Washington State University - Zero Energy House, Shoreline Community College Campus

Shoreline
COMMUNITY COLLEGE

www.shoreline.edu

RENEWABLE ENERGY PROGRAM DEVELOPMENT STUDY AND DACUM REPORT

RENEWABLE ENERGY STUDY
REVIEW OF NATIONAL SOLAR ENERGY CURRICULA
DACUM
INTEGRATION

RENEWABLE ENERGY PROGRAM DEVELOPMENT STUDY AND DACUM REPORT

- RENEWABLE ENERGY STUDY
- REVIEW OF NATIONAL SOLAR ENERGY CURRICULA
- DACUM
- INTEGRATION

FOR MORE INFORMATION

Berta Lloyd, Dean
Workforce Education
Shoreline Community College
16101 Greenwood Ave. North
Seattle, WA 98133

Phone: 206-546-4595
FAX: 206-546-4630
blloyd@shoreline.edu

PROJECT FUNDING

This project was made possible through the Carl D. Perkins Career and Technical Education Act of 2006

DOCUMENT CREDITS

Document and lead technical writing by Berta Lloyd, Shoreline Community College and Terryll Bailey, The Allison Group at 206-525-7175 or tbailey@theallisongroup.com.

Acknowledgements

Thank You to Industry and Education Focus Group Participants

The focus groups consisted of frontline workers, middle and senior management and business owners in the renewable energy field in the Puget Sound region and across Washington state. Representatives from the WSU Energy Extension Program also participated. They determined the critical work functions and key activities performed by renewable energy professionals and listed technical knowledge, skills and abilities, and employability skills required to succeed in this field. Their insights were an invaluable contribution to this work.

Claes Bye, Renewable Energy Corp. Solar
Ken Bailey, City of Seattle
Renee Boone, Architect, Boone & Associates
Pamela Burton, Solar Washington
Jeff Collum, Solar Washington
Jake Fey, WSU Extension Energy Program
Stephen Gerritson, Enterprise Seattle
Chris Herman, Winter Sun Design
Steve Johnson, Washington PUD
Thomas Maclean, Puget Sound Energy
Mike Nelson, WSU NW Solar Center
Larry Owens, Northwest Mechanical
Chuck Peterson, Seattle City Light
Gary Shaver, OutBack Power Systems Manufacturing
Jeremy Smithson, Puget Sound Solar
Jim Soules, The Cottage Company
Tim Stearns, WA State Dept. of C-TED
Matt Taylor, WSU, Architecture & Construction Management

IN ADDITION, we appreciate the support of Jane Weissman, Executive Director, Interstate Renewable Energy Council for her guidance and input on the project. We also express our sincere appreciation to Tony Costa, Program Manager, Perkins Students Services Support Program, Shoreline Community College, for his advice and guidance regarding the DACUM process.

Project Development and Coordination

- Berta Lloyd, Dean, Workforce Education, Shoreline Community College
- Jeanne Skaare, Administrative Assistant, Professional/Technical Education, Shoreline Community College
- Terryll Bailey, President, The Allison Group-Faciliator
- Madhuri Hosford, Marketing/Technical Communications

Dedication

DEDICATED TO

Washington State University's College of Engineering and Architecture

Washington State University's Extension Energy Program

Washington State University's Northwest Solar Center

A special thank you goes out to:

- Candis Claiborn, Dean, College of Engineering and Architecture
- Matt Taylor, Assistant Professor, Architecture and Construction Management
- Jake Fey, Director, WSU Extension Energy Program
- Mike Nelson, Director, WSU Northwest Solar Center
- Rep. Maralyn Chase, Washington State House of Representatives

This project would not have been possible without them. Their knowledge, expertise and insight have been phenomenal. Collaboration has been the key to this very successful project.

Berta Lloyd, Project Manager
Dean, Workforce Education

The Renewable Energy Program Development Study Project Outcomes

- Review of existing curricula from nationally–recognized programs in renewable energy

- Conduct a DACUM (Developing a Curriculum) focus group of industry representatives

- Prepare a report for renewable energy employers and educators with the data collected in the curricula review and the DACUM

The Next Steps

The completion of the curricula review and DACUM represent phase one of this endeavor. The next step is to provide oversight to the development of assessments and curriculum based on the DACUM. This is a cooperative and collaborative project with the renewable energy industry, labor unions, high schools, and colleges throughout the state.

Table of Contents

OVERVIEW

Introduction
Executive Summary
The State of the Industry

Introduction

This project proposes the development of curriculum for the renewable energy sector. In the spring of 2007, industry and education partners joined together in a focus group to determine the knowledge and skills necessary for workers to be successful in the industry.

This information, generated through strong collaboration between industry and educators, provides a sound starting point for the development of training programs that will prepare people for employment and career advancement while meeting industry needs for knowledgeable, and high-skilled workers for the renewable energy industry.

Industry and Education Perspectives

EDUCATION

President Lee D. Lambert
Shoreline Community College

"Our nation has become increasingly aware of the critical need to support a sustainable environment and the popularity of an emerging industry in renewable energy. This project demonstrates the critical role that education plays in developing a skilled workforce for employers. An outcome of this project is the research by which curriculum will be developed to meet the needs of the Renewable Energy sector here in Washington state.

Shoreline Community College is the current home to Washington State University's Northwest Solar Center (NWSC). The NWSC is committed to promoting solar and alternative energy awareness to the general public. The Zero Energy House (ZEH) will not only be used to promote training but to increase the technical knowledge among students, the community and industry employees. The ZEH is a demonstration project to build community awareness around clean technology. The Education-Industry partnership is key to creating a better more sustainable world, and we at Shoreline Community College stand ready to meet the challenge."

