120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #5891

INTEGRATION OF GREEN CONCEPTS IN THE TECHNOLOGY CURRICULM FOR WORK FORCE DEVELOPMENT FOR THE RENEWABLE ENERGY INDUSTRIES

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Abstract

With green industries poised for rapid growth, universities and workforce development centers are striving to develop a workforce that is well trained in renewable energy technologies. This paper describes the latest advances in an educational project, sponsored by the Texas Workforce Commission, to integrate renewable energy technology principles into the technical curriculum. This project has engaged faculty from technology programs in the College of Science, Mathematics and Technology at The University of Texas at Brownsville (UTB) to develop renewable technology courses; thereby allowing for the seamless integration of green technology principles and marketable skills into the existing technical certificate programs. This paper will address the pedagogy of integrating a renewable energy technology curriculum with previously-existing technology programs; and will describe the vertical integration of various green technology programs offered by the university.

Introduction

In the fall of 2011, The University of Texas at Brownsville expanded its technical curriculum to include short-term training and certificate programs in renewable energy and green building. This expansion, made possible by a funding award to UTB, increased the capacity of the university's technical curriculum by adding to, and expanding upon, existing courses; and by utilizing existing learning centers to offer a green-focused training curriculum. Students can earn a six-month career technical training certificate (co-listed for credit or non-credit) or a one-year certificate that can be directly applied to jobs in the growing fields of energy efficiency and renewable energy. The six-month training certificates may be applied in full towards the one-year certificates. Industry-recognized certifications are included, where possible, as an outcome.

The certificate programs also set the foundation for students who wish to build their credentials, by allowing credits to directly transfer to an associate of applied science degree in renewable energy technology or a bachelor's degree in engineering technology. This flexibility is possible because of a unique relationship between UTB and Texas Southmost College, a local community college. The first class of AAS students is scheduled to graduate in the Spring 2013 semester.

Commitment of UTB towards Green Workforce

UTB wants to ensure that students interested in, and dedicated to, advancing their educational training in green technologies are supported financially, if necessary. Currently 83% of the UTB student population receives some level of financial aid for formal education. Both the Texas Workforce Commission's Skills Development Fund and grants from the U.S. Department of Labor offer tuition assistance funds to support low-income students with educational training that can be linked to employment opportunities. Texas Workforce Solutions

also has local funding available for training associated with job creation and retainment. UTB continues to identify and pursue additional funding opportunities that meet the need of the green program and its target student population.

Curriculum Components

Our research has shown that there is a growing demand for skilled workers in the fields of green building and renewable energy in UTB's home region of South Texas. Due to the local nature of the employment opportunities in this field, it was determined that a localized program would be necessary to meet this demand. The new green technology curriculum was developed to train students in the energy-efficient building and construction industries (green building), and the renewable electric power industries (with wind, solar, and geothermal focuses).

UTB created the Renewable Energy and Green Building Technology curriculum by developing new courses and adapting existing ones. All new courses developed for the programs have been submitted to the Texas Higher Education Coordinating Board (THECB), to be considered for inclusion in the Workforce Education Course Manual (WECM) as non-credit or credit-hour courses. Also, as a condition of the grant, industry-recognized certifications were reviewed and incorporated as program outcomes. Specific preparations to pass the industry certifications have been designed into each track where industry certifications exist.

Upon completion of one semester of coursework—the equivalent of 15 non-credit hours—students earn a career technical training certificate (non-credit) in a specific track. Students with non-credit training can opt to have their program accepted as a block in the one-year, for-credit certificate. Students completing one year of coursework—30 to 32 credit hours—earn a certificate in a specific track. The renewable energy and green building technology curriculum consists of five different tracks: 1) Solar Photovoltaic Technology, 2) Small Wind Turbine Technology, 3) Solar Thermal Technology, 4) Geothermal Cooling and Heating Technology, and 5) Green Building Technology.

