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Design and Implementation of Solar PV Charging Stations for City of Huntsville Aquatic Center

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Dr. Reg Pecen is currently a Quanta Endowed Professor of the Department of Engineering Technology at Sam Houston State University in Huntsville, Texas. Dr. Pecen was formerly a professor and program chairs of Electrical Engineering Technology and Graduate (MS and Doctoral) Programs in the Department of Technology at the University of Northern Iowa (UNI). Dr. Pecen served as 2nd President and Professor at North American University in Houston, TX from July 2012 through December 2016. He also served as a Chair of Energy Conservation and Conversion Division at American Society of Engineering Education (ASEE). Dr. Pecen holds a B.S in EE and an M.S. in Controls and Computer Engineering from the Istanbul Technical University, an M.S. in EE from the University of Colorado at Boulder, and a Ph.D. in Electrical Engineering from the University of Wyoming (UW, 1997). He served as a graduate assistant and faculty at UW, and South Dakota State University. He served on UNI Energy and Environment Council, College Diversity Committee, University Diversity Advisory Board, and Graduate College Diversity Task Force Committees. His research interests, grants, and more than 50 publications are in the areas of AC/DC Power System Interactions, distributed energy systems, power quality, and grid-connected renewable energy applications including solar and wind power systems. He is a senior member of IEEE, member of ASEE, Tau Beta Pi National Engineering Honor Society, and ATMAE. Dr. Pecen was recognized as an Honored Teacher/Researcher in "Who's Who among America's Teachers" in 2004-2009. Dr. Pecen is a recipient of 2010 Diversity Matters Award at the University of Northern Iowa for his efforts on promoting diversity and international education at UNI. He is also a recipient of 2011 UNI C.A.R.E Sustainability Award for the recognition of applied research and development of renewable energy applications at UNI and Iowa in general. Dr. Pecen established solar electric boat R & D center at UNI where dozens of students were given opportunities to design solar powered boats. UNI solar electric boat team with Dr. Pecen's supervision won two times a third place overall in World Championship on solar electric boating, an international competition promoting clean transportation technologies in US waters. He was recognized as an Advisor of the Year Award nominee among 8 other UNI faculty members in 2010-2011 academic year Leadership Award Ceremony. Dr. Pecen received a Milestone Award for outstanding mentoring of graduate students at UNI, and recognition from UNI Graduate College for acknowledging the milestone that has been achieved in successfully chairing ten or more graduate student culminating projects, theses, or dissertations, in 2011 and 2005.

He was also nominated for 2004 UNI Book and Supply Outstanding Teaching Award, March 2004, and nominated for 2006, and 2007 Russ Nielson Service Awards, UNI. Dr. Pecen is an Engineering Technology Editor of American Journal of Undergraduate Research (AJUR). He has been serving as a reviewer on the IEEE Transactions on Electronics Packaging Manufacturing since 2001. Dr. Pecen has served on ASEE Engineering Technology Division (ETD) in Annual ASEE Conferences as a reviewer, session moderator, and co-moderator since 2002. He served as a Chair-Elect on ASEE ECC Division in 2011. He also served as a program chair on ASEE ECCD in 2010. He is also serving on advisory boards of International Sustainable World Project Olympiad (isweep.org) and International Hydrogen Energy Congress. Dr. Pecen received a certificate of appreciation from IEEE Power Electronics Society in recognition of valuable contributions to the Solar Splash as 2011 and 2012 Event Coordinator. Dr. Pecen was formerly a board member of Iowa Alliance for Wind Innovation and Novel Development (www.iawind.org/board.php) and also represented UNI at Iowa Wind Energy Association (IWEA). Dr. Pecen taught Building Operator Certificate (BOC) classes for the Midwest Energy Efficiency Alliance (MEEA) since 2007 at Iowa, Kansas, Michigan, Illinois, Minnesota, and Missouri as well as the SPEER in Texas and Oklahoma to promote energy efficiency in industrial and commercial environments.

Dr. Pecen was recognized by State of Iowa Senate on June 22, 2012 for his excellent service and contribution to state of Iowa for development of clean and renewable energy and promoting diversity and international education since 1998.

