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Abstract
Solar Energy is the fastest-growing energy resource in the United States and the world. This industry just hit an important milestone in 2019 of completing two million solar systems installations in the country and is expected to duplicate this quantity by 2023.

In this paper, the authors present the scheme for a new certificate in Solar Energy Systems as a part of the Engineering Technology curriculum. Our departmental Vision supports this proposal of giving the students robust technical knowledge through industry certificates and degree courses to be industry-ready and able to deliver results as soon as they join the workforce or as entrepreneurs. This proposal's backbone lies not only in our existing courses in renewable energies and specifically solar energy systems but also in our faculty's expertise and the department's relationship with the local industry in this field.

Introduction

The University of Texas Rio Grande Valley (UTRGV) is committed to expanding educational opportunities to the Rio Grande Valley population. The Texas Legislature created it in 2013, and since then, it has expanded its area of influence throughout the region with campuses and off-campus research and teaching sites. The Engineering Technology Program is part of the College of Engineering and Computer Science, based in Brownsville, Texas.
The Rio Grande Valley is located in the southernmost part of Texas and shares a border with Mexico through three of the four counties that form this region. It also has a coastal area of importance for the oil and gas industry, commercial trade, and tourism. The international trade agreements between the United States, Canada, and Mexico, have made this region a key location for many industries to set up operations in some border cities. Its coastal location has made it attractive as well for the aerospace industry.

Texas has abundant solar resources due to its geographical location. Many industries and institutions have started to recognize solar energy benefits for electricity generation with photovoltaic (PV) modules. According to the latest national solar jobs Census [1], Texas ranked in the top five states for solar jobs and had a growth of 9.3% in the past year. There are around 683 solar companies established in the state, according to the National Solar Database [2], which respond to the increase in solar installations in the recent year.

We have witnessed how new industries in our region consider solar systems to provide energy to their new facilities from the beginning of the construction project. We have also seen an increase of companies and institutions converting to this type of energy as the technology's cost becomes very accessible.

As the principal provider of knowledge and professional human resources in the community, our university should respond by training professionals that can keep up with the advance of this renewable energy.

It is undeniable that the solar industry will continue growing in our region following the same trends in the country and the world [3]. Universities, research centers, and companies worldwide continue developing technology to increase solar cells' efficiency and reduce the cost of the power electronics and batteries for energy conversion and storage, respectively.
Currently, the College of Engineering and Computer Science of the UTRGV has courses related to solar energy as part of the curriculums of Engineering Technology and Electrical Engineering programs. Both departments have laboratories of solar systems for teaching and research. Nevertheless, there are no specific courseware or certificate courses in this subject. There are also three technical colleges that serve the region, but none have curriculums in solar energy. Most of the offering in solar education in community colleges, universities or technical centers is located in the center or north of the state.

The need for a solar energy curriculum in technology and industrial education departments in US universities was identified several decades ago, even when the PV technology was still in its early stages [4]. Nonetheless, universities across the country started developing courses and technical education in this field, fostering interest and research that helped advance the technology.

We present in this paper the proposal for a new certificate in solar energy, which will help develop the professionals that the industry will need for the different aspects of its operation, such as design, installation, and maintenance. We hope at the same time to sow the seed that will give rise to new entrepreneurs and researchers in the field.

The rationale for a new solar energy certificate
In the last years, solar energy has shown exponential growth in our state's installed capacity and around the country. According to the Electric Reliability Council of Texas (ERCOT), there are over 2,700 megawatts installed but are expected to grow to as much as 21,000 megawatts by 2023. Besides this significant projection, there is also a relevant number of utility-scale solar capacity being studied that approaches 72,000 megawatts, of which 23,000 megawatts are in the south and coastal region of the state where our university is located [5].

The expanding solar projects in this region will require a skilled workforce in different areas such as marketing, sales, financial analysis, design, engineering, installation, and maintenance. The lack of prepared professionals may constitute a barrier to the successful deployment of solar projects. An unprepared and unqualified workforce can result in poor operation and performance of the systems that can affect current and potential users' perception. An educational effort to

tackle the challenges of adopting this technology is of utmost importance to obtain the benefits of this renewable energy.