Solar Photovoltaic Technology

This program provides training in the installation and maintenance of solar photovoltaic systems for domestic and commercial use. It is directed to electricians and other electrical professionals wanting to acquire additional skills, as well as to first-time apprentices seeking a career in the electrical field. The solar photovoltaic practitioner is required to be familiar with all electrical standards and procedures as well as specific issues related to solar photovoltaic and PV/wind hybrid systems. The Solar Photovoltaic Technology program was built upon UTB's existing Certificate of Proficiency Track for electricians. This was accomplished by adapting three WECM-approved courses, creating four new courses, and leaving three existing courses unchanged.

Small Wind Turbine Technology

This program provides training for individuals wishing to become involved in the design and installation of small wind and PV/wind hybrid systems. Graduates are able to access job opportunities in the fast-growing wind farm industry in South Texas, where UTB is located. This

program targets individuals interested in a career in the electrical field. The small wind turbine practitioner is required to be familiar with all electrical standards and procedures as well as specific issues related to small wind turbines and wind/PV hybrid systems. There are no existing WECM-approved courses or programs in the field of small wind turbine technology. For this curriculum, UTB has adapted two WECM-approved courses, created five new courses, and used two existing courses that are also offered under the Solar Photovoltaic track.

Solar Thermal Technology

This program provides training in solar thermal systems for water and space heating. This program is intended to attract plumbing practitioners wishing to enlarge their portfolio of skills and services, as well as first-time apprentices seeking a career in the field of hydraulic installations. The program builds on UTB's existing Certificate of Proficiency Track for plumbers. The solar thermal practitioner is required to be familiar with all standards and procedures associated with hydraulic installation, as well as specific issues related to the harvesting of solar energy. UTB adapted two WECM-approved courses, created six new courses, and used two existing courses to create the Solar Thermal Technology program.

Geothermal Cooling and Heating Technology

This program provides additional skills to air conditioning and heating professionals wanting to become engaged in ground-source/sink heat pump technology; and serves as an introduction to first-time apprentices seeking a career in the field of HVAC technology. It builds on UTB's existing Certificate of Proficiency Track for HVAC practitioners. The geothermal practitioner is required to be familiar with all standards and procedures associated with hydraulic installation, as well as specific issues related to the use of underground reservoirs for the storage of solar energy. There are no WECM-approved courses in geothermal technology. Several existing WECM-approved courses in the HVAC field have been adapted to the Geothermal Cooling and Heating Technology program. UTB created two new courses and used eight existing courses for this program.

Green Building Technology

This program enables graduates to pursue a career in the field of integration of sustainable building technologies. Built upon the existing certificate program for construction technology, the Green Building Technology program provides students with hands-on training in energy efficiency, renewable energy, alternate building materials, and sustainable and green design. While two WECM-approved green building/green design courses already existed, UTB developed new courses specifically for its Green Building Technology program. UTB adapted one WECM-approved course, created five new courses, and used four existing courses.

Partnerships

UTB leveraged existing partnerships and established new ones to develop the renewable energy technology and green building technology curriculum, in order to ensure that the curriculum developed would be relevant, applicable, and accessible. The major partnerships include:

1. The Brownsville Economic Development Corporation (BEDC)
2. Cameron Workforce Solutions, the local Workforce Board
3. The Brownsville Independent School District (BISD)

4. South Texas Energy Partnerships (STEPS)
5. The Community Development Corporation of Brownsville
6. E. ON Corporation, wind farm developer/project in Willacy County, and
7. Go Green Assistance Center

The fostering of these partnerships has ensured that the resulting curriculum is aligned with the community's economic needs and development goals. Likewise these partnerships create value to students both during and after the completion of their program of study. For example, the BEDC and Cameron Workforce Solutions both assist in identifying potential employers and job opportunities requiring green-enhanced occupational training. The South Texas Energy Partnership (STEP) assisted in establishing links between TSC and other resources for curriculum review and input; and in creating awareness in the community of the renewable energy technology and green building technology programs.

The Community Development Corporation of Brownsville has provided learning opportunities for high school students—potential future program participants—at green construction projects. The Brownsville Independent School District reviewed the curriculum with the purpose of entering into a training contract with UTB/TSC for the delivery of the programs for upper-level high school students. Texas Workforce Solutions continues to assist in identifying potential students and professionals with either a background or interest in green technical training.

