solar array production for a particular site considering issues such as climate, shading, and roof orientation.
- Create customized energy management packages to satisfy customer needs.
- Develop marketing or strategic plans for sales territories.
- Gather information from prospective customers to identify their solar energy needs.
- Prepare or review detailed design drawings, specifications, or lists related to solar installations.
- Provide customers with information such as quotes, orders, sales, shipping, warranties, credit, funding options, incentives, or tax rebates.
- Provide technical information about solar power, solar systems, equipment, and services to potential customers or dealers.
- Take quote requests or orders from dealers or customers.
- Demonstrate use of solar and related equipment to customers or dealers.

B2. Green Enhanced Skills Occupations: Heating, Ventilation and Air Conditioning

O*NET classifies occupations related to heating, ventilation and air conditioning as “enhanced skills” occupations in the green economy. While the essential purposes of the occupations remain the same, the tasks, skills, knowledge and external elements, such as credentials, are changing. For this occupation, demand is expected to increase much faster than average.

Because this grouping of occupations has been included in the O*NET database for many years, an extensive data base of information is available, only some of which is summarized below. Additional categories of information include: Abilities, Work Activities, Work Context, Tools and Technology, Interests, Work Styles, and Work Values.

Heating and Air Conditioning Mechanics and Installers (O*NET Code 49.9021.01)
Description: Install, service and repair heating and air conditioning systems in residences and commercial establishments.
Median National Wages (2009): \$19.76 hourly; \$41,100 annual / Projected Growth (2008-2018): 20+%
Sample of Reported Job Titles: Service Technician, HVAC Specialist (Heating, Ventilation, and Air Conditioning Specialist), HVAC Technician (Heating, Ventilation, and Air Conditioning Technician), Air Conditioning Technician (AC Tech), HVAC Installer (Heating, Ventilation, and Air Conditioning Installer), Mechanic, Service Manager
Related Occupations with O*NET Codes: Electric Motor, Power Tool and Related Repairers (49-2092.00); Motorboat Mechanic (49-3051-.00); Motorcycle Mechanic (49-3052.00); Outdoor Power Equipment and Other Small Engine Mechanic (49-3053.00); Control and Valve Installers and Repairers (49-9012.00); Refrigeration Mechanics and Installers (49-9021.02); Home Appliance Repairers (49-99031.00)
Classification of Instructional Programs (CIP): Heating, Air Conditioning and Refrigeration Technology/ Technician (ACH/ACR/ACHR/HRAC/HVAC/AC Technology (15.0501); Solar Energy Technology/ Technician (15.0505); Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (47.0201)
Related Registered Apprenticeship Partners Information Data System (RAPIDS): Heating-and-Air Conditioning Installer-Servicer (0637); Furnace Installer-and-Repairer, Hot Air (0678); Furnace Installer (0794); Oil-Burner-Services-and-Installer (0966); Air and Hydronic Balancing Technician (0990)
<p>Tasks:</p> <ul style="list-style-type: none"> ▪ Obtain and maintain required certifications. ▪ Comply with all applicable standards, policies, and procedures, including safety procedures and the maintenance of a clean work area. ▪ Repair or replace defective equipment, components, or wiring. ▪ Test electrical circuits and components for continuity, using electrical test equipment. ▪ Reassemble and test equipment following repairs. ▪ Inspect and test system to verify system compliance with plans and specifications and to detect and locate malfunctions. ▪ Discuss heating-cooling system malfunctions with users to isolate problems or to verify that malfunctions have been corrected. ▪ Record and report all faults, deficiencies, and other unusual occurrences, as well as the time and materials expended on work orders. ▪ Test pipe or tubing joints and connections for leaks, using pressure gauge or soap-and-water solution. ▪ Adjust system controls to setting recommended by manufacturer to balance system, using hand tools.
<p>Knowledge Areas:</p> <ul style="list-style-type: none"> ▪ Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance. ▪ Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and

evaluation of customer satisfaction.

- Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services.
- Design — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- English Language — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.
- Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications.
- Sales and Marketing — Knowledge of principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.
- Computers and Electronics — Knowledge of circuit boards, processors, chips, electronic equipment, and computer hardware and software, including applications and programming.
- Education and Training — Knowledge of principles and methods for curriculum and training design, teaching and instruction for individuals and groups, and the measurement of training effects.

Skill Areas:

- Troubleshooting — Determining causes of operating errors and deciding what to do about it.
- Repairing — Repairing machines or systems using the needed tools.
- Active Listening — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- Equipment Maintenance — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
- Critical Thinking — Using logic and reasoning to identify the strengths and weaknesses of alternative solutions, conclusions or approaches to problems.
- Installation — Installing equipment, machines, wiring, or programs to meet specifications.
- Social Perceptiveness — Being aware of others' reactions and understanding why they react as they do.
- Active Learning — Understanding the implications of new information for both current and future problem-solving and decision-making.
- Coordination — Adjusting actions in relation to others' actions.
- Reading Comprehension — Understanding written sentences and paragraphs in work related documents.

B3. Green Increased Demand Occupations: Refrigeration Mechanics and Installers

O*NET classifies refrigeration-related occupations as “increased demand” occupations in the green economy. While the impact does not entail significant changes in the work or worker requirements of the occupation, demand is likely to increase and the work context may change.