Mike Nelson, Director
Washington State University
NW Solar Center

"The economic goals established by both the U. S. Department of Energy and the European Economic Community call for price parity of solar with other energy sources by 2015. Already Washington state, through production incentives, has from the consumer perspective, effectively moved this date to 2008.

In order to achieve the price parity goal, Washington must prepare a workforce to satisfy the market demand and that these incentives have created."

Chris Herman, Faculty
Solar Home Design
University of Washington
Experimental College

"On the importance of education/industry partnerships, I have been teaching **Solar Home Design** at the UW Experimental College for 17 years. I saw interest peak during the Gulf War, but the class was on probation for low attendance (less than 8 students for 2 quarters) at one time. I have never seen the flood of interested people, old and young, that has occurred in the past two years. I had to move out of my room that held 26 into an auditorium. I added an extra section to satisfy the bundle of e-mails from folks who couldn't make the date of the scheduled class. The need for practitioners involved in renewable energy of all types is growing exponentially. I can't possibly keep up with the demand. I am thrilled and grateful that Shoreline Community College is taking up the challenge of training workers for this imminently important field. The solar industry has been growing worldwide at 30 percent per year for the past nine years, and now the surge is approaching America. We have big opportunities here to help the planet survive, mostly, as it is."

Barbara Hins-Turner, Executive Director
Energy Technology
Center of Excellence for
Energy Technology
Centralia College

"The energy industry is vital to the economic infrastructure and security of our nation, yet it is facing a crisis in terms of incumbent worker retirements. While the need to expand energy production continues, the industry is simultaneously challenged with recreating its infrastructure to include renewable energy and new technologies. Only through a collaborative partnership comprised of industry, labor, colleges and government working together can this looming workforce challenge be met."

INDUSTRY

Stephen Gerritson
Business Development Manager
Clean Energy and Technology
entepriseSeattle

"The hallmark of today's economy is rapid technological change, particularly in the field of renewable energy. To maintain our competitive advantage, we need a means of ensuring that the labor force remains highly qualified and productive. That mechanism is the partnership between Shoreline Community College and the renewable energy sector, which will train today's workforce in the cutting-edge technologies of tomorrow. This partnership is critical in the advancement of a sustainable economy."

Chris Herman, Principal
Winter Sun Design

"I have been involved in the solar industry in Seattle for almost 20 years. Making a living hasn't always been easy, but the move to renewable energy is necessary. And I've always known that I was in a good place. Now the country is catching up, and realizing that we can have the good life, and not significantly alter the planet in the process. We just need to shift our investments and incentives. As the demand for renewable energy increases, we in the industry desperately need the educational community to help us supply the demand by training skilled workers. We don't have the time or the expertise to train people to help us on the scale that is needed. I am thrilled, relieved and grateful that Shoreline Community College has taken on the challenge. The time is ripe, we have the technology and we can turn the tide on global warming. But we need a LOT more solar installers."

Gary Shaver, Director Operations
Outback Power Systems

"Growing concerns over global warming, pollution, energy prices, and geopolitical conflicts over energy resources have combined to spur staggering growth in the Solar PV Industry. Although a great deal of attention has been given to innovative solar legislation and bringing solar manufacturing costs down, little attention has been given to the quality and cost of the actual solar installations.

In order to meet the growing demand for solar PV in the U.S., knowledgeable and thoughtful installers and inspectors are needed. The combination of high quality solar PV products, quality installations, and efficient inspections will greatly assist in bringing the price of PV within the reach of the average consumer. Renewable energy training programs like what Shoreline Community College is proposing are key to this effort."

Larry Owens, Vice President
NW Mechanical & Solar Washington

"Shoreline Community College continues to show leadership by bringing together key partners in the development of the new renewable energy Program at the college. It is vitally important to the growth and development of the renewable energy industry to have strong connections with institutions of higher education, with businesses and individuals, government agencies, and other stakeholders. I applaud Shoreline Community College for taking a pro-active approach; an approach that draws upon the knowledge, experience, and collaboration of many experts in diverse fields in order to develop a strong program and a strong network of supporters.

The Renewable Energy industry is growing rapidly in the region, across the nation, and around the world. Opportunities abound, and by preparing students for entry into this field, SCC will provide an excellent way to move forward. Textbook learning is important, but so is the hands-on experience that business and community members bring to the table."

Executive Summary

Demand for Skilled Workers

THE DEMAND for skilled workers is growing in every renewable energy industry sector in this state. In the solar electricity industry this is especially true, with projections that between 1,960 and 4300[1] jobs will be created over the next six years in the solar electricity industry alone.

The majority of renewable energy companies are focused on crystal growth and purification, module and inverter production, balance of systems and systems integration and installation. In May 2005, Washington state enacted new legislation to encourage even more renewable energy companies to locate in the state by providing manufacturers of solar energy panels, components and systems, tax credits based on the value of solar energy systems sold. Companies with core businesses such as these require highly skilled employees with strong problem-solving, creative thinking, and scientific skills.

Solar electricity companies are deeply concerned over the shortage of workers with the skills needed to keep pace with the projected expansion of solar energy in Washington state, both from producer perspective and consumer perspective. At the same time, the workforce is severely challenged by corporate downsizing and relocation, and the need to keep pace with technology. The education, training, and information available to most workers are often insufficient to deal with technology-driven changes in the workplace.

Curriculum Development

TO HELP RESPOND to the gap between the demand for workers with specific skills and the availability of workers with those skills, Shoreline Community College in coordination with Washington State University (WSU), the Northwest Solar Center (NWSC) and solar industry leaders convened a focus group April 18, 2007, that identified the knowledge, skills and abilities necessary for a worker to be successful in the industry.