UTB has established the Go Green Assistance Center (GGAC), an applied research center with over 50 partners committed to utilizing green building technology in the region. The GGAC provides students with access to this partner base while serving as a practical learning space. Finally, with the recent adoption of *Imagine Brownsville,* the award-winning comprehensive plan for the City of Brownsville, there are many active governmental and non-governmental organizations able to assist in making the plan a reality. This existing network of community leaders will continue to be leveraged to ensure that the renewable energy and green building curriculum fits into the broader set of community and economic goals.

Economic and Labor Market Information

Renewable energy and energy efficiency initiatives have the potential to create significant economic growth throughout the state of Texas; creating numerous employment opportunities statewide, regionally, and locally. Texas has set aggressive goals for establishing renewable energy under the Renewable Portfolio Standard; and in 2008 consolidated its position as the leading state in installed wind power capacity[1]. It is estimated that by meeting these goals, Texas will create 8,896 new local long-term jobs. By 2025, Texas is aiming to produce 10,000 MW of renewable energy with 500 MW from non-wind resources, such as solar and geothermal energy[2].

Both solar and geothermal energy sources show great potential for growth. According to the State Energy Conservation Office, Texas is considered to be the highest-ranking state in the nation for solar energy potential[3]. The U.S. Geological Survey has estimated the nationwide potential for geothermal energy production to be up to ten times the current installed capacity[4]. Likewise, the growth in energy efficiency and green building is leading national trends. In 2008, Texas led the country in the number of Energy Star-qualified new homes, with a market

penetration of 41%. This number is expected to continue to rise as the demand expands statewide for green building in local markets.

Although there is little evidence that the Texas economy is greening, there are a growing number of subjective indicators that indicate the importance of training a local green workforce. Currently there are four wind farms proposed for the Rio Grande Valley. On average, these projects have a demand for 350 workers during the construction phase and 20 permanent employees. One of these projects is the recent award of an offshore lease 10 miles off the shore of Texas that could result in the nation's biggest wind farm[5]. A second project is a 250-turbine wind farm which the E.ON corporation is developing in Willacy County near Raymondville. A third wind turbine project has been proposed for the Port of Brownsville by Cielo Corporation, which will generate enough power for 270,000 to 350,000 homes. In addition, a small geothermal company is looking to establish itself in Texas.

While the exact demand for labor for these endeavors is uncertain at this juncture, it is important to prepare the local workforce to take advantage of job opportunities when they become available. A report for the 2008 U.S. Conference of Mayors showed that the Brownsville-Harlingen MSA had 238 green jobs in 2006; and estimated that number would grow to 1,885 by 2038[6-7]. As this projection preceded the current green initiatives by the President, Texas aims to increase that number by providing a skilled workforce that can create and attract new green investments to a location that boasts natural environmental advantages.

New Green Technology Courses

The project investigator worked with UTB faculty to develop a green technology curriculum and integrate it with classroom activities. The course curriculum was based on the current literature, best practices of renewable energy, and applied projects [8-18]. The existing five specializations in the technical trade have been infused with the renewable energy courses to present new specializations in green technology. The following new courses in renewable energy were developed and added to these one-year certificate programs:

I. Air conditioning & Refrigeration Technology Certificate – Geothermal Heating & Air Cooling system specialization.

A. HART 1371. Introduction to Geothermal Heating/Cooling Systems. Course outcomes:

1. Understand the reverse cycle system.
2. Understand the functions of mechanical and electrical components for heating and cooling a heat pump.
3. Understand the operation of geothermal unit in the heating or cooling mode.
4. Demonstrate the charging procedure for a system in the heating and cooling mode.
5. Knowledge of troubleshooting electrical, mechanical, water source system.

B. HART 1372. Installation of Geothermal Heating/Cooling Systems. Course outcomes:

1. Demonstrate working knowledge of a reverse cycle system.

2. Assemble and disassemble the mechanical and electrical components for heating and cooling a heat pump.
3. Demonstrate ability to install a geothermal unit.
4. Charge a system in the heating and cooling mode.
5. Troubleshoot electrical, mechanical, water source system.
6. Understand the difference between horizontal loop, vertical loop, and direct expansion.