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Mr. Lance David Sebesta

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Abstract

In addition to ABET-defined course objectives, goals and outcomes, senior design projects also serve as unique bridges between the academia and the communities. Residents at City of Huntsville-Texas Aquatic Center, a city owned recreation center, have had lacked satisfactory shaded areas particularly when they waited for their children or friends while swimming classes were in session. The residents also needed an easy access to AC outlets for charging their smartphones, laptops and other electronic devices. This paper presents design, construction, and operation of two separate solar Photovoltaic (PV) charging stations at the City of Huntsville Aquatic Center as part of a senior design course requirements in a B.S. in Engineering Technology program. 3D-sketches, electrical circuits, Gantt charts, bill of materials and student experience are provided. This senior project initially began with four undergraduate students with multidisciplinary engineering technology majors in Fall 2019, then extended to Spring 2020 due to the scope of the project, and finally completed in August 2020 by two different senior students due to the graduations and Covid-19 pandemic related challenges. The funding for the project was provided by the City of Huntsville. The students and faculty members involved in the senior design project have served for the community outreach purposes.

There are two objectives of this senior design project; (1) to provide more shading for guests and staff members in the aquatic center since the area is missing satisfactory shading, (2) to help the city for improving its sustainability efforts by providing renewable energy-based charging stations. Since the project was completed in Summer 2020, the PV charging stations have been used by aquatic center staff and guests extensively both during the day and evening programs since the charging stations also provide lighting through deep-cycle battery storage. This senior project provided students to use their knowledge and increase hands on and project management skills in a real-life environment. Students worked in the project were majored in interdisciplinary majors in the Department of Engineering technology including Engineering Design, construction management, safety management, and electronics and computer engineering technology. Students were also involved in professional meetings with city officials to discuss and present their project progress efforts. The Mayor’s office and the aquatic center staff officials expressed their strong interest to work with B.S. in engineering technology senior students and faculty to design and implement more renewable energy projects in future.

Problem Definition

Residents at the Huntsville Aquatic Center are lacking satisfactory shaded areas particularly when they wait for family members while swimming classes are in session. This has been a major problem during hot summer days when residents needed shaded areas while they also enjoyed water activities in the aquatic center. As smart phones became widely used, a sustainable charging becomes another issue. Therefore, residents’ easy access to charging stations for their smartphones and other electronic devices will provide better and safer facilities. Those parks having benches or canopies may not have outlets to charge consumer electronics, and while there are charging stations created, they are either indoors or dangerously exposed outdoors.

Therefore, designing and building a sustainable canopy to provide both PV-based, zero-emission charging as well as shading are necessary.

Figure 1 shows potential open areas where solar PV charging stations may be installed. Students and faculty audited the area and found out the following:

1. Parents do not have a suitable place to sit, and do not have access to any outlets to charge electronic devices especially smart phones.
2. There are places to sit but the shade and charging ports are excluded.
3. There are places to sit that provide shade, but do not provide charging ports.
4. Once a secure location for charging station is determined, keeping the station secure to the concrete construction will be necessary.

Figure 1. City of Huntsville-TX Aquatic Center and potential areas for PV Charging Installations

Finding a feasible location to place the charging stations were not difficult because there are plenty of open areas available in the aquatic center. Students agreed on one common spot as an open area in the courtyard. Students decided that this location would be an ideal one for the charging station since parents can comfortably sit under the shade, charge their electronics, and watch their kids in the water. The second location was selected as south west corner of the aquatic center with maximum solar irradiance levels and no shaded area.

The next phase of the project was determining an effective and safe type of canopy and bench design that will secure solar PV panels, electrical equipment including batteries, charge controller, light fixtures, and electrical junction boxes with fuses. Considering the area is a flood zone, placing battery box(es) to the floor would not be possible. A supporting frame holding the battery boxes under the rooftop section of the canopy was necessary. Figure 2 depicts two of the selected design types of the charging stations as one octagonal station and one rectangular station.