The Partnership: Zero Energy House Project Washington State University and Shoreline Community College

WASHINGTON STATE UNIVERSITY architecture, engineering, interior design and construction management students designed and built a zero energy house (ZEH) that was entered into the Solar Decathlon, a worldwide competition for college and university students. Over the course of a year, the house creates more energy than it consumes. The solar structure was later disassembled, shipped to the National Mall in Washington, D.C. and reassembled for the three-week

[1] *The Washington Solar Electric Industry: Sunrise or Sunset? A Closing Window of Opportunity*. Nelson, Mike and Shaver, Gary. Washington State University. All projections of employment are rough extrapolations based on a linear projection of industry trends. High and low ranges were use for each extrapolation based on current employment in the sector. STET 15 percent and a 25 percent growth rates were used. Data is based on industry “Roadmap” projections. No multipliers for spin off jobs were employed.

competition. The competition was sponsored by the U.S. Department of Energy. Following the competition, the ZEH was moved back to Washington state, eventually being moved to its final location at the main campus of Shoreline Community College.

The ZEH was built under the leadership of WSU's Assistant Professor, Architecture and Construction Management, Matt Taylor. Mike Nelson, Director, WSU Northwest Solar Center (NWSC), provided technical advice and support for the project. Rep. Maralyn Chase facilitated the move of the ZEH from Magnuson Park to the Shoreline Community College campus.

The model of alternative construction will be the site for the Northwest Solar Center and future training to educate and inspire students and community members about alternative energy systems. In addition, it will lead the development of curriculum that will provide skilled workers for the solar energy industry.

The State of the Industry

THE GENERATION OF ENERGY is the cornerstone of any modern society: modern economies and the people who live within them rely on it. However, great tension has grown over how to meet the rapidly growing demands of a growing world population and how to address the resultant domestic and global issues of air pollution, water pollution, global warming, electric infrastructure reliability, and, more recently, local and national security. Due to these rapidly evolving issues virtually unlimited economic opportunities are emerging in the energy industry, the largest and most vital industry in the world[2].

Photovoltaics (solar-electric technologies) offer an excellent alternative to traditional means of generating electricity. They convert light directly into electricity without moving parts, noise, or pollution. They also have a lifetime expectancy of 30 plus years, are readily adaptable to a variety of applications, and are made of the second most abundant material on earth—sand.

In the next 20 years worldwide energy demand is expected to expand by more than 50 percent, with demand projected to increase by 23 percent in industrialized nations and by more than double in the developing world, with Asia accounting for the lion's share of the growth[3]. By 2020, the solar-electric industry predicts a $15 billion worldwide industry.

Cell Electricity: Photovoltaics in the Northwest

WHILE THE AMOUNT OF SUNLIGHT in the Pacific Northwest does not rival the American Southwest, photovoltaic modules will produce electricity year round in the diffuse light of a cloudy climate. The US Coast Guard relies on PV for marine navigation lights. Burlington Northern Railway relies on solar powered railroad safety equipment; remote homes in many rural counties currently rely on the sun for their electrical needs. Solar cells react differently in different light intensities. When light intensity decreases (read clouds) current output drops. Interestingly, however, cell output voltage is not so greatly affected by light intensity. Voltage remains high over a wide variety of intensities even to low sunlight conditions (read rain). This means that a solar module will produce some current at an appropriately high voltage even under gray and cloudy skies. Further, analysis of available data shows that the amount of sunlight across the country only varies by plus or minus 25 percent from the national average. Anyone considering a PV system should be more concerned with seasonal variation in sunlight than in comparing differences between averages. Photovoltaic power will continue to find an increasing number of practical uses in the Pacific Northwest. Anticipated future cost reductions are forecasted which will make photovoltaic use even more common.

[2]See Washington State Community, Trade and Economic Development, Global Warming: Facts & Solutions 1 (2000).
[3]From WSU Energy Program survey of on grid and off grid solar installations, summer 2002

The Future

THERE ARE PRESENTLY a number of applied and theoretical research and development projects underway in the United States and around the world. Researchers are experimenting with new materials and new production techniques to lower cost and increase efficiency. Semiconductor materials such as gallium arsenide, copper indium diselenide, cadmium teluride and amorphous silicon hold particular promise. Refinements in wafer and ribbon manufacturing and wholly new approaches such as thin film deposits represent potential cost breakthroughs. More work is needed in areas that are “down line” from the cell. Batteries and inverters are two areas where much can and is being done. Integration of components and modularity of design are simplifying design and lowering costs. Probably the most significant breakthroughs in PV technology will come from work being done in the emerging nations. The largest markets at current prices exist in the third world with its 2 billion people who do not have utility power, and will probably never get it. As the poorest people in the world purchase greater quantities of solar power, mass production will lower prices until finally even the richest will be able to afford this technology.

RENEWABLE ENERGY DEVELOPMENT STUDY

Project Goals, Guidelines, and Methodologies
Definition of Terms

Project Goals and Guidelines

Goals

- Identify major functions and tasks for the renewable energy industry. These will be used to inform the development of curricula to prepare individuals for entry into renewable industry solar electricity careers at the technical level.
- Disseminate the results and support the use of the findings by educators, businesses, unions, students, workers, and government agencies.

Guiding Principles

- Experienced workers are the experts in their career field and are best able to identify the work performed and the skills, knowledge, and abilities required to be successful.
- Business, labor, and education must work as partners to ensure the creation of a link between the work expectations and the curriculum.
- The DACUM will describe the major functions and key activities, as well as the technical knowledge and skills, employability skills, and personal attributes needed to succeed in the workplace.