II. Commercial Electrician Certificate – Small Wind Turbine Technology

A. WIND 1371. Small Wind-Electric Systems. Course outcomes:
1. Demonstrate safe work habits while working with electricity.
2. Understand the operation of an electrical generator.
3. Understand the wind power equation.
4. Utilize Ohm's Law formulas to properly size the wind turbine generator.

B. WIND 1372. Safety Standards in Small Wind Systems. Course outcomes:
1. Demonstrate safe work habits while working with electricity.
2. Demonstrate the proper use of the lockout and tag-out procedures.
3. Explain electrical hazards in the workplace.
4. Explain how to avoid electrical hazard dangers in the workplace.

C. WIND 1373. Small Wind Turbine and Hybrid Wind-PV Installations. Course outcomes:
1. Demonstrate safe work habits while working with electricity.
2. Understand the operation of a small wind turbine generator.
3. Demonstrate the installation of a small wind turbine.
4. Demonstrate the installation of a solar photovoltaic generator.
5. Demonstrate the installation of the necessary wiring and hardware for the proper installation according to the National Electrical Code.

D. WIND 1374. Applications of Small Wind Systems. Course outcomes:
1. Understand wind turbine applications for residential installations.
2. Understand wind turbine applications for farm installations.
3. Understand wind turbine applications for commercial installations.
4. Understand wind turbine applications for school and church installations.
5. Understand city ordinance and city zoning applications for the placement of wind turbines.
6. Understand wind resources for wind turbine applications.

E. WIND 1300. Introduction to Small Wind Turbine Energy. Course outcomes:
1. Understand the evolution of wind turbine technology.
2. Understand general wind terminology.
3. Understand air flow characteristics.
4. Understand different blade efficiencies.

III. Residential Electrician Certificate – Solar Photovoltaic Technology Specialization

A. ELMT 1371. Safety Standards in Photovoltaic Systems. Course outcomes:
   1. Understand and describe safe work practices.
   2. Understand and describe the safety of the workers while installing the system, and the safety of all others who may come in contact with the system after it is installed.

B. ELMT 1372. Applications of PV Systems. Course outcome:
   1. The student will be able to understand, install, and test the systems in the laboratory provided by the instructor.

C. ELMT 1373. Solar PV Systems. Course outcome:
   1. Understand and describe the safety of the workers while installing the system and the safety of all others who may come in contact with the system after it is installed.

D. HART 1311. Solar Fundamentals. Course outcomes:
   1. Demonstrate safe and proper work habits.
   2. Categorize heat capacitance and specific heat values of various materials; categorize heat movement through reflection, absorption, radiation, and magnification.
   3. Categorize the collection control, dissipation, storage and distribution of heat energy.
   4. Maintain and repair mechanical equipment.

E. ELMT 1302. Solar PV System. Course outcomes:
   1. Design solar PV array.
   2. Define industry terms.
   3. Investigate certification requirements.
   4. Install troubleshoot systems.

IV. Plumbing Certificate – Solar Thermal Technology Specialization

A. SOLR 2371. Solar Piping and Materials. Course outcomes:
   1. Identify solar piping and materials; interpret specifications.
   2. Describe various types of solar pipes and fittings.
   3. Explain solar piping applications.
   4. Implement piping systems for solar applications.

B. SOLR 2372. Solar Thermal Systems. Course outcomes:
   1. Identify solar thermal systems and specifications.
   2. Describe various types of solar thermal components and applications,
   3. Identify and install plumbing systems.
   4. Calculate power requirements.
   5. Install control systems
   6. Commission various types of solar thermal systems.

C. SOLR 2373. Solar Thermal Equipment and Installations. Course outcomes:
   1. Identify solar thermal equipment and installation.
   2. Interpret solar thermal equipment specifications.
   3. Describe solar thermal components and applications.
   4. Install solar thermal systems.

D. SOLR 2374. Safety Standards for Solar Thermal Installations. Course outcomes:
   1. Define and identify safety and regulatory agencies in regards to the safety standards for solar and thermal installation.
   2. Implement safety standards for solar thermal installations.

