Subject Matter Expert Review

TAACCCT Grant – Round 1

Findings & Report

Program: Renewable Energy Solar

Program Courses: NRG 110 (Construction Standards), NRG 200 (Solar Energy Systems), NRG 201 (Photovoltaic Systems I), NRG 202 (Photovoltaic Systems II), NRG 203 (Concepts of Solar Thermal Design), NRG 204 (Cooperative Work Experience), NRG 207 (NABCEP Prep Class)

Faculty Developer(s)/Instructional Designer(s): Jennifer Clemons, David LaFazia, Cory Budischak

Subject Matter Expert: Matthew Fedorko

Subject Matter Expert Credentials:

- Masters Degree in Industrial Technology with a concentration in Renewable Energy.
- Five years with The Pennsylvania State University coordinating their work as a Regional Training Provider for the Department of Energy's Solar Instructor Training Network. This included:
    - Extensive experience with instructional design of face to face, online, and hybrid solar photovoltaic and solar thermal courses at a variety of institutions.
    - Organizing and leading wide variety of introductory, intermediate, and advanced solar courses at Penn State for resident Penn State students and instructors at other educational institutions in four states.
    - Developing curriculum for teaching instructors how to teach solar topics online.
    - Developing curriculum for the Department of Energy's Solar Ready Vets program.
    - Serving on multiple Advisory Board committees for community colleges' solar programs.

Date of Review: August, 2015

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Synopsis of Findings:

Delaware Technical Community College's Renewable Energy Solar Option is a strong program that should produce capable, knowledgeable graduates. Overall, I found very few deficiencies in their approach, their stated objectives, their content, or their assessments. The way they have organized the program, the type of materials they're using, and the specific learning objectives are in line with the majority of solar programs of which I am aware. I would have appreciated seeing a statement from DTCC about what type of jobs that graduates would or should pursue, which would give me a better sense of how students would end up using what amounts to the "standard solar curriculum." Based on my review of the existing curriculum, I believe the graduates would be best suited to enter as over-qualified installers, or as entry-level designers, or at some other related part of the solar project development process.

With that in mind, I would encourage DTCC program staff to make efforts early and often throughout the program to include content on:

1. The rapidly changing nature of the solar industry, including:
    a. The normalization of solar installations to existing construction processes, procedures, and staffing
    b. Vertical integration of large installers resulting in employee specialization
    c. The broader energy market, including regular policy changes for solar at the state level and the current natural gas boom
2. Career paths and backgrounds for a variety of existing jobs in the solar market
3. The need for students to be exposed to real world documents and paperwork, conditions and restrictions, and applications of the theory they're learning in class.
4. The portions of the solar project development process that aren't made explicit, so that the student can track all of the players that might be involved in a residential or small commercial system, as well as:
    a. Understand the role and motivations of each
    b. Understand the knowledge necessary for these people to perform their jobs well

I do not mean to diminish the work DTCC has accomplished by referring to it as "standard." Rather, I think that DTCC's solar classes are impressive representatives of a type. The inclusion of these classes beside the Construction Standards class and Co-Op opportunities, as well as inside a larger program (not under review here) ensures that the students graduating will be of a higher caliber than comparable programs that also feature "standard solar curriculums." I believe that if graduating students also are able to demonstrate to employers a thorough knowledge of the industry and communicate exactly which position they want or a desired career path, they will be hired as they walk across the graduation stage.

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1. PROGRAM AND COURSE OVERVIEW AND OBJECTIVES	The overall design and purpose of the program and each course is made clear to the student. Core Course Performance Objectives (CCPO's) build upon knowledge and skills through the sequence of the program and align to the Program Graduate Competencies (PGC's).

