Off-Grid Solar-Powered Electric Vehicle (EV) Charging Station – A Design-Build Project

Introduction

Our University is undergoing an intentional process of transformation in several areas in pursuit of more sustainable practices and systems on our campus. As the United States slowly moves forward in evolving our automobile inventory from fossil-fuel, combustion-powered vehicles to electric-powered vehicles (EVs), our research faculty partnership began looking for opportunities to utilize faculty experience and our available student talent to help advance the infrastructure on our campus by creating a new charging station for powering EVs driven to campus by our students, faculty and visitors.

Technology and systems currently exist for grid-powered EV charging stations. Technology and systems also exist for a select few off-grid stations. Our group sought to design our own proprietary off-grid system intended to serve as a model for a universally adaptable solution that could be deployed on virtually any new or existing property at any parking lot configuration for either public or private owners.

Knowledge Gained

Critical thinking was a skill that was improved upon while working on the budget due to the thought process that goes into estimating the cost of the final product.

Another skill improved upon was collaboration with other disciplines including the construction team and engineers. Information needed to complete the budget and design was found through discussions in weekly meetings.

Understanding of construction and components was also gained. There isn't a class that teaches students the materials required to build a project, and it is important as engineers to understand everything that goes into a design and be able to account for those items.

Overall, the knowledge and skills gained through this project were very similar to the professional setting. These will be able to be applied to processes learned from this experience to a career after school.

Learning Objectives

Our faculty research partnership exists in an academic department that benefits from having access to undergraduate students who are pursuing the architectural engineering disciplines of either structural engineering or electrical engineering and students earning their degree in construction science and management. This building systems design and construction knowledge pool of student talent was leveraged to support a multidisciplinary effort consisting of industry-experienced faculty guiding emerging-professional students representing all these practices.

While our overarching objective was to design a universally deployable solution for off-grid, solar-powered EV charging, our secondary objective was to develop a concept that was also more economical than other existing systems that are currently commercially available. To accomplish this, the team value-engineered each iteration of the design to recognize opportunities to utilize off-the-shelf system components wherever possible to minimize the cost increases associated with fabricating custom elements for the station.

Methods

To help the participating students relate their experiences to a real-world collaborative scenario, the team approached the project with the mindset of a Design-Build (DB) construction project where DB professionals provide both design services and construction services to a client under a single contract. This approach benefits from both sides—design and construction—listening to the challenges and issues of the other disciplines to mutually establish project solutions that equally satisfy the needs of design while supporting straightforward constructability.

Results

The resultant design originated through collaborative undergraduate research efforts of architectural engineering faculty and students working closely with construction management faculty and students in a “best-for-project" thinking environment.

A roughly 75%-complete design was ultimately presented to the College under which our department serves, and approval was granted to present the design to the University Facilities group as well as the leadership of the Campus Parking Authority. In support of the University’s sustainability initiatives, the project was green-lighted for site selection by both Facilities and Parking.

We are now finalizing the design, securing our funding, and making plans for our prototype to be fabricated and installed on our campus. Our team remains optimistic about the viability of our design and the possibilities for additional deployment at other locations on our campus pending the success of the first station.

Collaboration

Our faculty research partnership exists in an academic department that benefits from having access to undergraduate students who are pursuing the architectural engineering disciplines of either structural engineering or electrical engineering and students earning their degree in construction science and management. This building systems design and construction knowledge pool of student talent was leveraged to support a multidisciplinary effort consisting of industry-experienced faculty guiding emerging-professional students representing all these practices.

The Design-Build approach utilized by our research group involved numerous weekly team meetings where the evolving design and the estimated costs were iteratively analyzed, discussed and updated to push the station from a concept idea to being ready for actual, physical construction.

Licensed professional engineers were consulted during the initial schematic design and iterative design development phases of the project.