

FINAL REPORT

Award Number: DE-EE0003857

Recipient: University of North Carolina at Charlotte (UNC Charlotte)

Project Title: NET-ZERO ENERGY BUILDING OPERATOR TRAINING PROGRAM (NZEBOT)

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Executive Summary

The primary objective of the *Net-Zero Energy Building Operator Training Program (NZEBOT)* was to develop certificate level training programs for commercial building owners, managers and operators, principally in the areas of energy / sustainability management. The expected outcome of the project was a multi-faceted mechanism for developing the skill-based competency of building operators, owners, architects/engineers, construction professionals, tenants, brokers and other interested groups in energy efficient building technologies and best practices. The training program draws heavily on DOE supported and developed materials available in the existing literature, as well as existing, modified, and newly developed curricula from the Department of Engineering Technology & Construction Management (ETCM) at the University of North Carolina at Charlotte (UNC-Charlotte).

The project goal is to develop a certificate level training curriculum for commercial energy and sustainability managers and building operators that:

- 1) Increases the skill-based competency of building professionals in energy efficient building technologies and best practices, and
- 2) Increases the workforce pool of expertise in energy management and conservation techniques.

The curriculum developed in this project can subsequently be used to establish a sustainable energy training program that can contribute to the creation of new “green” job opportunities in North Carolina and throughout the Southeast region, and workforce training that leads to overall reductions in commercial building energy consumption.

Three energy training / education programs were developed to achieve the stated goal, namely:

1. Building Energy/Sustainability Management (BESM) Certificate Program for Building Managers and Operators (40 hours);
2. Energy Efficient Building Technologies (EEBT) Certificate Program (16 hours); and
3. Energy Efficient Buildings (EEB) Seminar (4 hours).

Training Program 1 incorporates the following topics in the primary five-day Building Energy/Sustainability Management Certificate program in five training modules, namely: 1) Strategic Planning, 2) Sustainability Audits, 3) Information Analysis, 4) Energy Efficiency, and 5) Communication.

Training Program 2 addresses the following technical topics in the two-day Building Technologies workshop: 1) Energy Efficient Building Materials, 2) Green Roofing Systems, 3) Energy Efficient Lighting Systems, 4) Alternative Power Systems for Buildings, 5) Innovative Building Systems, and 6) Application of Building Performance Simulation Software.

Program 3 is a seminar which provides an overview of elements of programs 1 and 2 in a seminar style presentation designed for the general public to raise overall public awareness of energy and sustainability topics.

Accomplishment of Project Goals and Objectives

The project goals and objectives were accomplished as outlined in Table 1.

Table 1: Project Goals and Objectives Summary: A comparison of the actual accomplishments with the goals and objectives established.

Goals and objectives established for the period	Actual accomplishments	Established goals met?	Reasons if not met
Identify energy efficiency knowledge gaps in existing programs	Complete	Yes	NA
Develop plan to address the gaps with either modified or new curricula.	Complete	Yes	NA
Go/recycle/no-go DOE determines whether or not to proceed.	Complete	Yes	NA
Curricula Development Prepare detailed description of the subject matter content and develop finished training material.	Complete	Yes	NA
Consolidated Training Material Synthesis and formatting of information into a clear and comprehensive program encompassing all subject matter content to be taught.	Complete	Yes	NA
Recognition/Certification/Accreditation Plan	Complete	Yes	NA
Commercialization and Sustainability Plan	Complete	Yes	NA

While this project was underway, the National Renewable Energy Laboratory (NREL) initiated a project to develop (1) job task analyses (JTAs), to identify and catalog all of the activities a worker performs in a given job; and (2) the knowledge, skills, and abilities (KSAs), which define the minimum requirements necessary for a person to adequately perform tasks related to commercial building job categories. In late 2011, a draft document for public comment was released by NREL for public review. This NREL draft document defined the following six commercial building job categories:

- Operating engineer/building technician
- Building energy auditor
- Energy/sustainability manager
- Energy modeler
- Commissioning/retro-commissioning practitioner
- Facility manager

The stated goal was to create “national guidelines” defining a common body of knowledge that any training organization would be able to draw from when developing curriculum. This body of knowledge would also be used by the General Services Administration and the Department of Energy to help meet the requirements of the Federal Buildings Personnel Training Act of 2010.