The experience of the partners involved in this project holds that the success of any program development project is critically linked to the full participation and commitment of all partners.

Definition of Terms

DACUM contains the following components:

Duties

Duties are general areas of competence that successful workers in the occupation must demonstrate or perform on an ongoing basis.

Tasks

Tasks are work activities that have a definite beginning and ending, is observable, consist of two or more definite steps, and leads to a product, service, or decision.

Knowledge

In DACUM, knowledge is an understanding and familiarity with facts and information.

Skills

Skills are the ability to perform occupational tasks with a high degree of proficiency

Traits

A trait is defined as an innate or learned ability or distinguishing quality that allows an individual to complete a job.

REVIEW OF NATIONAL SOLAR ENERGY CURRICULA

Research Process
Findings

Research Process

THE GOAL was to collect data on existing nationally–recognized programs in solar energy.

The executive director of the Interstate Renewable Energy Council IREC), Jane Weissman, was consulted with respect to nationally–known programs in solar energy. She provided the following contacts:

- Ken Walz at Madison Area Technical College (MATC)
- Roger Ebbage at Lane Community College (LCC)
- Johnny Weiss at Solar Energy International (SEI)

These individuals were contacted and information regarding their programs was requested.

In addition, an internet search was conducted.

Findings

BOTH Roger Ebbage, Energy Management Program Advisor at Lane Community College and Johnny Weiss, Board Member of Solar Energy International were very responsive to queries about their curricula. Ken Walz did not respond to requests for information; however data on the programs at Madison Area Technical College was available on the MATC website.

Lane Community College

THE ENERGY MANAGEMENT PROGRAM at Lane Community College is a two-year program, and includes a Renewable Energy Option, which is a stand-alone two–year program in and of itself. It includes courses in Energy Efficient Methods, Energy Investment Analysis, Photovoltaic Design and Installation and Solar Thermal Design and Installation. The complete program outline may be found in Appendix B. In addition, Lane Community College sent course outlines for courses in solar thermal and photovoltaic. These are also found in Appendix B.

Mr. Ebbage also founded and is the director for the Northwest Energy Education Institute at Lane Community College, which provides professional training and certification for energy and facilities managers, and may act as a fundraising arm for the LCC Energy Management Program. Currently, there is a proposed energy efficiency demonstration building at the LCC campus. Additional information is provided in a PowerPoint presentation, which may be found in Appendix B.

Solar Energy International

SEI is a not-for-profit private institute which focuses on training for decision makers, technicians and users of renewable energy sources. Its courses are ISP–approved and, where applicable, lead to NABCEP certification. The Institute for Sustainable Power (ISP) through IREC has established an audit procedure as more educational programs in renewable energy are being offered in the public and private education arenas. The purpose is to ensure students that the proper skills are being taught, the facilities utilize the proper equipment, the institutions are fiscally sound, etc. NABCEP (North American Board of Certified Energy Practitioners) provides certification of worker knowledge and skills. A complete listing of courses offered by SEI is provided in Appendix D.

SEI primarily offers short courses (two to six days) for a fee in locations across the country and online. SEI has also developed curriculum and text books for use in other institutions, and is in the beginning stages of negotiating licensing agreements for use of its materials and curricula.

SEI sent its text on photovoltaics, entitled *Photovoltaics Design and Installation Manual*, for review by Shoreline Community College. SEI also sent a promotional video, *Ride the Renewable Wave*. These materials accompany this report and may be viewed by contacting Berta Lloyd at Shoreline Community College.

Madison Area Technical College

THE MATC RENEWABLE ENERGY CERTIFICATE is a 12-credit (minimum) certificate program which includes topic areas in transportation, photovoltaics, solar thermal, wind, and biomass. Courses are available in-person or online, and also face-to-face courses are delivered in a full-day intensive format taught during weekends, winter break, spring break and/or summer sessions. The MATC course catalogue description of the program and listing of courses is provided in Appendix B.

In addition, MATC operates the Consortium for Education in Renewable Energy Technologies. This is a consortium of community and technical colleges which offer the MATC curriculum. Following is a current list of participants in the consortium:

Lansing Community College
Iowa Lakes Community College - Wind Energy & Turbine Technology
Iowa Lakes Community College - Biomass Energy Processing
Oakland Community College
Eastern Iowa Community College
Cape Cod Community College

DACUM

What Is DACUM

The term DACUM is an acronym for Developing A Curriculum. The DACUM process used is an innovative and effective method of occupational analysis. It is also very effective for conducting process and functional analysis. DACUM is used extensively by educators and by trainers when they are establishing a new education or training program, or revising an existing one. Shoreline Community College uses the DACUM process to establish a relevant, up-to-date and localized research base for curriculum and instructional development.

DACUM gathers information on the following items, using a focus group format with industry experts: Duties, Tasks, Knowledge & Skills, and traits.

Methodology

A MODIFIED DACUM process was used for this study. Traditionally, the DACUM process requires several-days, with numerous iterations and reviews of the data. The DACUM for this project was modified to complete in one half day session.

A panel of industry experts was recruited, along with a neutral facilitator (Terryll Bailey) and recorder (Madhuri Hosford). Observers were invited, and sat in the back of the room.

A sampling plan for the panel of industry experts was developed to ensure that there was diversity in company size, geographical location, area of specialization (including manufacturing and installation) and government, policy and non-governmental organizations in the area of Solar Energy. The panel had 18 participants, comprising an excellent cross section of the industry.

The DACUM was conducted on April 18, 2007. The session began with a welcome by Shoreline Community College President, Lee Lambert, and Instructional Dean, Workforce Education, Berta Lloyd.

An interactive introductory presentation was facilitated by Mike Nelson, Director, Northwest Solar Center.