E. SOLR 2375. Application of Solar Thermal Systems. Course outcomes:
   1. Identify applications of solar thermal systems.
   2. Define the benefits of heat generation and savings in fuel and fewer emissions which reduce the burden on the environment and the earth's climate.

V. Construction Technology Certificate – Green Building

A. CNBT 1371. Basic Remodeling. Course outcomes:
   1. Remodel residential buildings including green elements.
   2. Describe the procedures in procuring permits and establish executing contracts.
   3. Manage aspects of green building design and construction.

B. CNBT 1372. Sustainable Design/Green Building. Course outcomes:
   1. Students will learn to employ "systems approach" to optimize energy efficiency in building design.
   2. Students will be able to detect air leakages in buildings.
   3. Students will be able to incorporate building envelope tightness, insulation, ventilation, indoor air quality, energy efficiency, and comfort.

C. CNBT 1373. Alternate Building Material and Design. Course outcomes:
   1. Students will learn alternative designs, products, and methods of construction with an emphasis on efficient use of space, materials, and energy.
   2. Students will be exposed to the mainstream building designs, materials, systems, technologies, and methods of residential construction.
   3. Students will learn to implement environmentally responsive design building practices.

D. CNBT 1374. Energy Efficient Building Design. Course outcomes:
   1. Students will learn to employ "systems approach" to optimize energy efficiency in residential building design.
   2. Students will be able to detect air leakages in buildings.
   3. Students will be able to incorporate building envelope tightness, insulation, ventilation, indoor air quality, energy efficiency, and comfort.

E. CNBT 1375. Weatherization. Course outcomes:
   1. Identify aspects of improving the energy efficiency, health, comfort, and safety of new and existing homes.
   2. Perform energy audits, diagnostics, commissioning, certification, and computerized energy modeling.
   3. Apply weatherization strategies.

F. RBPT 1300. Fundamentals of Residential Building Science. Course outcomes:
   1. Discuss the whole-house approach to home construction using basic strategies to build energy-efficient, safe, and healthy homes with a variety of materials.
   2. Explain the movement in different climates of heat, moisture, and air through the building enclosure.
   3. Identify methods homeowners and building professionals use to contribute to the construction of resource-efficient, safe, healthy, and comfortable homes, while minimizing the impact on the environment.

Vertical Integration of Green Technology Curriculum

The one-year certificate program in green technology, with five specializations, is seamlessly integrated into the two-year Associate of Applied Science (AAS) program in renewable energy technology. Students have the option of completing the one-year certificate program and moving on to the AAS with an addition of 15 credits from any of the other four specializations. The renewable energy technology courses for these 15 credits are recommended by a faculty advisor. The five, one-year certificates with green technology specializations that are vertically integrated with the two-year AAS curriculum are given below:

- Commercial Electrician certificate – Small wind turbine technology (36 credits)
- A/C & Refrigeration Tech. certificate – Geothermal Heating & Cooling (30 credits)
- Residential Electrician certificate – Solar PV Technology (30 credits)
- Plumbing certificate – Solar thermal technology (30 credits)
- Construction technology certificate – Green Building (36 credits)

The structure of the AAS program is given below:

I. General Education courses: (16 Credits)
   A. ENGL 1301. Composition I. (3 credits)
   B. MATH 1314. College Algebra. (3 credits)
   C. MATH 1412. Pre-Calculus. (4 credits)
   D. ARTS 1301. Art Appreciation. (3 credits)
   E. XXX XXXX. Social/Behavioral Science. (3 credits)

II. Technical Core courses: (45-52 credits [from the certificates])

Total number of credit hours required for graduation with an AAS degree is 61-67 credits. The degree plan for the AAS in Renewable Energy Technology is given in Appendix II.

Plan to Sustain the Project

As with all technical programs at UTB, the renewable energy and green building courses are self-sustaining. Four funding mechanisms are utilized: student tuition and fees; state contact hour reimbursement based on utilization and development of WECM courses for all courses; the use of courses for corporate customized contract-based training; and the Skills Development Fund as well as federal grants. Federal sources such as Department of Labor grants are being utilized for the formation of an industry consortium, and for training for specific companies such as the E.ON corporation.