Refrigeration Mechanics and Installers (O*NET Code 49.9021.02)
Description: Install and repair industrial and commercial refrigeration systems.
Median National Wages (2009): \$19.76 hourly; \$41,100 annual / Projected Growth (2008-2018): 20+%
Sample of Reported Job Titles: Refrigeration Mechanic, Service Technician, Refrigeration Technician, HVAC/R Service Technician (Heating, Ventilation, and Air Conditioning/Refrigeration Service Technician), Refrigeration Operator, Commercial Service Technician, Field Service Technician, VRT Mechanic (Variable Retention Time Mechanic)
Related Occupations with O*NET Codes: Electric Motor, Power Tool and Related Repairers (49-2092.00); Motorboat Mechanic (49-3051.00); Motorcycle Mechanics (49-3052.00); Outdoor Power Equipment and Other Small Engine Mechanics (49-3053.00); Heating and Air Conditioning Mechanics and Installers (49-9021.01); Home Appliance Repairers (49-9031.00)
Classification of Instructional Programs (CIP): Heating, Air Conditioning and Refrigeration Technology/Technician (ACH/ACR/ACHR/HRAC/HVAC/AC Technology (15.0501); Solar Energy Technology/Technician (15.0505); Heating, Air Conditioning, Ventilation and Refrigeration Maintenance Technology/Technician (47.0201)
<p>Tasks:</p> <ul style="list-style-type: none"> ▪ Braze or solder parts to repair defective joints and leaks. ▪ Observe and test system operation, using gauges and instruments. ▪ Test lines, components, and connections for leaks. ▪ Dismantle malfunctioning systems and test components, using electrical, mechanical, and pneumatic testing equipment. ▪ Adjust or replace worn or defective mechanisms and parts, and reassemble repaired systems. ▪ Read blueprints to determine location, size, capacity, and type of components needed to build refrigeration system. ▪ Supervise and instruct assistants. ▪ Install wiring to connect components to an electric power source. ▪ Perform mechanical overhauls and refrigerant reclaiming. ▪ Cut, bend, thread, and connect pipe to functional components and water, power, or refrigeration system.
<p>Knowledge Areas:</p> <ul style="list-style-type: none"> ▪ Mechanical — Knowledge of machines and tools, including their designs, uses, repair, and maintenance. ▪ Customer and Personal Service — Knowledge of principles and processes for providing customer and personal services. This includes customer needs assessment, meeting quality standards for services, and evaluation of customer satisfaction. ▪ Engineering and Technology — Knowledge of the practical application of engineering science and technology. This includes applying principles, techniques, procedures, and equipment to the design and production of various goods and services. ▪ Mathematics — Knowledge of arithmetic, algebra, geometry, calculus, statistics, and their applications. ▪ Public Safety and Security — Knowledge of relevant equipment, policies, procedures, and strategies to promote effective local, state, or national security operations for the protection of people, data, property, and institutions. ▪ Building and Construction — Knowledge of materials, methods, and the tools involved in the construction or repair of houses, buildings, or other structures such as highways and roads.

- **Design** — Knowledge of design techniques, tools, and principles involved in production of precision technical plans, blueprints, drawings, and models.
- **English Language** — Knowledge of the structure and content of the English language including the meaning and spelling of words, rules of composition, and grammar.
- **Sales and Marketing** — Knowledge of principles and methods for showing, promoting, and selling products or services. This includes marketing strategy and tactics, product demonstration, sales techniques, and sales control systems.
- **Administration and Management** — Knowledge of business and management principles involved in strategic planning, resource allocation, human resources modeling, leadership technique, production methods, and coordination of people and resources.

Skills Areas:

- **Troubleshooting** — Determining causes of operating errors and deciding what to do about it.
- **Installation** — Installing equipment, machines, wiring, or programs to meet specifications.
- **Operation Monitoring** — Watching gauges, dials, or other indicators to make sure a machine is working properly.
- **Reading Comprehension** — Understanding written sentences and paragraphs in work related documents.
- **Active Listening** — Giving full attention to what other people are saying, taking time to understand the points being made, asking questions as appropriate, and not interrupting at inappropriate times.
- **Repairing** — Repairing machines or systems using the needed tools.
- **Active Learning** — Understanding the implications of new information for both current and future problem-solving and decision-making.
- **Equipment Maintenance** — Performing routine maintenance on equipment and determining when and what kind of maintenance is needed.
- **Equipment Selection** — Determining the kind of tools and equipment needed to do a job.
- **Learning Strategies** — Selecting and using training/instructional methods and procedures appropriate for the situation when learning or teaching new things.

C. Department of Labor Competency Models (www.careeronestop.org/competencymodel)

Sponsored by the U.S. Department of Labor (DOL), industry competency models promote an understanding of the skill sets and competencies that are essential to educate and train a globally competitive workforce. Over the past seven years, DOL has developed competency models in sixteen high-growth industries and areas of emerging technology. Incorporation of the DOL Competency model as well as O*NET are required components from the Dept. of Labor for this project.

A **competency** is the capability to apply or use a set of related knowledge, skills, and abilities required to successfully perform "critical work functions" or tasks in a defined work setting. Competencies often serve as the basis for skill standards that specify the level of knowledge, skills, and abilities required for success in the workplace as well as potential measurement criteria for assessing competency attainment.

A **competency model** is a collection of competencies that together define successful performance in a particular work setting. Competency models are the foundation for important human resource functions such as recruitment and hiring, training and development, and performance management because they specify what is essential to select for or to train and develop. Competency models can be developed for specific jobs, job groups, organizations, occupations or industries.

The Employment and Training Administration within DOL works with business leaders, educators and labor to create comprehensive and easily accessible competency models that document the foundational and technical skills and competencies required for workplace success. The models provide a resource for the development of competency-based curricula and training models; industry-defined performance indicators, skill standards, and certifications; tests that assess work-related competencies and resources for career exploration and guidance.

The **generic visual model and tiers/building blocks** that comprise it are shown on the next page, followed by a set of questions about the model that are relevant to the development of green career pathways. Appendix A includes a complete listing of all the competencies and a definition of all terms used in the development of the model.