The panel developed the list of duties using preliminary data developed from research by Terryll Bailey on existing workforce information and occupations, and reviewed and approved by Mike Nelson. The duties were revised and adapted by the focus group participants to meet the needs of the specific environment of the Solar Energy industry in Washington State.

For each duty, the panel then brainstormed and came to consensus regarding the associated tasks.

The panel then developed a list of knowledge and skills required to competently perform the tasks and meet the requirements of the duties.

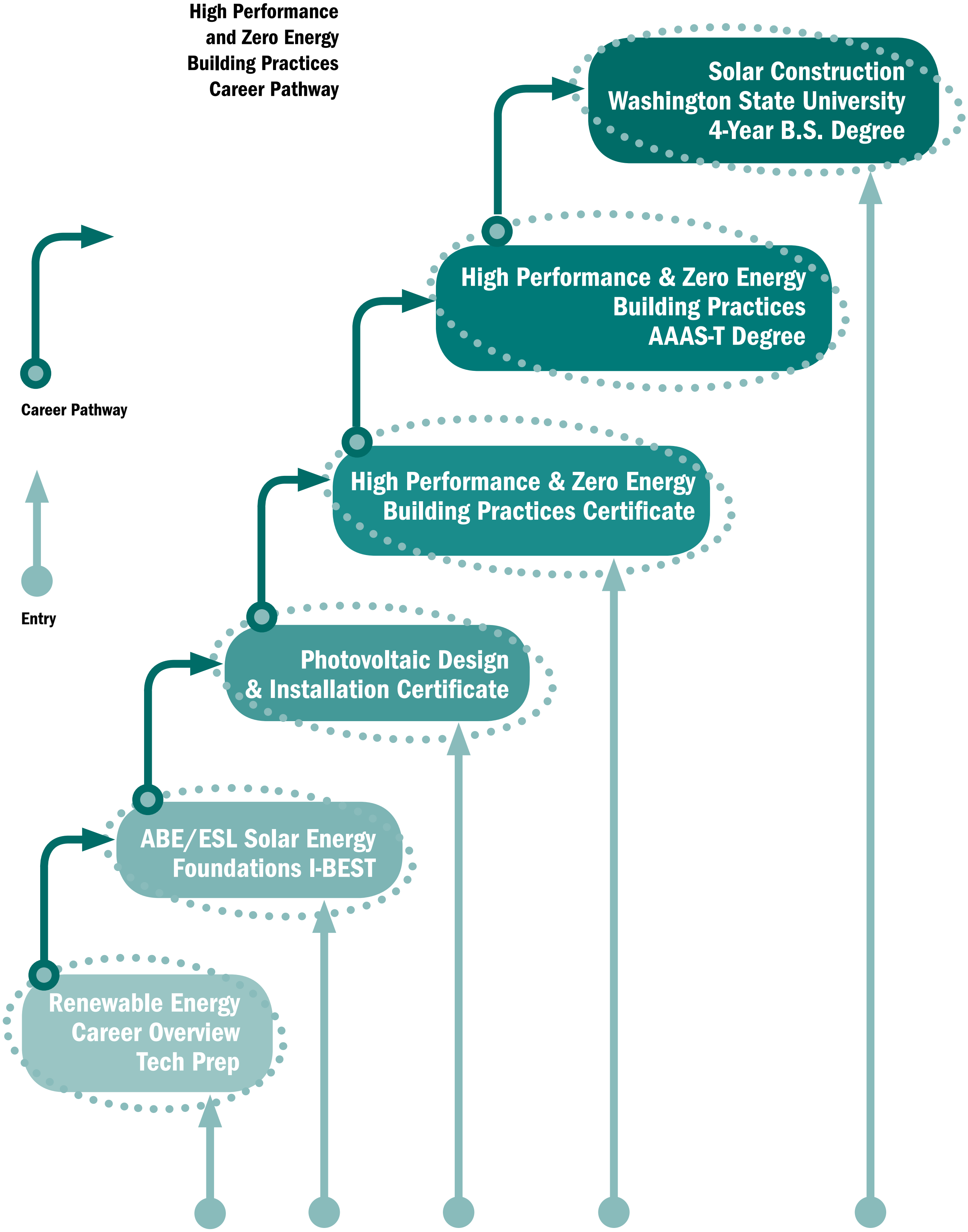
The DACUM ended with a full group discussion on jobs, wages and future trends.

Findings

THE FINDINGS from the DACUM are divided into the following sections:

- Potential High Performance and Zero Energy Building Practices Career Pathway
- DACUM Chart of Duties and Tasks
- Knowledge and Skills
    - General Knowledge and Skills
    - Tools and Equipment
- Worker Traits
- Job Titles and Wages
- Future Trends and Concerns