The categories were described in the NREL draft as follows on the DOE EERE website:

Commercial Building Energy Auditor: A Commercial Building Energy Auditor is an energy solutions professional who assesses facility systems, observes site conditions, analyzes and evaluates equipment and energy usage, and recommends strategies to reduce energy, water, and associated costs to help clients meet established goals.

Commissioning/Retro-Commissioning Authority: A Commissioning/Retro-Commissioning Authority manages the development and implementation of a documented quality assurance process to verify that new or existing buildings function according to the owner's requirements.

Commercial Building Energy Modeler: A Commercial Building Energy Modeler constructs engineering and economic models to represent the performance of buildings, in order to evaluate and quantify the impact of policy, design, retrofit, and operational decisions.

Energy/Sustainability Manager: An Energy/Sustainability Manager monitors energy and material consumption in facilities by performing site audits and conducting energy and sustainability analyses, to identify opportunities to increase building efficiencies, promote renewable resources, and minimize the social, environmental, and financial impacts of an organization's operation.

Facility Manager: A Facility Manager is a building maintenance specialist and property administrator who conducts building operations and maintenance activities, coordinates facility programs and projects, and supervises building personnel by inspecting the facility, analyzing building data, forecasting future needs, solving problems, and communicating with others to ensure the efficient and sustainable operations of the facility and the satisfaction of the facility occupants.

Operating Engineer/Building Technician : An Operating Engineer/Building Technician is a professional who manages commercial and laboratory buildings by maintaining, operating, and repairing HVAC, life safety, electrical, and plumbing systems, and performing general building maintenance to optimize equipment performance, maintain the building's operability, and ensure the comfort and safety of occupants.

Direction provided from DOE was to align our training program with one of these job categories when the project published the draft report defining the JTAs. The draft of the JTAs was distributed for public comment in late 2011 with public comment to close at the end of November 2011. Upon review of the draft JTA documents, the project team determined that the project was not an exact match for any one of the six commercial building job categories. This project and its goals were designed for technical professionals engaged with technical aspects of building operation at a professional level; as such, the program which most closely aligned was the energy/sustainability manager. Hence, a fresh gap analysis was performed to determine what additional content would need to be added to align the course content to the draft JTA for the Energy/Sustainability Manager job classification.

The project objectives were modified as per request from DOE to concentrate on developing a program which closely aligned with the KSAs from the JTA draft report. The revised course focused on an Energy/Sustainability Manager Certificate Training Program. Programming was

developed which addressed the changing needs of DOE during the project. The fundamentals program from the original statement of work was eliminated to allow time to develop the revised program. That fundamentals certificate, Energy Efficient Building Operators Fundamentals Program (EEBOT), was basic background material for building operators, material that is effectively covered by other training programs in the market.

Three training programs were developed as part of this project, namely:

1. Building Energy/Sustainability Management (BESM) Certificate Program for Building Managers and Operators (originally labeled Energy Efficient Building Operators Certificate Program (EEBOC) but modified to a 5- day certificate program to match Energy/Sustainability Manager JTA topics with identified KSAs defined mid-project by DOE NREL and subsequently titled Building Energy/Sustainability Management (BESM) Certificate Program for Building Managers and Operators);
2. Energy Efficient Building Technologies Certificate (EEBT); and
3. Energy Efficient Building Seminar (EEB) (4 hours).

The primary program developed is the Building Energy/Sustainability Management for Operators (BESM) Certificate Program as previously described. This is a five day program. Program 2, Energy Efficient Building Technologies (EEBT) Certificate program is a two day program covering advanced technologies. The third program developed is the Energy Efficient Building (EEB) Seminar, developed for the general public as an awareness program to stimulate interest in the community. Additional descriptions for each training program and the concurrent academic programs developed as concentrations is provided as follows:

Building Energy/Sustainability Manager (BESM) Certificate Program

A detailed curriculum was developed for the Energy/Sustainability Manager Certificate Training Program, a five-day program. Training materials were formatted into a clear and comprehensive program encompassing all subject matter content to be taught. The training program provides concurrent lesson plans with specific learning activities for five modules, including Strategic Planning, Sustainability Audits, Information Analysis, Energy Efficiency, and Communication. A certification exam was developed based on the training material developed in order to provide a complete assessment of subject matter knowledge gained.