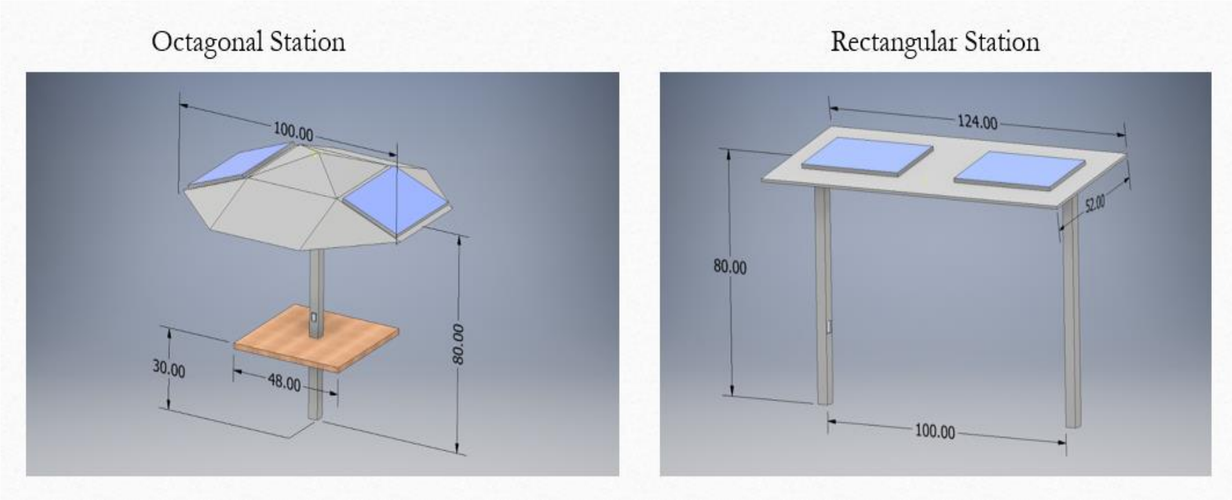

Figure 2. Selected design frame types of the charging stations

Sample Campus and Community Projects Previously Completed

There are plenty of campus and community projects completed by both senior design students and faculty researchers utilizing renewable energy applications including solar PV panels, wind turbines, micro hydro, and Hydrogen fuel cell systems. The University of Massachusetts researchers installed 15,576 PV panels across campus to provide 5.5MW of clean renewable electricity that was one of the largest installed capacity on U.S. campuses. This unique installation reduced the energy cost and provided savings of $6.2 million over 20 years and reduce greenhouse gas emissions.

The authors of this paper designed and installed multiple renewable energy projects both on campus and communities of the multiple states [2-8]. The design and construction of a small-scale solar PV, hydro- electric, and wind power station for generating zero-emission electricity for cabins and RV outlets in a state park (Hickory Hills) has provided major savings since 2008 [4]. An educational project promoting The Math-Science-Engineering Technology in Iowa using renewable energy applications aimed to provide area middle school teachers with an applied mathematics and science curriculum package based on Photo-Voltaic (PV), wind power, and hydrogen fuel-cell fundamentals [5].

Design and Implementation of a 12 kW Wind-Solar Distributed Power and Instrumentation System Education and training of workforce of Iowa in renewable energy applications have become a significant factor in the United States. Senior design students at the University of Northern Iowa established a 3 kW grid connected wind-solar hybrid power station on campus in 2002. This system has been used for teaching and research purposes besides the green power generation and a showcase for the recruitment to STEM fields [8].

Texas A&M University's consistent participation in the Solar Decathlon promoted solar PV energy and competition challenged students to create a 100% solar powered house following the rules and regulations of the National Electrical Code (NEC). Another goal of the this project was to understand how solar power could affect people's lives, as well as thinking in new ways about renewable energy [9].

To utilize the high level of solar radiation in United Arab Emirates (UAE), faculty and students at UAE University simply implemented a charging station for the electric golf carts used on campus. The simple design included only three PV panels in a circuit whose sole purpose was to charge the batteries. Due to the higher cost of charging 13 golf carts year-round through conventional grid, the PV charging station provided a lower cost showing an estimated annual saving of $ 2,858 [10].

Researchers at Dublin Institute of Technology investigated performance of a campus PV electric vehicle charging station in a temperature climate. They measured solar resource and EV energy consumption together with locational, mechanical and electrical constraints that were used to design a EV charging station comprised of 10.5 kW PV array with a 9.6 kWh Lithium-ion battery storage [11].

Solar Irradiance Levels in the City of Huntsville

Solar data collection and determining solar irradiance levels in the project location are significant factors for the effective operation of solar PV installations. The City of Huntsville's solar irradiance levels are very promising due to has an average monthly Global Horizontal Irradiance (GHI) of 4.61 kWh/m^2/day, which is approximately 4% greater than the average monthly Direct Normal Irradiance (DNI) of 4.42 kWh/m^2/day as seen in Figure 3 [12].