**Potential
High Performance
and Zero Energy
Building Practices
Career Pathway**



High Performance Building Curriculum Development

DACUM Chart: Duties and Tasks

INSTALL RENEWABLE ENERGY SYSTEMS	A-1 Design systems to meet code requirements	A-2 Obtain approvals and permits	A-3 Perform work safely	A-4 Identify structural supports	A-5 Assess quality of roofs to support and maintain weatherproofing of racks	A-6 Perform layout for rack installation per plans and adjust as necessary
INSPECT SYSTEM INSTALLATIONS	B-1 Check for leaks and system performances	B-2 Verify complete system, per plans or checklist	B-3 Verify appropriate materials at or better than code requirement for jurisdiction	B-4 Perform follow up inspections	B-5 Perform customer walk-through	B-6 Verify proper signage
PRODUCE SILICON	C-1 Maintain and repair plant equipment	C-2 Perform work safely	C-3 Perform chemical engineering	C-4 Perform electrical engineering	C-5 Perform materials engineering	C-6 Perform manufacturing engineering
MANUFACTURE MODULES AND INVERTERS	D-1 Maintain and repair plant equipment	D-2 Perform work safely	D-3 Perform electrical engineering	D-4 Perform materials engineering	D-5 Perform manufacturing engineering	D-6 Assist in laboratory processes
ASSIST WITH REPAIR, MAINTENANCE & INSTALLATION OF SOLAR EQUIPMENT	E-1 Troubleshoot equipment failures	E-2 Perform planned maintenance	E-3 Install new parts and equipment	E-4 Document repair, installation or maintenance	E-5 Commission equipment	
MONITOR SYSTEMS	F-1 Perform remote technical support using RF, GPS and other smart devices	F-2 Verify equipment performance	F-3 Commission equipment	F-4 Perform planned maintenance		
DESIGN HIGH PERFORMANCE HOUSES AND SYSTEMS	G-1 Select appropriate glazing	G-2 Perform heat loss analysis	G-3 Perform cost analysis	G-4 Perform solar gain analysis	G-5 Perform advanced framing design	G-6 Perform blower door test
PROVIDE CONSERVATION/ SOLAR INFORMATION AND ADVICE	H-1 Conduct energy audits	H-2 Provide conservation specialist functions for utilities	H-3 Provide PR for manufacturers	H-4 Educate the public	H-5 Provide solar site analysis	H-6 Provide technical support to installers, builders, and consumers
DESIGN AND SELL SYSTEMS	I-1 Sell to consumers	I-2 Sell to builders and developers	I-3 Use templates to design systems	I-4 Provide customer support		
ADVOCATE FOR SOLAR ENERGY	J-1 Develop policy	J-2 Educate the public	J-3 Market solar energy to the public, policy makers and businesses	J-4 Provide training for real estate agents and appraisers	J-5 Persuade policy makers	

A-7 Perform installation	A-8 Perform clean up and test for waterproofing	A-9 Interface with roofer	A-10 Communicate with project manager / team			
B-7 Assist with utility paperwork						
C-7 Assist in laboratory processes	C-8 Perform inventory control, shipping and bookkeeping	C-9 Monitor environmental regulations				
D-7 Perform inventory control, shipping and bookkeeping	D-8 Conduct quality control tests	D-9 Conduct performance tests	D-10 Operate computerized manufacturing equipment (robotics)	D-11 Perform product development (software, hardware)	D-12 Monitor environmental regulations	D-13 Monitor / manage production systems (pipes, gauges to maximize production performances
G-7 Research and specify alternative materials and systems	G-8 Utilize/apply sustainability principles	G-9 Design balanceable air systems	G-10 Document high performance buildings and check for compliance with LEED certification			
H-7 Explain utility bills to customers						

Knowledge and Skills

GENERAL KNOWLEDGE AND SKILLS

- OSHA, WSHA, and industry safety procedures and regulations
- Environmental regulations
- Building codes
- Plumbing codes
- Electrical codes
- Construction standards
- Read and understand plans and symbols
- Draw plans
- CAD and basic mechanical drafting/illustration
- Architectural standards
- Operate test equipment and interpret results
- Engineering principles
- Metering and interconnection
- Interface of solar with conventional systems
- Parameters for normal/abnormal operation of equipment for climate zones
- Knowledge of “normal” electricity usage
- Principles of good integrated design, physics of interchange
- Knowledge of principles of heat pumps, good lighting design, thermal dynamics, air-to-air heat exchangers
- Ability to provide a balanced assessment with options
- Production systems
- OEM data and specifications
- Life cycle costing for energy systems
- Knowledge of green manufacturing materials, processes (ISO 9001, 14001)
- Basics of global warming
- Sustainability principles
- Knowledge of principles of hydronics
- Properties of building materials (UV durability, weatherability)
- Knowledge of types of windows and building materials (overview of history of building science and methods)
- Knowledge of audit checklists
- Moisture migration and control
- Mold/indoor air quality (IAQ and radon)
- Depth of knowledge of the solar industry
- Knowledge of competing industries
- Energy history and lessons learned (ask Gary Shaver)
- Research effectively on the internet (including old equipment)
- Metric conversions
- Math: geometry, arithmetic, astronomy, trigonometry, algebra
- Basic physics and chemistry
- Basic scientific methods
- Communication: speaking, listening, writing
- Presentation skills

Tools and Equipment

TOOLS AND EQUIPMENT

- A wide variety of solar equipment
- Solar path finders
- Roof safety equipment
- Pneumatics, hydraulics and electrical manufacturing
- Automation (robotics)
- Software (Energy 10, RET Screen, PowerPoint, Office Suite)
- Energy auditing toolkit
- Oscilloscope, multi-meter, flash tester, pressure meter
- Lab equipment

WORKER TRAITS

- Be on time
- Reliability
- Dependability
- Ethics
- Customer service / customer focus
- Coordination and communication with team members
- Discernment
- Speech and presentations
- Ability to say I don't know

JOB TITLES AND WAGES

Job Title	Hourly	Annual
Construction Trainee	$15	$31,200
Design Trainee	$20	$41,600
Sales (Commission)		$20,000 - $60,000
Manufacturing (CA)	$11 - $15	$22,880 - $31,200
Floor Management (CA)		$40,000
Office Management (CA)		$60,000
Energy Auditor	$20	$41,600
Utility Conservationist/Specialist		$40,000
LEED Documenters		$30,000

Resource: Renewable Energy Industry Focus Group-April 2007-Shoreline Community College