Energy Efficient Building Technologies (EEBT) Certificate Program

This short course addresses the following technical topics in the two-day Building Technologies workshop designed to introduce advanced technologies to building managers and operators: 1) Energy Efficient Building Materials, 2) Green Roofing Systems, 3) Energy Efficient Lighting Systems, 4) Alternative Power Systems for Buildings, 5) Innovative Building Systems, and 6) Application of Building Performance Simulation Software. This two-day course covers newly developed energy efficient building technologies.

Energy Efficient Building (EEB) Seminar

This seminar is for owners, tenants, brokers, leasing, and sales staff with little or no technical knowledge. This program provides an appreciation for and a basic understanding of the specific benefits of improved energy performance using case studies. This half-day seminar

provides an overview of elements of programs 1 and 2 in a seminar style presentation designed for the general public to raise overall public awareness of energy and sustainability topics.

Academic Courses offered as Concentrations

The Department of Engineering Technology & Construction Management (ETCM) at the University of North Carolina at Charlotte (UNC-Charlotte) has organized academic courses leading to two energy related concentrations for enrolled students majoring in the Department's BSET and BSCM programs. The two concentrations, which are being reviewed for approval to offer beginning in 2014, are identified below.

Applied Energy & Sustainable Systems Certificate (14 credits)

A concentration in Applied Energy and Sustainable Systems is available to students successfully completing the following:

1. CMET 2680 Professional Development II: Sustainable Engineering and Construction
2. ETCE 2410 Intro to Environmental Engineering Technology
3. ETCE 3271 Building Systems or ETCE 3242 Hydraulics & Hydrology
4. ETCE 3271L Building Systems Laboratory or ETCE 3242L Hydraulics Laboratory
5. Any two (2) of the following courses
 - a. ETGR 3000: Special Topics in Energy / Sustainability
 - b. ENER 4140 Energy Management
 - c. ENER 4250 Analysis of Renewable Energy Systems
 - d. ENER 4275 Air Conditioning Systems
 - e. ETCE 3271 Building Systems or ETCE 3242 Hydraulics & Hydrology
 - f. SEGR 4961 Introduction to Energy Systems
 - g. SEGR 4962 Energy Markets

Energy Certificate (Choose 12 credits from the following list)

A concentration in Energy is available to students successfully completing the following:

ENER 4140	Energy Management
ENER 4250	Analysis of Renewable Energy Systems
ENER 4260	Hydrogen Production and Storage
ENER 4275	Air Conditioning Systems
ENER 4280	Fuel Cell Technology
ETGR 3000	Special Topics in Energy
ETCE 3271	Building Systems
SEGR 4961	Introduction to Energy Systems
SEGR 4962	Energy Markets

In general, these concentrations require completion of 12 to 14 credit hours of coursework and are then identified on the academic transcript along with the degree at graduation. These energy concentrations have the potential to impact approximately 800 undergraduate students in ETCM. Students completing the Special Topics in Energy/Sustainability course also receive the BESM Certification at completion.

Summary of Project Activities

Project activities were geared toward achievement of milestones and production of deliverables as summarized in the project task milestones and included as table 2 below.

Table 2: Project Task Milestones with planned and actual completion dates:

Milestone Log			
Milestones		Planned Completion Date (Revised due to NREL JTA/KSA delays and no-cost extension)	Actual Completion
1.0	Project Management Plan	August 31, 2010	August 31, 2010
2.0	Integration Plan	January 31, 2011	January 31, 2011
3.0	Curricula Deficiencies/Needs Analysis	April 30, 2011	April 30, 2011
	Go/Recycle/No Go Review	May 30, 2011	May 09, 2011
4.0	Curriculum Development Plan	November 30, 2012	Nov. 30, 2011
5.0	Consolidated Training Material	November 30, 2012	Nov. 30, 2012
6.0	Recognition/Certification Plan	December 15, 2012	Dec. 15, 2012
7.0	Commercialization/Sustainability Plan	December 31, 2012	Dec. 31, 2012

Milestone 1: Project Management Plan Revised (August 31, 2010)

The PMP was revised and submitted.

Milestone 2: Integration Plan (January 31, 2011)

Course outlines and syllabi with detailed sequenced topic areas to be covered along with a paragraph synopsis of each were prepared.

Milestone 3A: Curricula Deficiency/Developmental Needs Analysis (April 30, 2011)

Energy efficiency knowledge gaps in existing programs were identified with assistance from industry professionals. A plan was developed and reported to address the gaps.

Milestone 3B: Go/recycle/no-go (May 30, 2011)

DOE provides Go decision after reviewing the Needs Analysis.