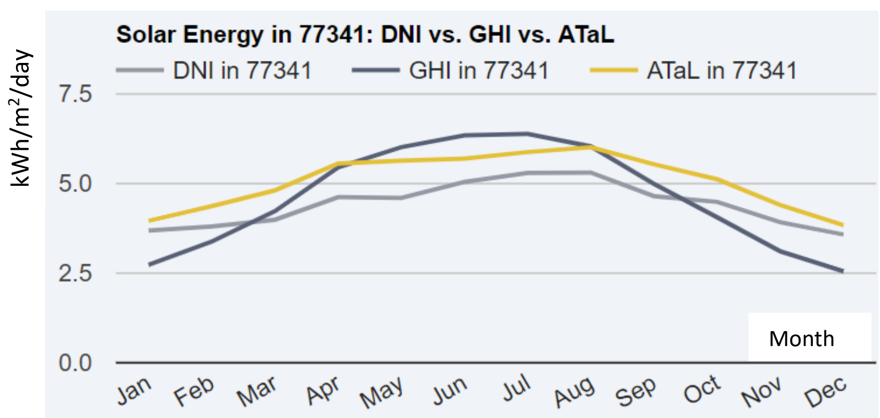

Figure 3. Solar Irradiance Levels in the City of Huntsville -TX [12].

"Solar installations in the area that are always tilted at the latitude of Huntsville-TX (Average Tilt at Latitude or ATaL) average 5.07 kWh/m^2/day, or about 10% greater than the average monthly GHI of 4.61 kWh/m^2/day and approximately 15% greater than the average monthly DNI of 4.42 kWh/m^2/day" [12]. Global Horizontal Irradiance (GHI) is defined as the total amount of solar radiation that is received per unit area by a surface that is always positioned in a horizontal manner. Direct Normal Irradiance(DNI) is defined as the total amount of solar radiation received per unit area by a surface that is always perpendicular to the sun rays that come in a straight line from the direction of the sun at its current position in the sky [12]. Average Tilt at Latitude(ATaL) is defined as the total amount of solar radiation received per unit area by a surface that is tilted toward the equator at an angle equal to the current latitude. ATaL will often produce the optimum energy output [12].

Design Phase of the Project

The project included two separate design of two charging stations in different location of the aquatic park. The octagonal design shown in Figure 4a where a 3D view of the overhang and bench demonstrates the size of the overall charging station. Figure 4b depicts the blueprints of octagonal design. Inside the overhang displays the batteries that will be stored inside to hold connect to the solar panels as well as the LED lights. The system includes a 50.9 Ah GEL Deep Cycle battery, and two PV panels connected in parallel. To keep the center of gravity even, the PV panels are placed opposite from each other as shown in Figure 4a. Placing them side by side will not only make the charging station look less appealing, but it would also cause unbalance load distribution on the overhang. The USB ports are installed opposite from each other, and the charging station have two sets of USB ports. Each set has a total of four USB ports, giving the charging station a total of eight USB ports.

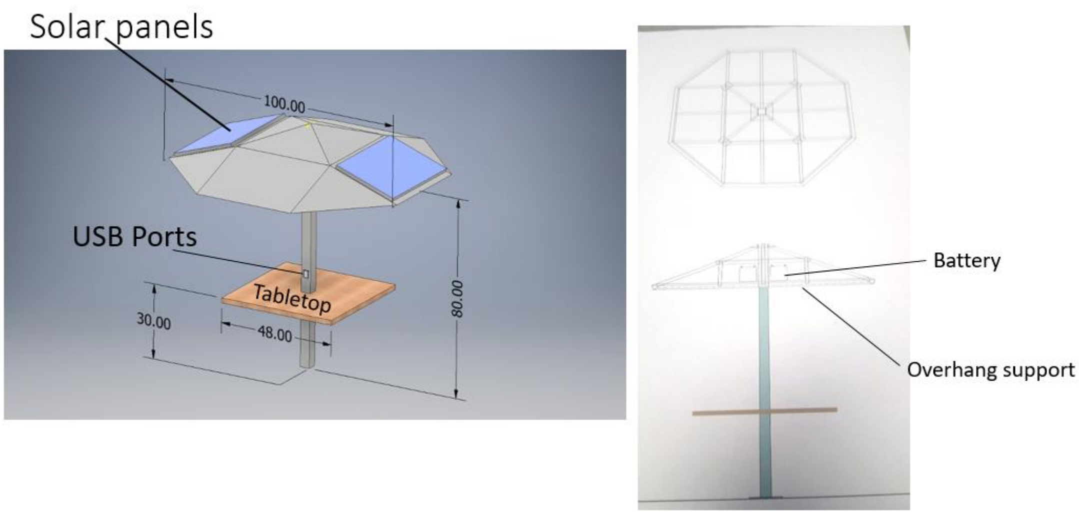

Figure 4. Octagonal design of first charging station, (a) 3D view of the overhang, and (b) blueprints

The second charging station is designed as a rectangular rooftop with a commercially available bench as shown in Figure 5. This design requires two support poles to hold the overhang up as opposed to the octagonal design that only requires one support. The blueprint schematics show the angle of the overhang as it should help the solar panels absorb sunlight, as well as provide shade to anyone sitting under it. Like the octagonal charging station, this rectangular station will have the solar panels connected in series with one battery. The side supports that hold the overhang up will have a set of USB ports on each support for easy access giving the charging station a total of eight USB ports for charging electronics.