Design and delivery of the certificate

The certificate will consist of two sections, one theoretical and one hands-on. The certificate will be an introductory course to Photovoltaic Solar Energy Systems for residential, commercial, and industrial applications. Below are listed the learning objectives formulated for this certificate and the course outline for the two sections that will support such objectives. The outlines list the modules in the sequence that should be offered.

Proposed learning objectives

- Understand the solar resource
- Calculate the energy available from solar resources
- Perform site assessments, conservation principles, and load analysis.
- Carry out economic analysis for energy systems proposals
- Calculate the size of PV systems for both grid-tied and battery-based systems
- Understand the effects of temperature, insolation, and shading on PV yield
- Apply the appropriate codes and standards in the design of an energy system
- Be able to prepare a bid to a customer for the installation of a custom PV system

Theoretical Course outline:

- Introduction to Solar Energy Systems. Markets and applications.
- Environmental Characteristics—Equation of time and longitude correction
- Solar angle and solar radiation
- The solar resource
- Basics of electricity, electrical circuits, and photovoltaics
- Photovoltaic Systems—Semiconductors and photovoltaic modules and arrays
- Photovoltaic Systems (cont.)—Batteries
- Photovoltaic Systems (cont.)—Inverters
- Photovoltaic Systems (cont.)—Charge controllers
- Direct-coupled PV Systems (grid-connected)
- Standalone systems and hybrid connected systems
- Project Planning, site survey
- Design of PV systems— Electrical loads.
- Design of PV systems (cont.)—Shading and spacing analysis.
- Design of PV systems (cont.)—Sizing of PV systems.
- Design of PV systems (cont.)—Mechanical design of the installation
- Commissioning, performance measurement, and maintenance
- Applicable regulations, codes, and standards in the State of Texas
- Solar Economics. Life Cycle analysis
- New developments and research in solar photovoltaics

Hands-on course outline

- Safety in electrical and photovoltaic systems
- Electrical measurements using the multimeter
- Measurement of the solar resource
- Practical on shading analysis, spacing, and orientation of solar modules
- Practical mechanical installation of solar panel and power electronics
- Practical of electrical connections of solar panels, batteries, and power electronics
- Measurement of the solar system performance

Each one of the theoretical and hands-on modules requires a two-hour instruction. The overall course consists of 60 hours of instruction. The students' learning outcomes of the theoretical section will be evaluated with module quizzes. The hands-on section with instructor assessments will be based on the student's performance in the practicals.

The curriculum is designed to make it compatible with the PV Associate credential of the North American Board of Certified Energy Practitioners (NABCEP®) [6], which is a widely recognized certification organization for professionals in renewable energies. This credential will give our graduates recognition as practitioners in this field.

Our initial target market for this certificate would be engineering undergraduate students. Nonetheless, offering this certificate in a second phase to the university community and society, in general, will help make it sustainable and serve the community better. An important aspect would be the pre-requisites for this course, given the high content of technical knowledge. However, prospects with high school level completed should not have any problem completing all the modules since there is an essential section for where the fundamental knowledge is explained.

In terms of the course delivery, lessons learned from the pandemic-era education have made us reflect on applying the same methods and tools of technology-based learning to make the course's theoretical section online to provide access and flexibility to the learners. The hands-on section is of utmost importance since, besides developing the technical skills, it also helps assimilate the abstract theory explained in the course [7]. Although our laboratory is equipped with a solar system that includes solar panels arrays, inverters, batteries, load controllers, and a solar resource measurement device, this section will be enhanced by some practicals carried out in systems installed with potential public and private partners. Our department is currently working on broadening our relations with several institutions and companies in the region. As of today, there are already potential Memorandums of Understandings being discussed.