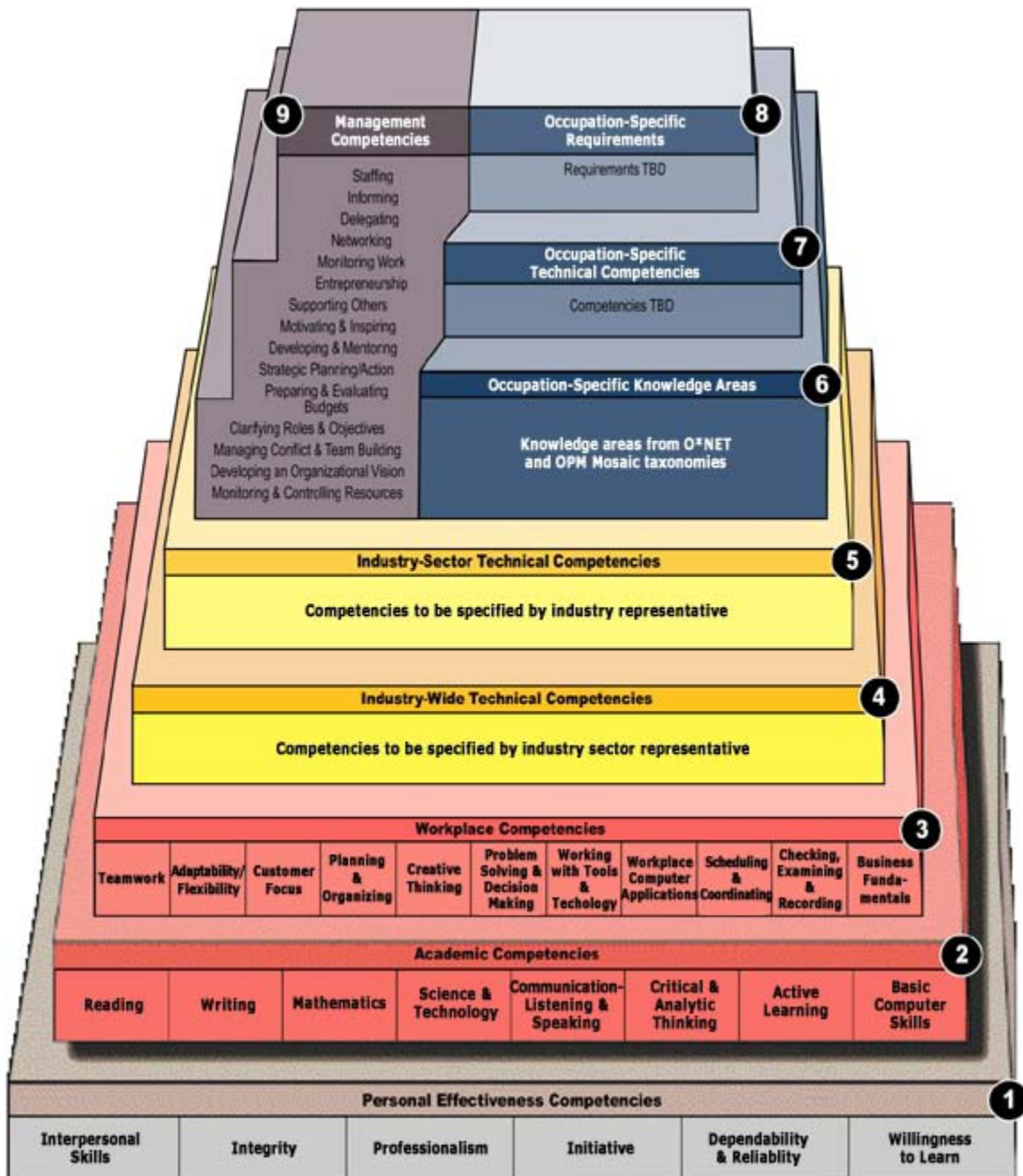
Four competency models are relevant to the development of the Oregon Green Career Pathways Statewide Roadmaps Project, particularly to the development of the prototype pathways in solar and HVAC/R. Those models, each of which is discussed in more depth in this report, include:

- Advanced Manufacturing (www.careeronestop.org/competencymodel/pyramid.aspx?hg=Y)
- Mechatronics (www.careeronestop.org/competencymodel/pyramid.aspx?ME=Y)
- Automation (www.careeronestop.org/competencymodel/pyramid.aspx?AT=Y)
- Energy (www.careeronestop.org/competencymodel/pyramid.aspx?NRG=Y)

In addition to the competency listings, each competency model also includes direct links to **relevant resources** in that industry, including skill standards, curriculum, model programs, etc.

Generic Competency Model

(See Attachment A for Outlines of Foundational Competencies)



Key Questions and Answers Regarding Competency Models (www.careeronestop.org/competencymodel/faq.aspx#q21)

Why is the Building Blocks Model portrayed as a pyramid? To help users quickly grasp the key features of the competencies required, the Building Blocks model is portrayed in a graphic format. The pyramidal shape conveys the increasing level of specificity and specialization of the content on the upper tiers of the graphic. Tiers 1 through 3, called Foundation Competencies, form the foundation needed to be ready to enter the workplace. Tiers 4 and 5, called Industry Competencies, show competencies that are specific to the industry or industry sector. The top tiers represent specialization or the knowledge and technical competencies within specific occupations within an industry.

Why did DOL/ETA create competency models rather than skill standards? As the Federal partner in the Workforce Investment System, ETA's role is not to set or enforce workplace standards. Standard-setting is more appropriately a function of business and industry; thereby ensuring that a standard can be tailored to an industry, region or individual employer's need. ETA's role is that of information broker - providing information, tools and resources about competency models and how they serve as a resource for talent development in a demand-driven system.

What is the difference between a competency and a skill standard? A competency is the capacity to draw upon and apply a set of related knowledge, skills, and abilities to successfully perform a work role, function, or task. Competencies often serve as the basis for skill standards that specify the level of knowledge, skills, and abilities required for success in the workplace. Skill standards in turn form the basis for measurement criteria to assess competency attainment. A competency model differs from a set of skill standards in that skill standards define levels of skills (or competencies) required in a given job or role, while competency models typically do not.