Milestone 4: Curricula Development (November 30, 2012)

Detailed description of the subject matter content was nearing completion. About the same time the NREL JTA/KSA draft report was being developed for public comment. DOE directed project direction change to review the JTA/KSA preliminary findings and incorporate into the curriculum development process at this time. A review of the draft JTA/KSA documents revealed significant incongruity among the six identified job functions and the initial course descriptions developed to that point. At this juncture, the curriculum required significant rework to align with any of the six job functions. The decision to align with Energy/Sustainability Manager required a new gap analysis and significant additional curriculum development. This essentially required an additional 6 months of effort. No additional funds were requested, but a no-cost extension would ultimately be necessary for the project as a result of these developments

and the timing of the release of the JTA/KSA draft report and effort to assimilate additional content identified in that reporting. A brief summary describing the curriculum changes related to the NREL job task analysis is shown in Table 3 on the next page. The changes listed as “needs changes” in the table required additional new material development by the project team. All elements of this additional work have been completed.

The detailed training material was modified and expanded to the new program of Energy/Sustainability Manager Certificate Program as the core certification program. Material to integrate the knowledge and skills identified in the EERE BUILDING TECHNOLOGIES Job/Task Analysis for Energy / Sustainability Manager were developed. In addition, materials for the public awareness and emerging technologies programs were also completed. The fundamentals module was dropped to allow time / effort to address this change request.

Internally, the ETCM Department at UNC Charlotte has integrated much of this content into Energy concentrations in the BS Engineering Technology & Construction Management curricula. Those concentrations are currently being formalized and submitted for final approvals internally. Additionally, some of the content is also integrated into the MS Applied Energy program and a graduate certificate in Applied Energy is proposed for delivery in 2014. A number of these modules are being beta tested this fall and next spring.

Table 3. Changes to curriculum based on items from NREL JTA/ KSAs proposed content blueprint for Energy/Sustainability Managers (Second Gap Analysis to accommodate NREL)

Duties and Tasks		Weighting	Changes
A	Developing Strategic Plans	26%	
1	Set-up Task Force	2%	Complete
2	Select Program Team	2%	Needs changes
3	Assess Existing Conditions	3%	Complete
4	Identify Future Industry Trends	2%	Needs changes
5	Establish Goals and Targets for Strategic Plan	3%	Complete
6	Develop Operational Matrix	2%	Complete
7	Write Energy Management and Sustainability Policies, Standards, and Guidelines	3%	Needs changes
8	Develop Implementation Plan	3%	Complete
9	Obtain Stakeholder Buy-In	3%	Needs changes
10	Develop Energy and Sustainability Program Budget	3%	Complete
B	Performing Site Audits	18%	
1	Perform Sustainability Audit	2%	Complete
2	Perform Energy Audit	3%	Complete
3	Perform Water Audit	2%	Needs changes
4	Perform Universal Waste Audit	2%	Needs changes
5	Evaluate Energy and Sustainability Opportunities	3%	Complete
6	Identify Non-Financial Impacts	3%	Complete
7	Finalize Sustainability and Energy Recommendations	3%	Needs changes
C	Performing Energy and Sustainability Accounting and Analysis	22%	
1	Conduct Building Energy Modeling	2%	Complete
2	Trend Operational Conditions	3%	Complete
3	Benchmark Sustainability Performance Measures	3%	Complete
4	Track Utility Costs and Consumption	4%	Complete
5	Track Sustainable Purchasing Programs	2%	Needs changes
6	Develop Performance Metrics for Energy and Sustainability Initiatives	3%	Complete
7	Calculate Carbon Footprint	2%	Complete
8	Determine Savings and Avoidance	3%	Complete
D	Improving Energy Efficiency and Sustainability	22%	
1	Improve Operations and Maintenance Procedures	3%	Complete
2	Optimize System Efficiency	3%	Complete
3	Ensure Optimum Performance of Equipment	3%	Complete
4	Manage Continuous Commissioning	3%	Needs changes
5	Integrate Energy and Sustainability Initiatives into Operations and Maintenance	3%	Complete
6	Implement Energy Conservation and Sustainability Measures	4%	Complete
7	Plan for New Construction	3%	Complete
E	Communicating with Others	12%	
1	Provide Energy and Sustainability Updates	3%	Needs changes
2	Participate in Third Party Recognition Programs	3%	Complete
3	Create a Culture of Sustainability	3%	Needs changes
4	Create Public Outreach Program	3%	Complete
Total		100%	

The changes listed as “needs changes” in Table 3 required additional new material development by the project team. All elements of this additional work were completed.