Accreditation of the Solar Energy Certificate

Creating a program with credibility and professionalism that could be recognized locally and nationally is of great importance [8]. Therefore, as stated previously, the curriculum's design is

intended to be aligned with the requirements of NABCEP®. This institution provides certifications for practitioners and accreditation for training sites. One of the milestones in developing the solar certificate in our department would be to obtain this certificate for the site and the instructors.

Roadmap for developing the certificate

Figure 1 shows the sequential steps to follow in the project's proposal development and execution until the program launch.

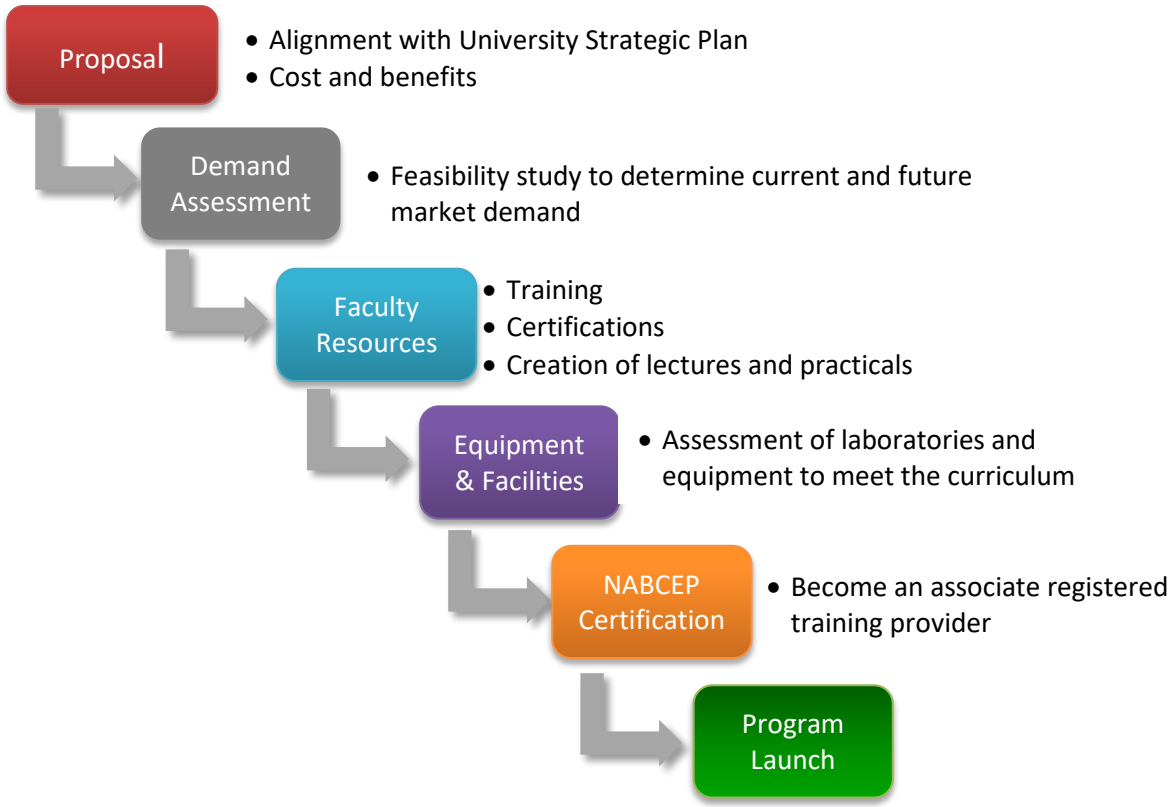

Figure 1. Developing roadmap of the Solar Energy Systems Certificate

Conclusions

Given the increased presence of solar energy technology in our lives, we present this proposal to create a Solar Energy Systems certificate as part of the Engineering Technology curriculum, which will be open for community and local industry members. We link the curriculum to credentialization from NABCEP to ensure the highest standards in quality education. This scope will be a pioneer in our region and of great relevance to cope with certified professionals' demand in this field. As this program grows, it will be possible to diversify the curriculum into more specific solar energy practice aspects.

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