Why doesn't the model specify 'levels' or 'degrees' of competencies? The competency model framework identifies competencies, or the knowledge, skills and abilities needed for success. When curricula or standards are developed around the competencies identified for an industry or occupation, the level or degree of competence must be considered by the developer. For example, plane geometry is an example of a competency needed for carpenters, drafters, and architects, but the level of competence varies with occupation. The industry competency models do not include performance indicators or measurement criteria for each competency content area. Performance indicators of competence must be developed by industry.

How do the competency models relate to career clusters? As organized by the U.S. Department of Education, Career Cluster are grouping of occupations and broad industries based on commonalities, which are then further sub-divided into between two and eight Career Pathways. The Career Clusters and the Industry Competency Models both identify foundational and technical competencies, but their efforts are not duplicative. The Career Clusters have a greater emphasis on elements needed for curriculum performance objectives, measurement criteria, scope and sequence of courses in a program of study, and the development of assessments. The Industry Competency Models focus more on competencies needed for performance of the work in the workplace and do not go into the same level of detail. As such, they are designed to be used together. See www.careerclusters.org for more information.

How can the competency models be used to develop to career paths?

A career path may take many forms: career and technical education in a traditional or alternative high school, Job Corps training, apprenticeship training, military training and experience are some of the more common paths. The competencies articulated in the industry models provide the core foundation and technical competencies that must be addressed regardless of the source of the education or training. The model is not just for entry-level workers, but should be used in a continuum of training so that workers have the foundation competencies to advance in their careers.

How do education and training providers use competency models? Competency Models enable educators and training providers to:

- Work with business and industry to identify skill requirements to ensure that the curriculum and/or technical training programs are responsive to these requirements
- Design and develop course and program curriculum based on skills required by business and industry
- Determine which competencies are in highest demand and help students plan their courses accordingly
- Promote articulation between secondary and postsecondary education offerings.

The Advanced Manufacturing Competency Model was the first to be developed, over five years ago, in partnership with the National Association of Manufacturers/Manufacturing Institute (NAM/MI), the National Council for Advanced Manufacturing (NACFAM) and the Society of Manufacturing Engineers (SME). To ensure that the model reflects the knowledge and skills needed by today's manufacturing workforce ETA worked with its industry partners to update the original model. Completed in April 2010, the updated model contains new information on Sustainable and Green Manufacturing, as summarized below as well as updated key behaviors in several competency areas.

Sustainability Practices (part of Workplace Competencies)

- Meeting the needs of the present without compromising the ability of future generations to meet their own needs.
- Abide by applicable federal, state, and local regulations and policies.
- Safeguard the public interest.
- Ensure equipment and systems are designed to minimize environmental impact.
- Seek to upgrade processes beyond pollution control to pollution prevention.
- Utilize advances in science and technology to upgrade levels of efficiency and environmental protection.
- Promote sustainable business practices consistent with ISO 14001 International Environmental Management Guidance.

Sustainable & Green Manufacturing (part of Cross-Cutting Technical Competencies)

Manufacture products using processes that minimize negative environmental impacts; conserve energy and natural resources; are safe for employees, communities, and consumers; and are economically sound.

Entry-Level Critical Work Functions

- Strive to minimize waste, improve efficiency, and reduce resource use.
- Operate with a triple bottom line, emphasizing financial profitability, environmental integrity, and social equity.
- Understand life cycle analysis: the environmental and economic effects of a product at every stage of its existence, from extraction of materials through production to disposal and beyond.

Entry-Level Technical Content Areas

- **Waste Awareness and Reduction:** Fundamentals of solid waste streams and their sources and focusing on the 4Rs - Refuse, Reduce, Reuse, Recycle.
- **Sustainability into Practice:** Developing the business case for implementing a comprehensive environmental management or sustainability program.
- **Energy Management:** Managing energy usage and investing in energy efficiency to cut energy costs and reduce carbon footprint.
- **Water Conservation:** Applying lower-cost and conservation principles/practices in operation and design of water systems.
- **Pollution Solutions:** Improving emission control and environmental management systems, and new technologies to reduce air pollution.
- **Green Chemistry:** Applying green chemistry principles and techniques throughout the business.

C2. Mechatronics Competency Model

(www.careeronestop.org/competencymodel/pyramid.aspx?ME=Y)

Mechatronics is the synergistic application of mechanical engineering, electrical engineering, controls engineering, and computer science to make useful products. It emphasizes troubleshooting of automated machinery with a systems point of view. It is included in this research because of the increasing complexity of the technology driving heating, air conditioning, and refrigeration systems, and the need to utilize a systems approach in the green industrial economy.

Over the last five years, the Berks and Lancaster County Workforce Investment Boards have been working with Reading Area Community College and other community and technical colleges around the country to define the skill standards, the curriculum, and career paths that lead to a mechatronics engineering technologist. In collaboration with the Employment and Training Administration (ETA) the results of those efforts were formatted into a competency model for the Mechatronics Industry. The validation of the work of this partnership and the model through the sponsorship of the Packaging Machinery Manufacturers Institute (PMMI) connects this field with the packaging industry, a multi-billion dollar industry worldwide needing workers with a sophisticated skill set. PMMI has committed to working with partners to keep the model up-to-date.

Mechatronics

Systems, processes, and standards supporting the application of integrated manufacturing systems.

Critical Work Functions

- Understand the necessary steps to plan, execute, and control a mechatronic system.
- Program, calibrate, configure, test, start-up, and operate a mechatronic system.
- Understand mechatronics as the integration of multiple disciplines in industrial processes.
- Identify major application areas for mechatronics.
- Apply mechatronics in various manufacturing, scientific, and technical applications.
- Abide by mechatronics industry codes, standards, and regulations.
- Research and apply emerging and future mechatronics technologies.