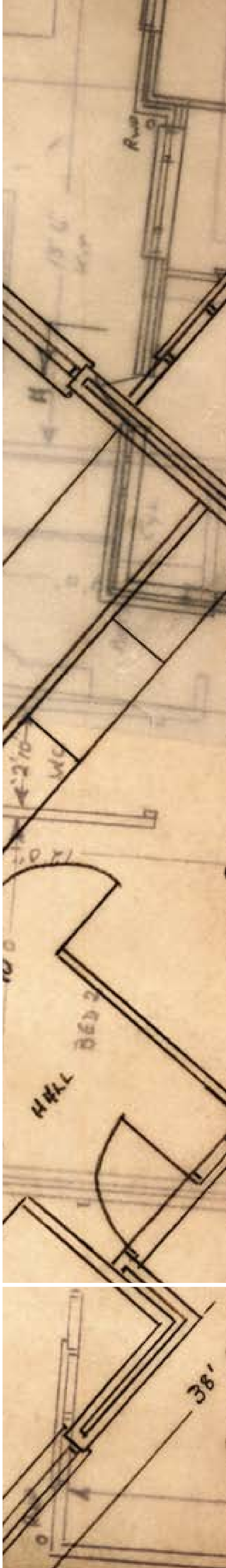
FUTURE TRENDS AND CONCERNS

- Renewable energy will shift from niche market of enthusiasts to broad-based market acceptance and demand (much as the computer market has done).
- New construction must meet new "green" standards and raise the bar to drive the consumer to the point where society needs the consumer to be.
- Simplification of systems, modularization of systems, standardization and movement toward an appliance modality.
- Move from specialized custom installers to mass market (Costco, Office Depot, Utilities?).
- Peak oil and worldwide energy picture; competition from China, Taiwan, overseas.
- Big Japanese players may enter market for various renewable energy components (Honda, etc.).
- Long term warranty and service will be enhanced; quality and after-sale support will increase.

Resource: Renewable Energy Industry Focus Group- April 2007-Shoreline Community College

INTEGRATION

Assessment and Certification: A Vital Connection
Assessment Strategies
Assessment Design



Assessment and Certification: A Vital Connection

DACUM, while useful on its own, is just one part of a much larger equation. DACUM establishes a list of knowledge and skills, but does not tell a person whether he or she is workplace ready to utilize a particular knowledge or skill.

For this reason, performing a DACUM does not end with their publication. Washington state is also working to develop voluntary assessments and certifications which will make it possible for students, workers and interested persons to determine their strengths and weaknesses based on the standards, and to earn certification showing that they can perform work competently as established by the DACUM.

In today's fast-moving technological economy, the necessity for assessments and certification is crucial. The demand for both technical and employability skills is escalating as work becomes more complex. The workforce is more mobile, with workers moving freely between jobs and industries. This job mobility requires that workers must be able to communicate their qualifications to potential employers. As technology changes, workers must keep up with technological change through continuous learning and worker retraining, and must be able to prove they have kept pace. All of these factors mean more training and education for individuals, and the ability to show evidence that this training translates to performance on the job.

Voluntary assessments and certifications based on DACUM will help us address all these needs because of the guiding principles upon which DACUM is based, and because of the stakeholders—employers, educators, workers, students, and government—whose needs DACUM is designed to meet.

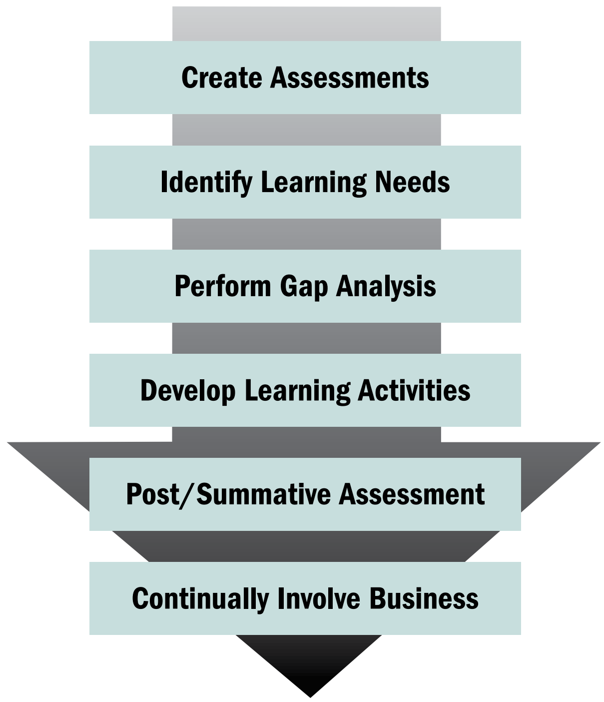
Please Note: To ensure the use of standards and their related assessments and certifications do not contradict U.S. employment law, employers will need to conduct an internal validation of the standards before using the DACUM outcomes to make hiring and promotion decisions. The purpose of this validation is to ensure that the knowledge, skills, and performance described by the standards are needed for competent performance in an employer's organization. The need to validate the standards internally is a key requirement of U.S. employment law, which seeks to protect individuals from discrimination in hiring and promotion.

The first step toward a statewide system of assessments and certifications is the development of assessments which measure an individual's ability to perform work competently as described by the DACUM. Once these assessments are developed, curriculum can be reviewed to determine that all necessary topics and practicums sufficiently cover the items in the assessment. Once any gaps are identified, learning activities and content adjustments can be made, and post/summative assessments can be administered. Finally, it is critical that industry be involved every step of the way, and that standards are continuously reviewed and updated. The diagram below provides a summary of this process.

Assessment Strategies

UPON COMPLETION of the development of DACUM, curriculum needs to be developed and performance assessment can be created to assess the criteria identified. Sample curriculum and assessments may be distributed to instructors and curriculum developers who will be educated on the elements of DACUM.