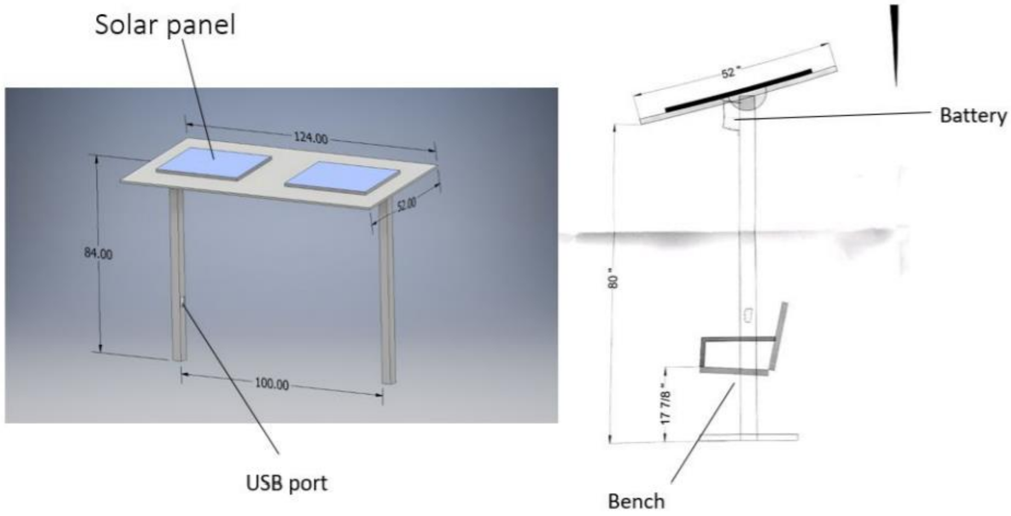

Figure 5. Second charging station – rectangular design with a bench

Construction Phase of the Project

As the metal parts arrived at the production lab students realized that the level of metal work would be more than expected considering none of them had any previous experience on metal works including actions of cutting an welding metal pieces. Dr. Coogler with his extensive skills on metal works was essential to mentor senior design students as seen in Figure 6.

Figure 6. Metal works, cutting and welding of the solar PV charging stations in the production labs

Although metal beams were welded together, students experienced unleveled frames which resulted in cutting the welds and applying pressure on certain corners while the welding process was repeated to ensure that the frames were well leveled as seen in Figure 7a. The rectangular frame for the bench charging station was first fully built as the students experienced challenges on leveling out the frame for the octagonal shaped station as seen in Figure 7b.

Figure 7. (a) Reinforcing of the metal frame of the charging stations, (b) bench charging station frame was completed

As one of the challenges of real-life projects, students experienced receiving wrong sheet metal. Rather than a flat sheet metal, corrugated sheet metal was received from the vendor, and this was not realized until the roof top section of the charging station was started to be built. Since PV panels were supposed to be installed on the flat sheet metal, corrugated metals would be very risky during the windstorms with the possibility of not staying intact with the frames causing solar PV panels to fall easily as seen in Figure 8a and 8b.