Technical Content Areas

- Project planning, execution, and control for a Mechatronic System
- Establish project objectives
- Show linkage between project, technical, and business objectives
- Develop a work plan, schedule, and budget
- Implement a work plan through teamwork and shared responsibility
- Demonstrate knowledge of each of the four areas of mechatronics
- Integrate the four areas of mechatronics to design a system
- Use oral, written and computer communication skills to communicate and document plans, actions, and results
- Design, construct, program, calibrate, configure, test, startup, operate, troubleshoot, and repair a mechatronic system
- Create documentation for a mechatronic system including maintenance procedures
- Complete a project audit to determine best practices and areas for improvement

Four Areas of Mechatronics

- Mechanical Engineering
- Electrical and Electronic Engineering
- Systems and Process Control Engineering
- Computer Science

C3. Automation Competency Model

(www.careeronestop.org/competencymodel/pyramid.aspx?AT=Y)

In collaboration with the Automation Federation the Employment and Training Administration (ETA) has worked with industry leaders to develop a comprehensive competency model for careers in automation. Development of the technical competencies relied heavily on *A Guide to the Automation Body of Knowledge*, 2nd Edition, Vernon L. Trevathan, Editor. The model is designed to evolve along with changing skill requirements. The Automation Federation has committed to working with its industry partners to keep the model current.

Included below are sections of the critical work functions associated with Maintenance, Installation and Repair, as well as

Maintenance, Installation, & Repair: Maintain and optimize technology in support of process or manufacturing equipment and systems.

Critical Work Functions

- Support the installation, customization, or upgrading of equipment.
- Coordinate preventive maintenance to ensure production or industrial process runs smoothly.
- Identify, diagnose, and/or repair equipment problems.
- Communicate with others to ensure maintenance and repairs meet operational needs.
- Maintain hands-on knowledge of equipment operations.
- Maintain equipment, tools, and workstations.

Technical Content Areas

- **General Skills:** Basic Disassembly/Assembly Skills, Installation and Calibration of Instrumentation, Equipment troubleshooting, Installation of Parts for Industrial Equipment, Schematic Drawings and Control Documents, and Use of Hand Tools
- **Maintenance, Installation, and Repair Skills** (including but not limited to a basic knowledge of): Electrical/Electronic Systems, Hydraulic/Pneumatic Systems, Mechanical Power Transmission Systems, Mechanical Systems, and Piping Operations
- **Reliability and Maintainability:** Analysis of Failure Data, Basic Reliability Models, Documentation Requirements, and Investigative Techniques

Automation Fundamentals: Systems, processes, applications and standards supporting the design and application of automation.

Critical Work Functions

- Understand the role of automation and control in industrial processes.
- Identify major application areas for automation technology and calculate the potential financial benefits of that automation.
- Integrate automation in various manufacturing, scientific, and technical applications.
- Abide by automation industry codes, standards, and regulations.
- Research and apply emerging and future automation technologies.

C4. Energy Competency Model

(www.careeronestop.org/competencymodel/pyramid.aspx?NRG=Y)

The competency model for energy focuses on the Generation, Transmission and Distribution sector of the Energy Industry. The Center for Energy Workforce Development (CEWD), a non-profit consortium of electric natural gas and nuclear utilities and their associations, played a major role in its development. CEWD is the first partnership between utilities, their associations, contractors and unions to focus on the need to build a skilled workforce pipeline that will meet future industry needs.

CEWD is teaming with secondary and post secondary educational institutions and the workforce system to create workable solutions to address the need for a qualified, diverse workforce. CEWD has established a partnership with the Association for Career and Technical Education, American Association of Community Colleges, National Association of Workforce Boards, Energy Providers Coalition for Education and the International Brotherhood of Electrical Workers. See www.cewd.org for general information on their mission and national activities.

CEWD has also developed two documents of interest:

- **Greening of the Industry: Energy Efficiency, Generation, Transmission and Distribution.** This two page document summarizes the implications of “green” to the energy industry and job content. See: <http://www.cewd.org/greendocs/greenjobsdefinition.pdf>
- **Get into Energy Career Pathways for Skilled Utility Technicians.** This document outlines the CEWD “Get into Energy” Career Pathways Model, based on part on the DOL Energy Competency Model. Its three components include a targeted awareness campaign, developing a system of career pathways and stackable credentials in partnership with education and training providers, and employer partnerships. See: <http://www.cewd.org/documents/pathwayswhitepaper.pdf>

Industry Principles and Concepts: Knowledge of the basic and emerging principles and concepts that impact the energy industry, including: energy production, energy transmission and alternative energy technologies.

- Is able to explain the flow of energy from generation through distribution to the customer
- Is able to explain the role of regulators and unions in the industry
- Demonstrates an awareness of alternative and renewable energy technologies, including geothermal energy, solar energy, wind energy, water energy and biofuel

Troubleshooting: Diagnoses and corrects abnormalities and malfunctions in equipment and production processes.

- Monitors equipment to ensure maintenance schedules are adhered to
- Demonstrates knowledge of normal equipment operation (how the individual pieces of equipment relate to each other) in order to spot potential equipment problems before they occur
- Determines causes of operating errors, decides what to do about them and knows when to notify more senior personnel








D.DOL National Office of Job Corps “Greening” of the Curriculum

Through an investment of the American Recovery and Reinvestment Act (ARRA), Job Corps launched an initiative to “green” current programs offered in construction, automotive and manufacturing, as well as to develop new programs in weatherization, solar panel installation, overhead and underground transmission line and smart grid technology. Greening of the existing curriculum had four elements, including:

- Addition of sustainability principles to the curriculum by adoption of the National Center for Construction Education and Research (NCCER) *Your Role in the Green Environment* (www.nccer.org/green.aspx) curriculum for all center-operated construction and manufacturing programs.
- Facilitated meetings of instructors representing all union-based and center-operated construction, automotive and manufacturing programs, along with employers and certification sponsors to work collaboratively on “greening” the curriculum.
- Determine of which **current competencies** in the curriculum needed to be **modified** and which **new competencies** needed to be **added** to reflect the requirements of the green economy.
- Staff training: (1) for additional instructor certification as required, such as for hybrid vehicles in the automotive area; (2) placement personnel who would be marketing new “green” graduates.

