Northwestern | sustainNU

Electric Vehicle Charging Infrastructure Upgrade Project

Case Study

Executive Summary

Northwestern University is committed to fostering environmental and ethical stewardship. The University's Strategic Sustainability Plan establishes a vision for reducing the University's environmental impacts. In the area of transportation, the University's vision is to reduce the environmental impact of student, faculty, staff, and visitor travel by providing safe, environmentally efficient modes of transportation and the required support infrastructure. As a step toward achieving this vision, Northwestern committed to upgrading the electric vehicle (EV) charging infrastructure on campus in 2017.

Before upgrading the existing EV chargers, sustainNU sponsored a feasibility study conducted by students in a senior design course within the Department of Industrial Engineering and Management Sciences at Northwestern University's McCormick School of Engineering and Applied Sciences. The course offers students an opportunity to work on real, industry-based problems during their senior year. Sponsored projects from internal University departments or external companies receive high quality analytic services from a team of engineering students advised by a faculty member.

Northwestern was able to leverage the students' findings and recommendations to expand access to EV charging infrastructure, increase the equity of use, and select technology that collects data that is used to calculate avoided greenhouse gas emissions. The University upgraded campus charging stations and doubled the number of EV charging ports from 8 to 16, establishing a comprehensive institutional EV charging policy that ensures greater equity in access to the stations.

Background

Before the EV infrastructure upgrade in 2017, the University's garages were fitted with Schneider Electric charging stations with two charging ports each. The charging stations were non-networked and unable to automatically regulate the amount of time drivers used the stations. This resulted in concerns about equity of access due to "squatting" behavior – the tendency of some drivers to leave their vehicles in a designated EV charging parking space for extended periods of time, despite having fully charged batteries. In addition, the University did not institute a policy to regulate EV commuters when the EV chargers were initially installed, which further enabled squatters.

To solve the inefficient use of the existing EV charging stations and to gain access to quantifiable usage data, sustainNU provided a submission for a feasibility study to the McCormick School of Engineering's Industrial Engineering & Management Sciences (IEMS) senior design course. A group of students selected this project and completed the study over the course of a quarter with support and sponsorship from sustainNU and stakeholders in key University departments including Facilities Management's Electric Shop and the Department of Safety & Security's Transportation & Parking Office.

After combining the students' findings and researching best practices from leading universities, Northwestern was able to perform a complete overhaul of the EV infrastructure and adopt a University-wide EV Charging Policy.

Project Goals

This project supports Northwestern's vision for the future of sustainable transportation on campus. The University's Strategic Sustainability Plan states that "Northwestern University's vision is to reduce the environmental impact of student, faculty, staff, and visitor travel by providing safe, environmentally efficient modes of transportation and the required support infrastructure." This overarching vision provided the context for setting the goals of the project, as outlined in the Transportation program area of Northwestern's Strategic Sustainability Plan, sections 2.9 and 2.10.

- 2.9. Provide new and renovate or retrofit existing parking facilities to increase and incentivize the use of environmentally sustainable transportation by 2021.
- 2.10. Establish an electric vehicle charging policy by 2017.

Student Research Project, Phase 1

sustainNU requested support from the McCormick School of Engineering, IEMS Winter quarter senior design course to make the business case for expanding the University's EV charging infrastructure. The student team that selected the project received sponsorship from sustainNU and several University departments, including Facilities Management and the Department of Safety & Security's Transportation & Parking Office. The senior design project was led by Jordan Susskind, Willem Wang, Liana Korber, Shindy Lu, and Josh Roberts, all members of Northwestern University's McCormick School of Engineering Class of 2017. The project team researched electrical demand trends, parking accessibility, and technology specifications to develop a list of recommendations.

Based on submetering data showing the electrical demands of the existing EV charging stations, the students were able to determine that EV commuters were squatting in the designated charging parking spaces, as the project team had suspected. The submetered data revealed commuters' time of arrival, which was indicated by an increase in amperage levels from the charging stations and the time of a completed charge, which was indicated by a decrease in amperage.

Despite amperage fluctuations, the chargers continued to draw sufficient electrical demand after the initial decrease in amperage suggesting that electric vehicles remained plugged into the charging stations after the batteries were fully charged. The average commuter parked for 6.28 hours, while the average charging duration was 84.5 minutes.

The students' research demonstrated a clear need for an EV charging infrastructure upgrade, which would enable the University to monitor energy usage, the number of unique drivers, and charging duration through an online dashboard. The students proposed the development of an EV charging policy to discourage squatting and promote best practices among the University's EV commuters.

Institutionalizing an Electric Vehicle Charging Policy, Phase 2

Prior to upgrading the EV charging infrastructure, the project team developed a policy to guide EV commuters on the proper use of the charging stations. The EV charging policy was key to ensuring that access to electric vehicle charging infrastructure is equitable and stations remain available to all EV commuters. The tenets of the EV charging policy were developed by the sustainNU Transportation Working Group, one of five sustainNU Working Groups on campus. These Working Groups are responsible for planning and implementing initiatives aimed at achieving the University's sustainability objectives. After the policy was drafted, it was proposed to the University's Policy Review Committee.