Milestone 5: Consolidated Training Material (November 30, 2012)

Synthesis and formatting of the training materials into a clear and comprehensive program encompassing all subject matter content was completed. The training program provides concurrent lesson plans which align with required elements of each certificate or seminar as outlined in the previous section and in the project goals and objectives section.

Milestone 6: Recognition/Certification Plan (December 15, 2012)

The plan for recognition and certification was completed. UNC Charlotte is authorized to provide certificate programs and continuing professional development and continuing education units (CEUs). Some of the developed material will be part of the existing programs that are already accredited at UNC Charlotte. In addition, UNC Charlotte will issue continuing education units for the NZEBOT courses for practitioners and develop a certificate program for individuals completing all the program requirements at UNC Charlotte. Moreover, formal external recognition of the proposed programs will be explored with a variety of governmental and professional organizations and through major employers. The plan is to work with these organizations such that they *recognize* the program and credit hours or continuing education units awarded for the Building Operator Certification classes. Recognition means the organization formally endorses the program as a professional development opportunity for employees or members. Certification standards and requirements will include assessment of subject matter knowledge gained, the ability to apply critical thinking skills (e.g. problem solving), and communication skills (e.g. writing/presentations).

Formal recognition of the Building Energy/Sustainability Manager Certification (BESM) program in the marketplace is expected to grow once the certificate program is offered. The plan envisions partner agreements which will be developed with various organizations to recognize BESM for their members, and acknowledgement of continuing education units for BESM classes. Recognition by the organization means the organization formally endorses the program as a professional development opportunity for employees or members.

The following organizations and employers are identified as initial targets for partnering to either accredit or recognize BESM coursework and certification (Tables 4-6).

Table 4: Prospective sustainability and energy efficiency organizations to recognize BESM

Organization
NC / SC Boards of Professional Registration
Department of Energy
Sustain Charlotte http://sustaincharlotte.org/home/sustain_charlotte-home.php
Envision Charlotte http://www.envisioncharlotte.com/
US Green Building Council. Charlotte Region Chapter http://www.usgbccrc.org/default.asp
Charlotte Center City Partners http://www.charlottecentercity.org/
Department of Labor
North Carolina General Administration (and other states)
US Department of Defense
Governors and State Energy Offices

Table 5: Prospective Professional organizations to recognize BESM

Professional Organizations
International Facility Management Association (IFMA)
American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) 029 NORTH PIEDMONT GREENSBORO, NC 030 SOUTHERN PIEDMONT CHARLOTTE, NC 031 SOUTH CAROLINA COLUMBIA, SC 032 ATLANTA ATLANTA, GA 097 GREENVILLE GREENVILLE, SC 106 TRIANGLE RAL / DURHAM, NC 113 CHARLESTON CHARLESTON, SC
American Society of Mechanical Engineers (ASME)
Association of Energy Engineers (AEE)
Association for Facilities Engineering (AFE)
Building Owners and Managers Association International (BOMA)
American Society for Healthcare Engineering (ASHE)
Air Conditioning Contractors of America (ACCA)
Association of Energy Services Professionals (AESP)
The Energy and Environmental Building Alliance (EEBA)
Society of Women Engineers (SWE)
NATIONAL ASSOCIATION OF WOMEN IN CONSTRUCTION
Building Science Corporation (BSC)
U.S. Green Building Council
Association of general contractors
National Council of Structural Engineers Association (NCSEA)

Table 6: Prospective Regional Employers Identified for recognition agreements for BESM

Company	Industry
Advanced Development Concepts, LLC	Construction
American Trutzschler, Inc.	Manufacturing
Americ-Evolved Manufacturing, LLC	Manufacturing
Avalon Flooring, LLC	Construction
B&B Holdings, Inc.	Construction
Babcock & Wilcox Company	Manufacturing
Bank of America Corporation	Finance
Barnhardt Manufacturing Company	Manufacturing
BCF Piping, Inc.	Construction
Belk Printing, Inc.	Manufacturing
Black River Energy, LLC	Utilities
Blythe Development Company	Construction
Bonterra Builders, LLC	Construction