A special icon was developed and incorporated into the Training Achievement Records (curriculum outlines) for all programs that were “greened” so students could quickly discern that learning tasks that had green implications, as illustrated in the example below.

Examples of Competencies Enhanced or Added to Welding Program to “Green” Curriculum

1. Explain how the use of safe welding practices in accordance with OSHA and EPA guidelines are designed to protect the environment and workers. 
2. Demonstrate how to handle and store hazardous materials as assigned while adhering to safe practices in accordance with OSHA and EPA requirements and guidelines. 
3. Describe clean-up and proper disposal procedures for spills of various substances and locate spill kits. 
4. Explain how the impact of spills of hazardous materials can negatively impact the environment if not properly contained. 
5. Identify and list hazardous materials used in welding to ensure that they are stored and labeled appropriately. 
6. Explain how proper techniques for removing hazardous materials are designed to protect the environment. 
7. Identify OSHA requirements for preventing or minimizing a catastrophic release of toxic, reactive, flammable, or explosive materials. 

E. The Greening of Registered Apprenticeship. U.S. Department of Labor Office of Registered Apprenticeship. [http://www.doleta.gov/oa/pdf/Greening Apprenticeship.pdf](http://www.doleta.gov/oa/pdf/Greening_Apprenticeship.pdf)

This report, *The Greening of Registered Apprenticeship*, is an environmental scan of the impact of recent policies and investments supporting “green jobs” on current and potential Registered Apprenticeship and other labor management training programs. The scan highlights the trends, activities, and changes that are underway in several key industries that will likely make up a significant portion of the emerging green economy.

This report does not define specific green jobs, but generally sees green jobs as both existing and emerging occupations across a wide range of industries engaged in working with these new green processes, materials, or technologies. Construction, transportation, advanced manufacturing, utilities, and building maintenance are critical industries at the forefront of our nation’s push to be more energy efficient, less dependent on oil and more environmentally and ecologically sound. Each of these industries depends on its Registered Apprenticeship and rigorous training programs to prepare and educate existing and emerging workers in a variety of occupations.

To better understand the impact of green and implications for policy development, the U.S. Department of Labor (DOL), Employment and Training Administration’s (ETA) Office of Apprenticeship (OA) met, during March and April of 2009, with 14 stakeholders representing these critical industries. All stressed that green is not a new approach and that Registered Apprenticeship is positioned to help lead the training of our nation’s green-collar workforce.

**The Greening of Register Apprenticeship
Conclusions Based on Stakeholder Group Process**

- Policies and investments in green jobs should lead to long-term, sustainable careers with an emphasis on building America’s middle class.
- Due to its unique training approach and usage as the primary entry point into key occupations, Registered Apprenticeship is positioned to be at the nexus of the green economy.
- In order to continue to meet rapidly changing market demands and to appeal to the next generation of skilled workers, Registered Apprenticeship stakeholders are taking advantage of newer, more flexible training approaches for both green jobs and current occupations.
- Pre-apprenticeship programs and identifying occupational career ladders can provide pathways out of poverty and further engage traditionally hard to reach populations in the green-collar economy.
- New and innovative partnership models have occurred in order to embrace the changing needs of our global and green economy.
- Great opportunities exist for widespread, systemic partnerships between Registered Apprenticeship and the education and public workforce system.

IV. ADDITIONAL “GREEN” REPORTS AND STUDIES

A. **Building Effective Green Energy Programs in Community Colleges. Workforce Strategy Center. 2010**

www.workforcestrategy.org/images/pdfs/publications/green_energy_programs_2010-05.pdf

In this paper, the Workforce Strategy Center (WSC) examines how community colleges leading the field in green energy education are grappling with a variety of challenges as they work to establish leading edge programs. The paper identifies best practices that address: (1) responding to industry demand; (2) developing career pathways to facilitate career advancement (Columbia Gorge is featured!); (3) developing curricula that includes hands-on learning experiences (Lane Community College is featured!); and (4) offering courses and programs that meet industry standards. The aim of the paper is to help colleges across the country navigate a path forward through evolving terrain as they develop green energy education and training programs, particularly for low-income populations.

B. **Green Jobs Guidebook California. Environmental Defense Fund and the Ella Baker Center for Human Rights. 2008**

www.edf.org/cagreenjobs

The Green Jobs Guidebook is a resource for various stakeholders, including program designers, about the tremendous potential of the existing and growing green job marketplace. Although the data is specific to California, the document includes a wealth of information that is more widely applicable, including job descriptions, salary information, minimum education requirements, potential certifications, employer types, and much more. The document profiles over 200 green jobs, and includes a user-friendly career and education pathways map/visual to guide job seekers and current employees looking to advance and/or join in the green economy.

C. **Greener Skills: How Credentials Create Value in the Clean Energy Economy. The Center on Wisconsin’s Economy (COWS) 2010**

http://www.cows.org/pdf/rp-greener_skills.pdf

This report assesses the state of green training and makes the case that responding to the requirements of the emerging green economy may provide an opportunity to “transform the current “fractured” education. The paper maintains that a far greater investment is needed in workforce development and skills - particularly those at the lower end of the labor market- need to be delivered in different ways. Priorities for change include: (1) need to create a navigable system of career pathways with more on and off ramps; (2) curricular modularization and alignment with industry credentials; and (3) integration of social service supports necessary for advancement. The report offers policy suggestions for federal, state and system stakeholders and provides models and lists of existing credentials related to “green” industries.