Specific Review Standard	**Accomplished**	**Satisfactory**	**Not satisfactory**
1.1 The program graduate competencies are clearly stated.		X	
1.2 The goals and purpose of each course are clearly stated.	X		
1.3 Prerequisites and/or any required competencies are clearly stated.	X		
1.4 Learning objectives for each course describe outcomes that are measurable.	X		
1.5 Learning objectives are appropriately designed for the level of each of the courses.	X		
1.6 Instruction, activities, and assignments in courses are scaffolded from course to course, and throughout the program.	X		

Comments: Delaware Technical Community College has done a good job creating a strong set of program graduate competencies and solar-related learning objectives. While portions of the PGCs are addressed in coursework not under review here (PGC 1- 3), the PGCs as a whole point to a desire by DTCC program staff to develop a well-rounded broadly competent student. The knowledge, skills, and abilities (KSAs) outlined in the PGCs and the individual course learning objectives would be as useful to a student intent on entering the solar industry as it would be to someone who works with building energy efficiency or the larger energy efficiency market with less direct work with solar energy.

Considering the thorough and excellent job done in each course to document the core course performance objectives and the measurable performance objectives, I believe PGCs 5 – 7 could be rewritten to better reflect both the impressive depth of the content and to better advertise to the student or to employers the KSAs that students will gain in this program (more on this in the Relevancy section of this review).

For example, consider PGC #7 beside the CCPOs and MPOs of NRG202 – PV Systems II. The content as described in the objectives is at a much greater depth than PGC#7 would indicate. The

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PGC as written does communicate that the student would have an understanding of basic electrical design principles ("deriving panel configuration" implying an understanding, at a minimum, the concepts of series and parallel wiring, the voltage limitations of NEC 690.7, and the basic concepts of string and inverter matching). However, there is much involved in the process of starting with a potential solar site and ending with a completed project. Much of that process is captured in existing CCPOs and MPOs, especially the latter, and that should be incorporated into either more PGCs or rewritten versions of the existing PGCs that concisely but more fully reflect what the student will be able to do upon completion of the program, as well as the full scope of the solar project development process.

Finally, not to be too focused on the minutia, but it would be more appropriate to say "estimate the output of an...array" rather than "calculate the output" in PGC #7.

2. RELEVANCY	Program Graduate Competencies (PGC's) and Core Course Performance Objectives (CCPO's) are relevant to students, industry, and employers.

Specific Review Standard	**Accomplished**	**Satisfactory**	**Not satisfactory**
2.1 Program Graduate Competencies (PGC's) represent industry's expectation of the overarching knowledge, skills, and abilities an associate-degree level student should have.	X		
2.2 Program competencies (PGC's) and core course competencies (CCPO's) are relevant to **industry and employers.**	X		
2.3 Instruction, activities, and assignments in individual courses are relevant and engaging to **students**.	X		

Comments:

Some limitations of the current PGCs as written were discussed in section 1, above.

In terms of industry relevance, the key challenge in crafting a modern solar educational program is to properly place the KSAs the student will exit with inside the broader context of the industry. Unfortunately, it can be particularly difficult to understand that context in an industry that is growing at such a rapid pace. This is particularly true now, where a significant amount of the job growth in the solar industry is at the entry-level, installation end of the spectrum, while there are fewer open positions for designers, managers, sales, or any of the other exact positions where the

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type of knowledge gained in a program like this would be most beneficial. By the same token, the larger employers have become much more compartmentalized, and in turn the employees have become much more specialized.

The PGCs, as written, and the specific CCPOs and MPOs for each course are fairly standard in the sense that most solar programs work to cover the whole "solar" topic which includes everything from the motion of the sun in the sky to torque ratings on lag screws to ROI calculations. DTCC also covers general construction topics (NRG 110) and requires a co-op or externship opportunity (NRG 204). Considering the number of courses and the length of the program, individual students have the opportunity to develop a truly holistic understanding of the topic, and this will serve them well as they enter the solar industry.

An exiting student would be exceptionally well-equipped to enter the industry at an entry-level installation position, but they would be overqualified for it. This isn't inherently bad, as the opportunities for advancement in an expanding industry should be plentiful. A student exiting this program would also be well-equipped to enter a design, sales, project development, or associated position. But, again, are there enough of these jobs available?