Conclusion

The project has been successfully completed in all aspects of curriculum development, procurement of renewable energy technology training kits, and obtaining training for the faculty. Following course development, the program was implemented in Fall 2011. Two classes of one-year certificate programs have followed the green technology curriculum to graduation. The AAS program is scheduled to graduate students in Spring 2013.

Other institutions in the state of Texas are able to take the developed green technology coursework, as submitted to WECM, and replicate the programs offered. This is potentially limited only by the existing internal capacity at a given institution. While the coursework prepares students for green job opportunities both statewide and nationwide, the strength of this program is its focus on local economic conditions and populations. Therefore, any institution adopting the curriculum would need to alter the content to specifically cater to its own local conditions.

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Appendix I

Award 19213 - Renewable Energies Technologies - 460412

Award Information

Award Action: Add

Award Status: Complete

Award Type: AAS

Award Title: Renewable Energies Technologies

Award CIP Code: 460412 - BUILDING/CONSTRUCTION SITE MANAGEMENT/MANAGER

Proposed Implementation Date: Sept. 1, 2011

Is this award taught at a correctional facility? No

Is this award Tech-Prep? No

Appendix II

AAS Degree Plan

1st Year

1st Semester

Course Number	Course Name	Course Type	Weekly Lec Hrs	Weekly Lab Hrs	Weekly Extended Hrs	Contact Hrs	Credit Hrs
Renewable Energy Technology Electives (15 hrs. from the courses listed below)							
CNBT 1301(OR)	Introduction to Construction	Elective	2	4	0	96	3
HART 1301	Basic Electricity for HVAC	Elective	2	4	0	96	3
ELTN 1391	ST: Electrical Blueprint Reading	Elective	2	4	0	96	3
HART 1307(OR)	Refrigeration Principles	Elective	2	4	0	96	3

HART 1311(OR)	Solar Fundamentals	Elective	2	4	0	96	3
CNBT 1302(OR)	Mechanical, Plumbing, and Electrical Systems in Construction	Elective	2	4	0	96	3
CNBT 1346	Construction Estimating I	Elective	2	3	0	80	3
ELPT 1345(OR)	Commercial Wiring	Elective	2	4	0	96	3
HART 1303(OR)	Air Conditioning Control Principles	Elective	2	4	0	96	3
ELPT 1320(OR)	Fundamentals of Electricity II	Elective	2	4	0	96	3
SOLR 2371(OR)	Solar Piping and Materials	Elective	2	4	0	96	3
CNBT 1391	Special Topics in Construction/Building Technology/Technician	Elective	2	4	0	96	3
ELPT 1325(OR)	National Electrical Code I	Elective	3	0	0	48	3
ELMT 1302(OR)	National Electrical Code I	Elective	2	4	0	96	3
PFPB 1306(OR)	Basic Blueprint Reading for Plumbers	Elective	2	4	0	96	3
CNBT	Basic Remodeling	Elective	2	3	0	80	3

1371							
1st Semester Totals (Maximum)			**10**	**20**	**0**	**480**	**15**

2nd Semester

Course Number	Course Name	Course Type	Weekly Lec Hrs	Weekly Lab Hrs	Weekly Extended Hrs	Contact Hrs	Credit Hrs
Renewable Energy Technology Electives (15 hrs. from the courses listed below)							
ELPT 1341(OR)	Motor Control	Elective	2	4	0	96	3
HART 1371(OR)	Introduction to Geothermal Heating & Cooling Systems	Elective	2	4	0	96	3
ELMT 1371(OR)	Safety Standards in Photovoltaic Systems	Elective	2	4	0	96	3
PFPB 1321(OR)	Plumbing Maintenance and Repair	Elective	2	3	0	80	3
RBPT 1300	Fundamentals of Residential Building Science	Elective	2	4	0	96	3
ELPT	Programmable Logic	Elective	2	4	0	96	3
HART 1341(OR)	Residential Air Conditioning	Elective	2	4	0	96	3