Integrating DACUM



Assessments based on the outcomes for the DACUM process may include pre-and post-evaluations of the student to measure skill progression and to track the success rate of obtaining certification, where applicable.

Within a competency-based system, assessment is the generation and collection of evidence of performance which can be matched to specified explicit standards that reflect expectations of performance in the workplace.

There are two main forms of evidence:

- Evidence of actual performance
- Evidence of underpinning knowledge, skills and abilities

The types of evidence may vary and will include:

- Direct evidence (products and items produced by the performer)
- Indirect evidence (supporting evidence and information about the performer)

Evidence can be collected in a wide variety of educational or business settings. To a large extent, the range of opportunities available for demonstration will determine the most appropriate setting. Often it is difficult to actually perform the task in the authentic work setting. In this case, evidence generated during an educational course or an in-house training session can be collected by individuals and added to their overall portfolios.

By requesting that the student or trainee produce tangible results in the form of take-away products (videos, tapes, paper, and electronic products), the participant will have created real evidence which can be shown to human resource personnel, hiring managers, supervisors or assessors. When assessing these products, the trained assessor will seek:

- Validity
- Currency
- Authenticity
- Sufficiency

Therefore, when designing a competency-based assessment for an educational course or training session, the assessment process and results will meet four criteria:

Validity: The assessment instrument/process clearly relates to the relevant standards.

Currency: The assessment instrument/process calls for a demonstration of the current standards in the industry.

Authenticity: The individual being assessed produces the assessment results; it is their own work. Team activities will be useful to demonstrate the skills and abilities to work effectively with others, not necessarily the total end results. The individual can, if possible, identify his or her part of the team project to demonstrate evidence of his or her own results.

Sufficiency: Enough evidence is collected to match the key task and the performance level required in the workplace.

When designing/revising the curriculum for Solar electricity, students will be assisted in generating high-quality evidence of performance or of underpinning skills, knowledge and abilities which will help them to be successfully assessed as fully competent.

Assessment Design

Type of Authentic Assessment	Description of Authentic Assessment Strategies
Project	▪ Hands-on demonstration of knowledge, skills, and attitudes that reveals a student's ability to plan, organize, and create a product or an event. ▪ Documentation of process of development from initial steps to final presentation.
Portfolio	▪ Collection of pieces of evidence of a student's knowledge, skills, and attitudes. ▪ Showcase of best work, work-in-progress. ▪ Record of student's progress over time. ▪ Content selection by student in collaboration with the teacher. ▪ Centerpiece for parent conferences.
On-Demand Demonstrations	▪ Hands-on performance by a student, which illustrates levels of knowledge, skills, and attitudes. ▪ Typically involve a "real life" problem or situation to solve. ▪ Focus on the application of knowledge and skills learned in one situation as it connects to a new and different one.
Case Studies	▪ Analysis of events and individuals in light of established criteria. ▪ Synthesis of evidence to support generalizations based on individual cases.
Paper/Pencil Tests	▪ Multiple-choice, essay, true-false questions that rely on extended responses to further clarify a student's understanding of the knowledge being assessed. ▪ Graphic representations that reveal a student's understanding of connections among ideas.
Structured Observation	▪ Observation of events, groups, and individuals that focuses on the salient traits of the skill or attitude being observed.
Scenarios	▪ A problematic or challenging situation presented in the context of a career-technical perspective. ▪ Study required to analyze or evaluate a situation. ▪ Apply relevant knowledge or skills. ▪ Prepare and justify a reasonable solution
Critical Incident	▪ An interview where the assessee is asked to describe past experiences which demonstrate skills.

From: Center for Occupational Research and Development, November 1996, and Skill Standards Volume 2: Assessment, 1999, Washington State Board for Community and Technical Colleges.

APPENDIX

Appendix A: References
Appendix B: Curriculum

Appendix A
References

Built To Work, National Skill Standards Board, 2000

The Washington Solar Electric Industry: Sunrise or Sunset? A Closing Window of Opportunity. Nelson, Mike and Shaver, Gary. Washington State University, 2003

WEB REFERENCES

Northwest Solar Center,
http://northwestsolarcenter.org/
WSU Extension Energy Program,
http://www.energy.wsu.edu/energy
Shoreline Community College,
http://www.shoreline.edu/
National Alternative Fuels Training Consortium,
http://www.naftc.wvu.edu/
Center of Excellence Energy Technology Centralia College,
http://www.centralia.ctc.edu/coe
Lane Community College,
http://www.lanecc.edu/
Madison Area Technical College,
http://matcmadison.edu/matc/
North American Board of Certified Energy Practitioners,
http://www.nabcep.org/
Solar Energy International,
http://www.solarenergy.org/
Interstate Renewable Energy Council,
http://www.irecusa.org/index.php?id=9
Consortium for Education in Renewable Energy Technologies,
http://matcmadison.edu/ceret/
Partnership for Environmental Technology Education (PETE)
http://www.ateec.org/pete

Appendix B
Curriculum

Lane Community College

- Energy Management Technician – 2 Year Program
- Renewable Energy Technician Certificate

For curriculum details go to:

http://www./lanecc.edu/

Madison Area Technical College

- Renewable Energy Certificate

For curriculum details go to:

http://matcmadison.edu/matc/

Solar Energy International (SEI)

- Photovoltaic Design & Installation
- Advanced Photovoltaics
- PV Design Online
- Solar Industry Seminar

For curriculum details go to:

http://www.solarenergy.org/

Washington State University - Zero Energy House, Shoreline Community College Campus

Shoreline
COMMUNITY COLLEGE

www.shoreline.edu