Given this dynamic, I would suggest including under the general envelope of "Appraise the photovoltaic market" (CCPO #1 in NRG 201) content about this exact issue, meaning what does the market look like from the perspective of the student-cum-job-seeker? What types of jobs are available regionally or nationally? What skills are necessary for particular jobs?

This would allow the student, a participant in a necessarily broad program, to focus their interests and work (where possible) on aspects of the industry that interest them and would potentially give them a leg-up when it is time to find a specific co-op opportunity or an actual job. We sometimes tell students to "dress for the job they want." They should also be told to educate themselves for the job they want.

In other words, because the industry is changing so fast, the best equipped student is not the one who just "knows solar," but the one whom also has an active and on-going understanding of the solar industry. MPOs that reflect that are advised.

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3. RESOURCES AND MATERIALS	Instructional materials being delivered achieve stated course objectives and learning outcomes *(note: not all program/course materials are deliverable under CC BY licensing)*.

Specific Review Standard	**Accomplished**	**Satisfactory**	**Not satisfactory**
3.1 The instructional materials contribute to the achievement of the stated course learning objectives.	X		
3.2 The purpose of instructional materials is clearly explained.	X		
3.3 The instructional materials present a variety of perspectives and approaches on the course content.		X	
3.4 The instructional materials are appropriately designed for the level of the course.	X		

Comments:

The DTCC instructional materials that I have access to (a limited number of presentations, class-level resources lists, schedules, and many homework and lab assignments) align very well with the stated learning objectives, and are at a depth appropriate to student's progression through the knowledge. DTCC has done an excellent job of providing a wide variety of additional, external resources from codes and standards bodies, organizations that work to promote professional and safe solar systems, and trade magazines, among others. Any of these would encourage a student to pursue life-long learning in his or her chosen field. This is especially valuable in the solar industry, due to the rapid pace at which things change, or how new editions of codes or standards, or a single accident at a solar installation can have dramatic impacts on the entire industry.

Most of my comments about course content relate to the homeworks and assessments, and are included in the following section.

I recommend that the resources or presentations include as many real-life examples or case studies as possible. By that I mean that when talking about, say, electrical schematics, the student should be exposed to numerous schematics for solar systems, whether from final plan sets, designed by the instructor, or pulled from permit applications. When students can see the variety

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of ways that certain tasks can be done (like building a plan set, for instance, or what influenced certain design decisions), they can begin to see how the various topics they've learned about (codes and standards, the sun's path, the effect of temperature on modules, etc) influence final design decisions, or the construction process, or how a plan set is organized, or the financials. I have found a good source of these materials is publicly funded projects, where the responses to Requests for Proposals are often posted publicly; from code enforcement offices, where permit applications (which usually contain drawings) are generally public information; or from local industry partners. DTCC has done this at a number of places—having students complete an actual interconnection agreement as part of an assignment stands out—but more is better, as long as the integration of the document with the existing learning objective can be ensured.

4. ASSESSMENT AND MEASUREMENT	Assessment strategies use established ways to measure effective learning, evaluate student progress by reference to stated learning objectives, and are designed to be integral to the learning process.

Specific Review Standard	**Accomplished**	**Satisfactory**	**Not satisfactory**
4.1 The course evaluation criteria/course grading policy is stated clearly on each syllabus.	X		
4.2 Course-level assessments (those that can be delivered) measure the stated learning objectives and are consistent with course activities and resources.	X		
4.3 Specific and descriptive criteria are provided for the evaluation of students' work and participation and are tied to the course grading policy.		X	
4.4 The assessment instruments (that can be delivered) are sequenced, varied, and appropriate to the content being assessed.	X		
Comments:			

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The assignments and assessments that DTCC have provided do a good job of emphasizing the KSAs associated with the specific MPOs for each course. I feel they accurately assess the learning objectives listed.