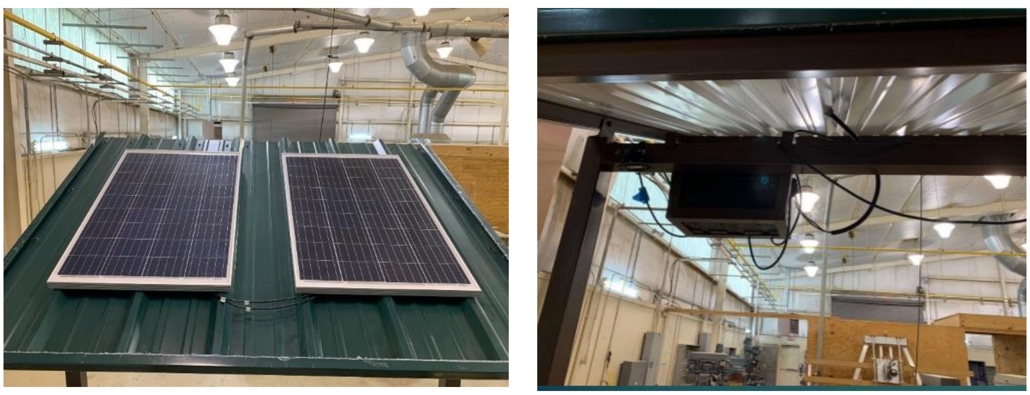

Figure 8. (a) Two PV panels installed on the bench roof top, (b) Battery box and charge controller installed in the production lab

Another problem that students experienced was how seal effectively any holes or cracks that could allow water to enter from the roof top. There will be instances where it will rain and any water that enters the PV covering could either cause the metal to rust or cause an electrical short. Sealing any exposed holes and cracks will also prevent any foreign debris or prevent children or people from encountering any wires or electrical components that could either potentially harm them or damage the charging station. While the solar panels charging the battery through a charge controller, the battery gains more power and needs to be discharged at night. The problem was solved by adding two LED light fixtures that will also help visitors to continue using sustainable power for lighting purposes at evening programs. LED fixtures use would easily be discharging the battery until the next morning. Figure 9 depicts the last steps of installing charger stations while making sure that grounding rods were also connected.

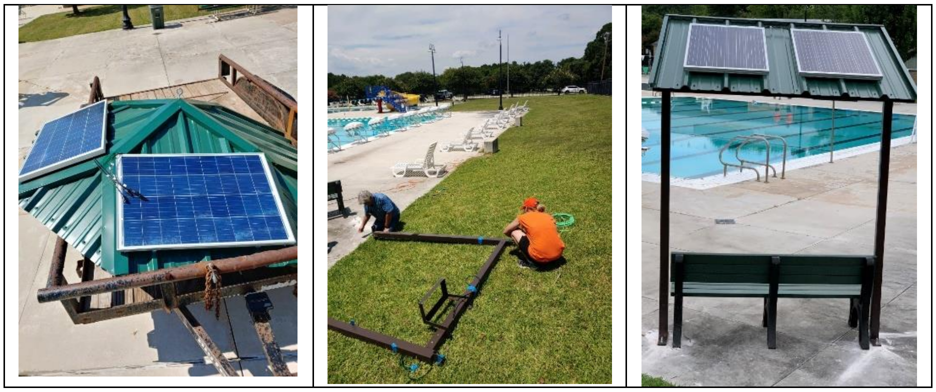

Figure 9. Installation of octagonal design and bench design solar PV charging stations

Figure 10 depicts two completed charging stations, and students and faculty worked on the project.

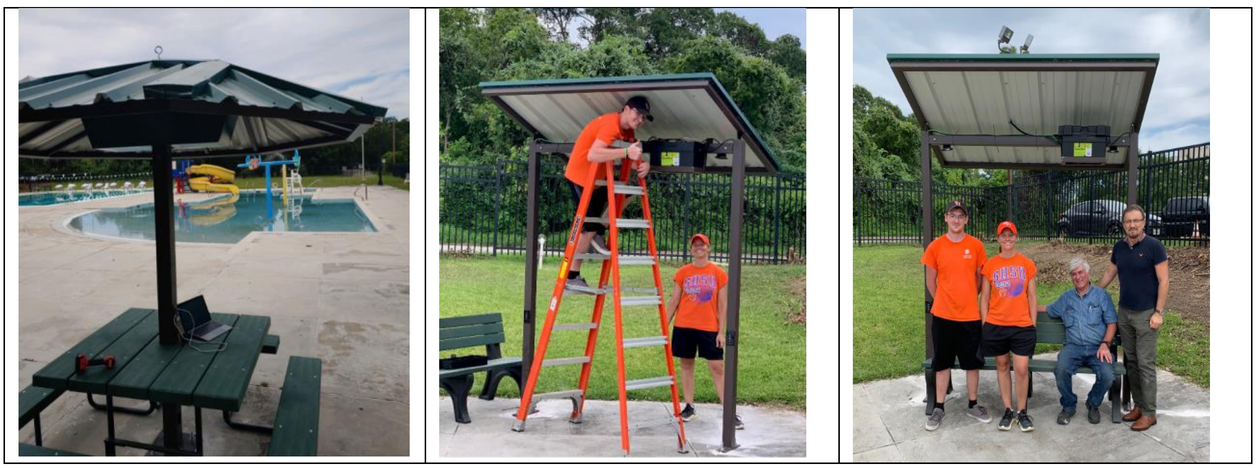

Figure 10. Solar PV Charging stations in the City of Huntsville Aquatic Center are functional since August 2020.