ELMT 1372(OR)	Applications of Photovoltaic Systems	Elective	2	4	0	96	3
SOLR 2373(OR)	Solar Thermal Equipment and Installations	Elective	2	4	0	96	3
CRPT 1325	Forms and Foundations I	Elective	2	4	0	96	3
WIND 1300(OR)	Introduction to Small Wind Turbine Energy	Elective	2	3	0	80	3
HART 1372(OR)	Installation of Geothermal Heating & Cooling Systems	Elective	2	4	0	96	3
ELMT 1373(OR)	Solar Photovoltaic Installations	Elective	2	4	0	96	3
PFPB 2309(OR)	Residential Construction Plumbing I	Elective	2	3	0	80	3
CRPT 1315	Conventional Wall Systems	Elective	2	4	0	96	3
ELPT 1315(OR)	Electrical Calculations I	Elective	3	0	0	48	3
ELTN	Special Topics in	Elective	2	4	0	96	3

1391(OR)	Electrician						
SOLR 2372(OR)	Solar Thermal Systems	Elective	2	4	0	96	3
CRPT 1311	Conventional Roof Systems	Elective	2	4	0	96	3
2nd Semester Totals (Maximum)			**10**	**20**	**0**	**480**	**15**

2nd Year

1st Semester

Course Number	Course Name	Course Type	Weekly Lec Hrs	Weekly Lab Hrs	Weekly Extended Hrs	Contact Hrs	Credit Hrs
Renewable Energy Technology Electives (15 hrs. from the courses listed below)							
WIND 1371(OR)	Small Wind Turbine Electric Systems	Elective	2	4	0	96	3
HART 2349(OR)	Heat Pumps	Elective	2	4	0	96	3
ELPT 1325(OR)	National Electric Code I	Elective	2	2	0	64	3
SOLR 2374(OR)	Safety Standards for Solar Thermal Installations	Elective	2	4	0	96	3
CNBT 1372	Sustainable Design/ Green Building	Elective	2	3	0	80	3
WIND 1372(OR)	Safety Standards in Small Wind Systems	Elective	2	4	0	96	3
HART	EPA Recovery	Elective	3	0	0	48	3

1356(OR)	Certification Preparation						
ELPT 1329(OR)	Residential Wiring	Elective	2	3	0	80	3
SOLR 2375(OR)	Applications of Solar Thermal Systems	Elective	2	4	0	96	3
CNBT 1373	Alternate Building Material and Design	Elective	2	3	0	80	3
WIND 1373(OR)	Small Wind Turbine and Hybrid Wind-PV Installation	Elective	2	4	0	96	3
HART 2301(OR)	Air Conditioning and Refrigeration Codes	Elective	3	0	0	48	3
CNBT 1375	Weatherization	Elective	2	3	0	80	3
WIND 1374(OR)	Applications of Small Wind Systems	Elective	2	4	0	96	3
HART 2336 OR HART 2388 (OR)	Troubleshooting Internship	Elective	2 0	4 0	0 12	96 192	3 3
CNBT 1374	Energy Efficient Building Design	Elective	2	3	0	80	3
1st Semester Totals (Maximum)			**10**	**20**	**0**	**480**	**15**

2nd Semester

Course Number	Course Name	Course Type	Weekly Lec Hrs	Weekly Lab Hrs	Weekly Extended Hrs	Contact Hrs	Credit Hrs
COMP 1301	Composition I	ACGM	3	0	0	48	3
MATH 1314	College Algebra	ACGM	3	0	0	48	3
CHEM 1311	General Chemistry I	ACGM	3	0	0	48	3
ARTS x3xx	Art Appreciation ARTS 1301 or Music Appreciation MUSI 1306	Elective	3	0	0	48	3
XXXX x3xx	Social/Behavioral Science Elective	Elective	3	0	0	48	3
CHEM 1111	General Chemistry Lab	ACGM	0	3	0	48	1
2nd Semester Totals (Maximum)			**15**	**3**	**0**	**288**	**16**
Program Totals			**45**	**63**	**0 or 12**	**1728**	**61**