I appreciate that in numerous cases the assignments ask the student to do research on a topic (returning to the idea of getting the students to understand the rapidly changing nature of the solar industry, policies that affect the industry, the regulatory environment, etc), or to create tools to answer questions rather than simply answering the questions (as they do with some of the spreadsheet work with string sizing, wire sizing, etc). For a student to meet an individual MPO in, say, NRG 201 by understanding and applying the concepts is significantly different than being able to do that same task efficiently, accurately, and with precision by creating a reusable tool, and the latter represents a higher order application of the same knowledge.

Similarly, numerous assignments ask the students to create from whole-cloth reports, plans, or designs. This is the type of data and knowledge synthesis that will make students more valuable in mid-level, managerial, procurement, project management, sales, or design positions.

My chief suggestion is to extend this approach outwards into the solar project development process. Obviously the schedules, syllabi, and learning objectives are sized for the amount of class time that the semesters allow, so adding materials of any kind would displace something else. However, if the existing learning objectives were practiced by asking the students to adopt the perspective of other players in the solar industry or by examining parts of the solar project development process that aren't currently addressed in the coursework, students could still meet these objectives while learning more about the industry they hope to enter. For instance, regarding the topic of codes and standards, I have seen other solar programs and classes assigning students tasks such as:

1. Researching what codes apply in a new area their 'company' is bidding jobs
2. Mimicking the plan review process by having students review completed designs for compliance with the code
3. Applying a new edition of codes to an existing electrical or mechanical design
4. Researching and writing-up the permitting process for a new area (fees, time required, locating and completely paperwork, etc) or zoning requirements

Any of these would help practice existing learning objectives (MP0 2 in NRG 110 for the first example I give; MP0 1.12 among others in NRG 202 in the second and third examples; construction budgeting and scheduling for the fourth example), but would also allow the students to replicate tasks that they might be expected to complete during their co-op position or in a future job in a way that multiple choice questions might not. Furthermore, they are higher order

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tasks. An entry-level installer, for instance, might be handed a plan set and told to install, without many considerations beyond what's on the page. A DTCC-graduate installer, however, might catch an error that would result in an inspector requiring work to be done, or one that might cause a decrease in system performance because they were given multiple opportunities to see how what's on the plans affects reality, or vice versa.

In general, I believe DTCC has done an excellent job of creating assessments and assignments to support their stated learning objectives, and that many of them involve higher order learning (synthesis, analysis, creation, etc). I think using this same structure to introduce more variety, or more perspectives from other jobs or roles in the solar industry would only help.

Finally, I would like to address the NABCEP Entry Level Exam. This certificate is the closest thing to an industry standard that can be gained by education experience alone, and its inclusion here, as well as its obvious influence on the learning objectives of the specific courses, is unremarkable. Basically, whatever the pros and cons of the NABCEP ELE, there's really nothing better that would apply to the situation these students are in, because the only comparable or subsequent certifications all require industry experience.

I do not have a specific suggestion here, other than to recognize that specific students might be interested in reaching towards these other certifications. In turn, they might be able to meet the experience requirements for these certifications soon after graduation. How does DTCC figure into this? How can DTCC ensure that the student's time at DTCC would be enough for them to meet the educational requirements of those certifications and prepare them for any exam? In other words, if a student wants to enter the installation or construction field, and feels that the NABCEP PV Installer Professional certification would help her or him, than it would be to that student's benefit to pursue an understanding of the knowledge required to pass that exam.

I bring this up because the NABCEP ELE Learning Objectives, while very broad, are unclear about what depth of knowledge they hope students to reach. DTCC's approach to what is effectively a recasting of the ELE learning objectives will result, based on my reading, on a depth of knowledge that exceeds that which is required to pass the NABCEP ELE exam. Is it feasible for a student who understands the materials at DTCC's level, a level above the NABCEP ELE, to also begin to reach towards the understanding required to pass something like the NABCEP PV Installer Professional or PV Technical Sales exams? And can DTCC make this explicit in their learning objectives by incorporating objectives based off of the NABCEP PV Installer Professional or PV Technical Sales Job Task Analyses? Should they? I don't have an answer, but ask DTCC to consider it.

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