Table 1 indicates Bill of Materials for electrical parts and materials for both projects. Additional cost of support metals, frame and sheet metals made the total cost of the project about $4,750.

Table 1 Bill of Materials (BOM)

Electrical Parts & Materials for Solar PV Project at ______Aquatic Center			
Peimar 100 W 12V Poly Solar PV Panel	(x4)	$596	AltEStore.com
Morning Star 20A, 12 V Charge Controller, $96 each	(x4)	$384	AltEStore.com
MK 8G22NF GEL 50.9 Ah (20HR) T881 Terminal Battery, $194 each	(x2)	$388	AltEStore.com
Miniature Circuit Breaker DZ47-63 2P 400V AC Miniature Circuit Breaker Leakage Protection Air Switch 25A 40A	(x4)	$40.76	Amazon
PV Wire, 10AWG, Green	(x4)	$88.50	AltEStore.com
Erico 5/8" x 8' Copper Ground Rod	(x4)	$38.94	Home Depot
Magnadyne WC-USB-B 12V Wall Mount USB Charging 4 Ports 12-16V DC Input Included with Wall Plate	(x4)	$111.96	Amazon

Zookoto 10A Solar Panel PV MC4 in-Line Fuse Holder w/Fuse PV Connectors 1000V Waterproof 10 A	(x4)	$51.96	Amazon
Supernight DC Power Step Down Converter Regulator 12V / 24V to 5V 5A 25W Low Voltage Transformer Power Adapter DC-DC Volt-Reducer (5V 5A 25W)	(x4)	$35.96	Amazon
HQST Solar Panel Mounting Z Brackets with Nuts and Bolts - 4 Sets of RV, Boat, Roof, Wall and Other Off Grid Installation	(x4)	$39.96	Amazon
Surge Arrester for Lightning Strikes Midnite Solar Surge Protection Device, $91.44 each.	(x2)	$183	AltEStore.com
2 Pack - AC DC 12V 10A Auto On/Off Photocell Light Switch Photoswitch Light Sensor Switch	(x4)	$19.98	Amazon
Kawell 2 Pack 20W Flood Cree LED Light Bar Flush Mount LED Pods Off Road Backup Driving Lights Fog Lamp ATM (20W Flush Mount)	(x4)	$65.98	Amazon
Kawell Off Road LED Light Bar Wiring Harness with ON Off Switch 2 Lead 12 Ft Power 40A Relay Fuse for Trucks ATV Jeep (2 Lead Harness)	(x4)	$47.96	Amazon
BougeRV MC4 Connectors Y Branch Parallel Adapter Cable Wire Plug Tool Kit for Solar Panel	(x4)	$14.49	Amazon
DC Fuses 15 A	(x4)	$40	Amazon
Field Guardian Grounding Rod Clamp 1/2 Inch	(x3)	$14.43	Amazon
	Total	$2,162	

Conclusions

Introduction of renewable energy applications to engineering technology curriculum at Sam Houston State University (SHSU) has both positively impacted students, faculty, and the University community and served as promising outreach efforts. This paper presented a detailed study of a capstone senior design project to design and construct solar PV- based charging stations for promoting environmentally friendly technologies as well as serving the local communities.

Students from multidisciplinary majors including engineering design, safety management, construction management, and electronics and computer engineering technology were involved in this project.

Environmental outcomes:

- The PV charging stations provide zero emission sustainable charging as well as lighting for City of Huntsville's aquatic center staff and visitors.
- Although this was a small-scale application, it still helped to enhance city's efforts for achieving more sustainable operation.

Educational Outcomes and Community Outreach:

• Exposing students to a real-life renewable energy application and providing opportunities for professional communication with city manager and technical staff.

• Displaying an effective show case of solar power applications to the public [13-14]

• Continue promoting Science Technology Engineering Mathematics (STEM) Education at SHSU facilitating applied renewable projects that will also have positive impact to the university's community outreach efforts [13-14].

Students experienced challenges on welding, precise joint cuttings, and drilling of the metal frame. Permanent installation of charging stations in the aquatic center and placing grounding rods for both PV charging units through the concrete base of the aquatic center were other challenges that students experienced.