D. Mapping Green Career Pathways: Job Training Infrastructure and Opportunities in Wisconsin, January 2010. Center on Wisconsin Strategy (COWS) and the Apollo Alliance.
www.cows.org/pdf/rp-mappingreportWI.pdf

This paper identifies training opportunities in Wisconsin that prepare workers for green-collar jobs in the construction and manufacturing sectors, a source of “middle-skill” jobs that require more than a high-school degree but less than a four-year college education and a projected source of 55% of the projected new jobs in the renewable energy and efficiency industries nationally. It highlights existing programs that are beginning to tie together the various elements of a workforce strategy, and provides policy recommendations on how to begin the challenging, but critical, work of building and strengthening green career pathways. The appendix offers a detailed description of the research conducted and the conclusions that emerged during the process, as well as specific information about technical colleges and apprenticeship programs that are, or could be, integrated into green career pathways in Wisconsin.

E. Mapping Green Career Pathways: Job Training Infrastructure and Opportunities in Ohio, January 2010. Policy Matters Ohio and the Apollo Alliance.
www.policymattersohio.org/GreenCareers2010.htm

This paper is similar to the Wisconsin paper referenced above, but appendixes reference specific information about technical colleges and apprenticeship programs that are, or could be, integrated into green career pathways in Ohio.

F. Mapping Green Career Pathways: Job Training Infrastructure and Opportunities in Michigan, January 2010. Center for a Skilled Workforce and the Apollo Alliance.
<http://apolloalliance.org/wp-content/uploads/2010/01/mappingreportmichiganjan27.pdf>

This paper is similar to the state-related papers referenced above, but appendixes reference specific information about technical colleges and apprenticeship programs that are, or could be, integrated into green career pathways in Michigan.

G. Pathway to Clean Jobs and Prosperity: Working Poor Families Project. 2010.
http://www.workingpoorfamilies.org/pdfs/WPFP_policybrief_spring2010.pdf

The “clean energy” economy has the potential to bring renewed prosperity to working families and create high quality, middle-skill jobs within the construction and manufacturing industries. Targeted state government policies can increase opportunities for skill development, raise wages and ensure employer commitment to hiring low-income, disadvantaged workers. This policy brief describes state level efforts for advancing public policies that expand access to clean energy jobs for workers who are typically underrepresented in the trades. It describes the efforts of several leading edge states and makes recommendations for tailoring skills development programs and investments to low-skilled, low-income adults, increasing employer commitment for hiring low-income and disadvantaged workers, and improving the quality of clean energy jobs.

H. Roadmap for Advancing the Green Economy in Rhode Island. Rhode Island Economic Development Council and New Commons Think Tanks. February 2010

<http://publications.riedc.com/qgcju.pdf>

This Roadmap for advancing the green economy in Rhode Island focuses on four targeted initiatives: advanced manufacturing, energy efficiency, innovation and wind power. The document identifies three key meta projects that will serve as roadmap outcomes: (1) develop a comprehensive state energy strategy; (2) organize access to capital for green companies; and (3) create life-long learners on green career pathways. Major initiatives related to pathways development will be the analysis of skill demand, the creation of a training collaborative, a green workforce research and innovation lab, and the development of green internships. Additionally, an education and training component which outlines identified needs and proposed solutions is imbedded in each section.

V. CURRICULUM RESOURCES

A. Greening the Curriculum at Anne Arundel Community College, Maryland

www.league.org/league/projects/sustainability/files/greening.pdf

This power point presentation describes efforts underway at Anne Arundel Community College in Annapolis, Maryland, to green their curriculum. It walks through the specific steps the college took relative to a pilot in Architectural Design, looking at key courses to infuse sustainability concepts. Another approach with Mechanical and Electrical Systems resulted in a course redesign that included changing the name, the curriculum and alignment with industry-certification. The old course outline covered: plumbing, fire suppression, electricity, lighting and HVAC. The new course includes: sustainable sites, water efficiency, indoor environmental quality, etc.

B. The Green Curriculum, California Community College Chief Instructional Officers

<http://www.ccccio.org/documents/CCLCGreenCurriculum.ppt>

This power point presents the findings of a survey conducted by the California community colleges to determine the current status regarding efforts to “green” the college curriculum. The survey addresses faculty engagement, sustainability courses, “green” across the curriculum, corporate partnerships, etc. While it doesn’t present curriculum per se, it provides an excellent set of questions to consider in evaluating the “readiness” of a group of community colleges to support green education and training efforts.

C. Purdue Technical Assistance Program (TAP) Green Enterprise Development

www.tap.purdue.edu/green and http://www.mep.purdue.edu/prod_services/green/brochures.aspx

This program and curriculum was developed by Purdue's Technical Assistance Program in 2009 for manufacturers and others interested in learning how to apply sustainable, environmentally friendly practices in the workplace. The purpose of this 3-level program was to develop a workforce training and accreditation program in the field of sustainability. It includes lecture, hands-on activities, simulations, and case studies that teach how the implementation of environmental sustainable projects lead to increased efficiency and cost reduction. Level 1: Green Generalist (8 hours); Level 2: Green Specialist (up to 48 hours); Level 3 Society for Manufacturing Engineers (SME) Green Manufacturing Specialist Certificate.

D. Society of Manufacturing Engineers (SME) Green Certificate Body of Knowledge

<http://www.sme.org/downloads/cert/greenBOK.pdf>

Developed by the Society of Manufacturing Engineers, the Green Certificate Body of Knowledge (BOK) forms the basis for SME Green Manufacturing Specialist Certificate (see reference above). SME offers a three-day Green Specialist Certificate Preparation Workshop. The BOK was developed by SME through a survey of industry sustainability experts and covers the following topics: (1) Sustainability; (2) Material and Solid Waste Management; (3) Energy Management; (4) Chemical Waste Management; (5) Climate/Air Emissions Management; (6) Supply Water/Wastewater Management; and (7) Environmental Business Management.