BV Belk Investments and Development	Construction
Carlisle Companies, Inc.	Manufacturing
Carmel Construction, Inc.	Construction
Carolina Foods, Inc.	Manufacturing
Carolina Handling, LLC	Manufacturing
Carolina Healthcare Foundation, Inc.	Healthcare
Carolina Steel & Stone, Inc.	Construction
Cartner Glass Systems, Inc.	Construction
CEM Corporation	Manufacturing
Champion Residential Services, Inc.	Construction
Charlotte Mecklenburg Hospital Authority	Healthcare
Classic Graphics, Inc.	Manufacturing
Coats North America	Manufacturing
Coca-Cola Bottling Co.	Manufacturing
Color Craft Printing Company, Inc.	Manufacturing
Controls Southeast, Inc.	Manufacturing
Cox & Schepp, Inc.	Construction
Crescent Resources, LLC	Construction
Crowder Construction Company	Construction
D.W.Flowe&Son, Inc.	Construction
Davis Homes, Inc.	Construction
Davis Steel and Iron Company, Inc.	Manufacturing
Designline Corporation	Manufacturing
Duke Energy Corporation	Utilities
Eastwood Construction Company, Inc.	Construction
Edifice, Inc.	Construction
Edison Foard, Inc.	Construction
Electrolux North America, Inc.	Manufacturing
EnPro Industries, Inc.	Manufacturing
Environamics, Inc.	Construction
FHG, Inc.	Construction
Floyd King & Sons, Inc.	Construction
Fontaine Modification Company	Manufacturing
Goodrich Corporation	Manufacturing
Griffin Masonry, Inc.	Construction
GSD Corporation	Manufacturing
Heard-Ratzlaff Construction, Inc.	Construction
Ingersoll-Rand Company	Manufacturing
Intercon Building Corporation	Construction
Ira L. Griffin Sons, Inc.	Manufacturing
Itek Graphics, LLC	Manufacturing
J&T Trading Company	Manufacturing
J.F. Schultze Construction, LLC	Construction

James River Cogeneration	Utilities
Jim Myers & Sons, Inc.	Manufacturing
Lennar Carolina, LLC	Construction
Lions Services, Inc.	Manufacturing
Lockwood Identity, Inc.	Manufacturing
Loftis Construction Corporation	Construction
Marand Builders, Inc.	Construction
Marlof Construction, Inc.	Construction
Marshall Air Systems, Inc.	Manufacturing
Max Daetwyler Corporation	Manufacturing
McGee Corporation	Manufacturing
Metrolina Builders, Inc.	Construction
Morgan Corporation	Construction
Mueller Die Cut Solutions, Inc.	Manufacturing
Mulvaney Homes, Inc.	Construction
Murata Machinery USA Holdings, Inc.	Manufacturing
Nucor Corporation	Manufacturing
O'Brien & Gere/Crowder	Construction
Old North State Masonry, LLC	Construction
Otto Industries North America, Inc.	Manufacturing
PC Godfrey, Inc.	Construction
Piedmont Natural Gas Company, Inc.	Utilities
Pike Energy Solutions, LLC	Sci and Tech
Polymer Group, Inc.	Manufacturing
Polypore International, Inc.	Manufacturing
Price Brothers, Inc.	Construction
Provident Development Group, Inc.	Construction
Quality Sprinkler Company, Inc.	Construction
R&G Construction Company, Inc.	Construction
Randolph & Son Builders, Inc.	Construction
Red Clay Industries, Inc.	Construction
Rexam, Inc.	Manufacturing
Sanders Utility Construction Company, Inc.	Construction
Scurry Construction, Inc.	Construction
Showalter Construction Company, Inc.	Construction
Snyder's-Lance, Inc.	Manufacturing
Sorensen Gross, Inc.	Construction
Source Technologies, Inc.	Manufacturing
Southern Electrical Equipment Company, Inc.	Manufacturing
Southern Mechanical of the Carolinas, Inc.	Construction
Southern Steel Company, LLC	Manufacturing
Southside Constructors, Inc.	Construction

Specialty Manufacturing, Inc.	Manufacturing
SPX Corporation	Manufacturing
Titan Construction Group, LLC	Construction
Trinity Mechanical Systems, Inc.	Construction
Tyler 2 Construction, Inc.	Construction
Ultrablend, LLC	Manufacturing
United Construction Company, Inc.	Construction
United Mechanical Corporation	Construction
Ward Tank and Heat Exchanger Corporation	Manufacturing
Waxhaw Stainless Fabricators, LLC	Manufacturing
XSYS Print Solutions US, LLC	Manufacturing