With the increasing importance of renewable energy resources in present and future energy scenarios, an ability to design and analyze further solar PV energy systems becomes essential for engineering and technology educators and students. All students in the project showed improvement in learning and understanding concepts about renewable energy sources by complementing a theory-based lecture with hands-on experiments.

In addition to completing a senior design project, students also developed presentation and research skills utilizing a variety of applied research papers and the project management tools such as Gantt Charts. Lastly, the students refined their technical knowledge and communication skills by professionally working with City of _______ officials, and finally experienced the positive benefits of effective teamwork.

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References

[1] UMass installing thousands of photovoltaic panels. (2016). Recorder, The (Greenfield, MA), p. 2. Available from NewsBank: World News – Historical and Current: https://infoweb-newsbank-com.ezproxy.shsu.edu/apps/news/document-view?p=WORLDNEWS&docref=news/15E7C2DA07D43620, accessed March 2, 2021.
[2] Pecen, R., & Yildiz, F. (2019, June), *A Smart Grid Implementation for an Engineering Technology Curriculum* Paper presented at 2019 ASEE Annual Conference & Exposition , Tampa, Florida. 10.18260/1-2--31996
[3] Pecen, R., Timmerman, M. (2001, June), *A Hands-on Renewable Energy Based Laboratory for Power Quality Education* Paper presented at 2001 Annual Conference, Albuquerque, New Mexico. 10.18260/1-2—9328.
[4] Pecen, R., & O'Meara, R. (2004, June), *Design And Construction Of A Solar Powered Outdoor Digital Display As A Senior Design Project* Paper presented at 2004 Annual Conference, Salt Lake City, Utah. 10.18260/1-2—1351
[5] Chalkiadakis, F., & Fahmy, M., & Pecen, R. (2005, June), *Design And Construction of A Hydro Wind Hybrid Renewable Power Station In Iowa Hickory Hills State Park* Paper presented at 2005 Annual Conference, Portland, Oregon. 10.18260/1-2—15539.
[6] Pecen, R., & Humston, J. (2009, June), *MSETI Area: Math Science Engineering Technology In Iowa On Applied Renewable Energy Areas* Paper presented at 2009 Annual Conference & Exposition, Austin, Texas. 10.18260/1-2—5819.
[7] Pecen R., Yildiz F., Johnson K., Aguirre A., Dakeev U. (2018). A Novel Curriculum Development in Solar and Wind Energy Systems in an Engineering Technology Program. International Journal of Modern Engineering (IJME), Vol. 19, Number 1, Fall/Winter 2018, http://www.ijme.us
[8] Pecen, R., & Yildiz, F., & Yuksek, B. Z., & Dakeev, U., & Baltaci, K. (2012, June), *Design and*

Implementation of a 10 kW Wind Power and Instrumentation System Paper presented at 2012 ASEE Annual Conference & Exposition, San Antonio, Texas. 10.18260/1-2—21148.
[9] Ramirez, E. J. (2008). Engineering Design, Construction, Operation and Analysis of the 2007 Texas A&M University Solar Decathlon House. Energy Systems Laboratory. Available electronically from http://hdl.handle.net/1969.1/85723.
[10] Bdwawi, A., Al Ahbabi, H., Al Shamsi, S. A., Hussein, A.A., "Modular PV Charging Station for UAE University Golf Carts", Elsevier, Energy Procedia, Vol. 75, August 2015, pp. 314-318. https://www.sciencedirect.com/science/article/pii/S1876610215011303.
[11] Esfandyari, A., Norton, B., Conlon, M., McCormack, S. J., "Performance of a campus PV EV Charging Station in a temperate climate", *Elsevier Solar Energy*, 177 (2019) 762-771. https://www.sciencedirect.com/science/article/pii/S0038092X18311800.
[12] Solar Energy Local - Solar Data Access, https://www.solarenergylocal.com/states/texas/77341/ accessed March 5, 2021.
[13]SHSU Engineering Technology students help reduce Huntsville's environmental footprint, Local Paper, Itemonline.com, news story by Michelle Wulfson, September 1, 2020. https://www.itemonline.com/news/local_news/shsu-engineering-students-help-reduce-huntsvilles-environmental-footprint/article_ae4754a2-4cf7-55a4-843a-05ba1527cd43.html, accessed March 5, 2021.
[14] Engineering Technology Students build solar charging stations for Huntsville, Story Coverage by Wes Hamilton, https://www.shsu.edu/today@sam/T@S/article/2020/engineering-ace