VI. BEST PRACTICE PROGRAMS

A. Model Green Programs: Community Colleges . California EDGE Campaign.

<http://californiaedgecampaign.org/download/CollinsPres.pdf>

This power point presentation was prepared for a briefing to a California Legislative Committee by the California EDGE (Education, Diversity, and Growth in the Economy) Program staff. EDGE is a non-partisan coalition of California community colleges, workforce boards, unions, employers and community-based organizations that have come together to urge that workforce development become a priority on the state's public policy agenda. Three of their broad pillars are: (1) Provide all Californians access to high-quality post-secondary education and skills training; (2) Provide working adults with opportunities to move up the skill ladder; and (3) Link workforce programs and institutions to create pathways to high wage jobs. Their career ladders project is designed to foster educational and career advancement through research, policy initiative and direct assistance to community colleges. The power point describes the Career Advancement Academies (CAAs) at community colleges, many of which focus on green initiatives.

B. Laney Community College: Environmental Control Tech/ Green Energy Building Program (with support services for low-skilled students)

<http://eetdnews.lbl.gov/nl20/eetd-nl20-2-college.html>

Laney Community College is located in Oakland, California, in a high-poverty area. The college has had a long-standing and high-performing HVAC technician program that has evolved to emphasize energy efficiency. The college partnered with the Lawrence Berkeley National Lab and the UC Davis Western Cooling Efficiency Center to develop a program that emphasizes energy efficient and high-performance building operations. The college offers a new certificate and AS degree in controls, building automation systems and energy management. They also won an National Science Foundation grant to expand its commercial HVAC program and deepen its curriculum to focus on best energy management practices in system design, installation, repair, operations and maintenance.

C. City University of New York (CUNY): Career Pathways in Green Building Operations

www.cuny.edu/academics/conted/green/training-programs.html and

www.workforcestrategy.org/images/pdfs/publications/green_energy_programs_2010-05.pdf p.19

The largest urban public university in the nation – including six community colleges - CUNY has made a strategic decision to systematically increase its renewable energy and energy efficiency programs and career pathways. In response to legislation to reduce greenhouse gas emissions in government, commercial and residential buildings, which will require that every large building have an energy audit by 2013, major training efforts are underway to build the skilled workforce needed. CUNY sees building operations as one of the green industry areas where entry-level positions are possible. As part of this pathway, and to accommodate the basic skill needs of disadvantaged workers, City Tech is developing a Green Maintenance for Building Programs pathway that offers contextualized GED and math courses, career counseling and green

terminology. At the higher levels, the pathway includes five certificate programs and four AAS degree areas, plus articulation with undergraduate and degree programs at other CUNY colleges.

D. Arapahoe Community College: Solar Energy Training Pathways

www.arapahoe.edu/departments-and-programs/a-z-offerings/energy-technology

Arapahoe offers a pathway of solar related certifications and degree programs designed to prepare individuals for a range of jobs in the growing field of solar technology, plus skill development opportunities for electricians, plumbers, and contractors. Programs include: Solar Photovoltaic Systems Technician Certificate, Active Solar Thermal System Technician Certificate, Residential Energy Analyst Certificate, Smart Home Technician Certificate, and LEED exam preparation. Targeted occupations include solar energy system integrators, packagers, installers, and solar equipment manufacturing.

E. Wisconsin Regional Training Partnership: Entry-Level Construction Certificate in Weatherization www.wrtp.org

The Wisconsin Regional Training Partnership (WRTP/Building Industry Group Skilled Trades Employment Partnership (BIG STEP) is one of the nation’s preeminent labor-led sector partnerships. Working with unions, businesses, community groups and the public workforce system, WRTP/BIG STEP has helped thousands of Milwaukee-area workers – often low-income or unemployed women and people of color – grow their skills and find good jobs while also helping dozens of local employers connect to the skills and workers they need.

WRTP/BIG STEP’s Center of Excellence offers workers a wide range of support during their preparation for construction and manufacturing careers, including academic assessments and individualized tutoring for apprenticeship exams; pre-employment skills training and certification; and connections to community organizations that can assist with daycare, transportation, GED preparation, job readiness and other services.

In addition to helping candidates move up the pipeline into its apprenticeship-prep program, WRTP/BIG STEP helps participants find jobs – and succeed in them. The Center of Excellence maintains a database of apprenticeship-ready workers, and can certify them for construction projects with residential hiring requirements. Once WRTP/BIG STEP participants are placed, the Center of Excellence continues to provide individualized support and evaluation to help apprentices advance in their careers. See Career Pathways visual in Greener Skills, page 25.

<http://www.cows.org/pdf/rp-greenerkills.pdf>

F. Lansing Community College, Alternative Energy Education www.lcc.edu/energy

Lansing Community College was one of the first colleges in the nation to incorporate alternative energy into its curricula and to offer Associate Degrees in Alternative Energy Technology. With support from a \$1M grant from the Department of Energy, LCC instructors were tapped to create alternative energy curricula for colleges and universities across the country. LCC's automotive technology students work on hybrid vehicles and have built an internal combustion engine powered by a fuel cell. LCC's Heating, Ventilation, and Air Conditioning (HVAC), Electrical,

and Building Construction students learn energy management and alternative methods for heating and cooling buildings and residences. Alternative energy students also study wind, solar, geothermal, and bio-mass/gas energy production systems to develop an understanding of the challenges and opportunities in developing a renewable energy economy.

The college offers three AAS degrees in Alternative Energy Technology, Energy Management Technology, and Customer Energy Specialist, as well as six certificate level programs. In addition, the Technology Careers Division is committed to infusing green and sustainable concepts across the curriculum.