Milestone 7: Commercialization and Sustainability Plan (December 31, 2012)

The NZEBOT commercialization and sustainability plan was developed with input from the project team and industry advisory members. It addresses marketing, deployment, financial characterization, and sustainability of the program(s) to support workforce development in energy and sustainability. The certification and training programs will be marketed under the Energy Production & Infrastructure Center umbrella at UNC Charlotte with assistance from our continuing education group. The Energy Production and Infrastructure Center (EPIC) at UNC Charlotte was formed in response to the need from industry to supply highly trained engineers qualified to meet the demands of the energy industry – through traditional and continuing education, and provide sustainable support the Carolina energy industry by increasing capacity and support for applied research. EPIC has a new \$76M building with additional industry investments of approximately \$16M in gifts and an annual operating budget of approximately \$5M from the state of North Carolina. EPIC is a highly collaborative industry/education partnership that produces a technical workforce, advancements in technology for the global energy industry while supporting the Carolinas’ multi-state economic and energy security. The energy industry faces a workforce crisis just as there is a need to build new energy facilities and UNC Charlotte has a history of supplying professional talent to energy and engineering firms. An ample energy supply and well-trained professional workforce are foundations for economic development and the Charlotte Region is an energy expertise hub that can become more vibrant through EPIC. EPIC is at the center of the Charlotte energy hub which is surrounded by more than 250 regional energy corporations that include Duke Energy, Siemens, AREVA, Westinghouse, the Electric Power Research Institute (EPRI), The Shaw Group, URS Washington Group, STEAG, and many others. Industry involvement is led through a board of advisors that oversees the center's strategy and helps build industry relations. A separate industry implementation team is working with the university to align curriculum to industry needs, assist in student projects and identify research topics.

Project Completion (December 31, 2012)

All project elements were completed in December 2012 except for final reporting requirements.

Products Developed

Products developed under the award include items under other category to include:

- Comprehensive curriculum materials for the NZEBOT project. This includes the primary course, Building Energy/Sustainability Manager (BESM) Certificate Program. Training materials were developed to correspond to the corresponding JTA: Energy/Sustainability Management.
- Website for the NZEBOT program at <http://nzebot.uncc.edu/>

The primary training program provides lesson plans with specific learning activities for five modules to include:

- Strategic Planning
- Sustainability Audits
- Information Analysis
- Energy Efficiency
- Communication

Materials developed for the Building Energy/Sustainability Manager (BESM) Certificate Program include:

- Curriculum Workbook for Participants
- Corresponding lesson plans
- Powerpoint presentations
- Certification examination

The project has ended and all course modules are developed. Deliverables for the course modules were provided to the DOE separate from this final report. Initial delivery of training modules is planned for spring 2014. The curriculum outline table of contents for the Building Energy/Sustainability Management (BESM) Certificate Program for Building Managers and Operators (40 hours) is appended to this report as Appendix A and the curriculum outline table of contents for the Energy Efficient Building Technologies (EEBT) Certificate Programs (16 hours) is included as Appendix B.

Appendix A: BESM Curriculum Outline



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE *of* ENGINEERING

Department of Engineering Technology and Construction Management

NET-ZERO ENERGY BUILDING TRAINING PROGRAM

Building Energy/Sustainability Manager (BESM) Certificate Program

Developed with funding from DOE award number DE-EE0003857 under project title:

NET-ZERO ENERGY BUILDING OPERATORY TRAINING PROGRAM (NZEBO)

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Building Energy/Sustainability Manager (BESM) Certificate Program

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Appendix B: EEBT Curriculum Outline



UNC CHARLOTTE

The WILLIAM STATES LEE COLLEGE of ENGINEERING

Department of Engineering Technology and Construction Management

NET-ZERO ENERGY BUILDING OPERATOR TRAINING PROGRAM

Energy Efficient Building Technologies (EEBTC) Certificate Program

Notebook

Highly Efficient Building Technologies

EEBTC 01 – Highly Efficient Building Technologies

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Department of Engineering Technology and Construction Management

NET-ZERO ENERGY BUILDING OPERATOR TRAINING PROGRAM

Energy Efficient Building Technologies Short Course (EEBTC)

Notebook

Highly Efficient Building Simulation Short Course

EEBTC 02 – Simulation and Case Studies of Building Performance

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