Northwestern's Policy Review Committee is a standing University committee that advises the Northwestern community on policy development and reviews and approves proposals for new policies and policy revisions.

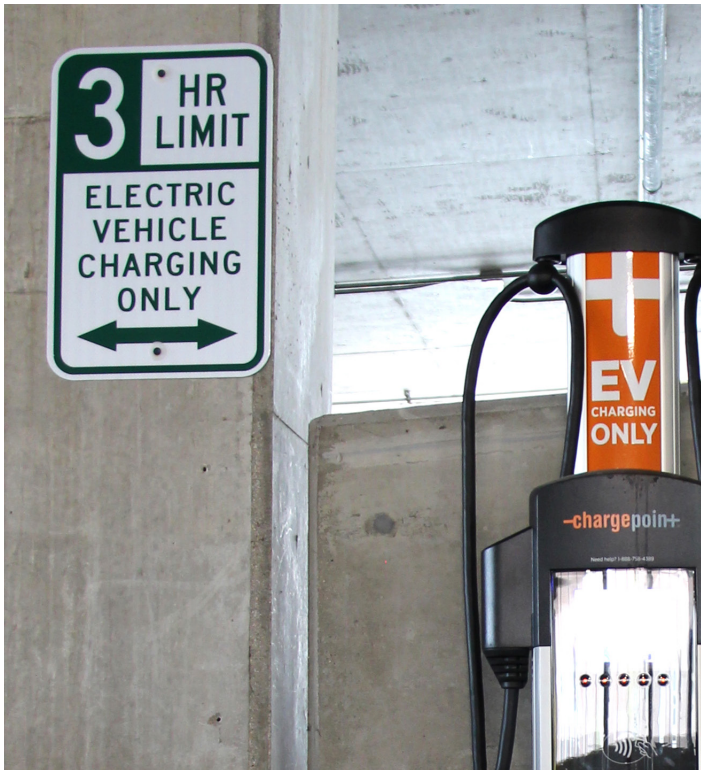
The main tenets of the EV Charging Policy are:

1. Three hours of gratuitous charging are offered, after which the electric vehicle owner must remove their car from the charger and the parking space that is designated to the charger.
2. Three hours of gratuitous charging will be followed by a period where $2.00/hour is charged to the electric vehicle owner via the charger itself.

The policy also included General Usage Rules to ensure that the University's EV community is adhering to best charging practices. These rules read as follows:

1. **Safety:** Please remember to charge your vehicle safely. All electric vehicle charger users must wrap up and store charging cords properly when not in use.
2. **Preferred Users:** Preference for charging is given to fully electric vehicles over plug-in hybrids. Internal combustion vehicles, as well as non-plug-in hybrids are not permitted to park in a parking spot designated with an electric vehicle charger.
3. **Fair Charging:** If your car does not require a charge to reach your end destination, do not use a charger. This ensures that the chargers are available to those that need the charge to make it to their end destination without using fossil fuels.
4. **Yield to Signage:** All drivers must adhere to the signage that is posted near the electric vehicle chargers. Failure to do so may result in fines as outlined in this policy.

To read the full text of Northwestern's Electric Vehicle Charging Policy, visit the link here.



Selecting the Right Technology, Phase 3

Throughout the duration of the student research project, the students reached out to several of the leaders in the EV charging industry to determine the best technology for the University. Based on their research, the students recommended ChargePoint as the ideal option due to their superior technology and large percentage of market share.

Several different charging technologies were considered once the University was ready to upgrade the EV infrastructure. Networked and data-driven stations were essential to fully understanding the charging habits of the EV community and the amount of greenhouse gas emissions being avoided.

Another consideration was ease of use and familiarity for the University's EV commuters. As of April 4, 2018, there were over 420 public EV charging sites in the state of Illinois. ChargePoint represents a majority of these sites at 57.9 percent, the next competitor represents only 23.7 percent of these sites. (Source: Alternative Fuels Data Center) This large percentage of ChargePoint charging stations in Illinois ensured that the members of Northwestern's EV community and visitors to campus alike would recognize the upgraded technology and have no difficulties using the stations to their full capacity.

The selection of the specific charging stations was also driven by the existing EV infrastructure in the City of Evanston. Evanston, the University's host community, uses ChargePoint EV charging stations for the existing public charging infrastructure. Coordinating the University's infrastructure with the City's was an intentional way to keep Northwestern's campus offerings user-friendly and recognizable.

ChargePoint is the only EV charging company that has ENERGY STAR® certified products. This distinction means that ChargePoint products are 40% more efficient than standard EV charging stations currently on the market (Source: ChargePoint Blog: Charging the Future.) Northwestern has been an ENERGY STAR Partner since 2015 and is a proud ENERGY STAR Partner of the Year 2017, so ChargePoint's commitment to energy efficiency and the ENERGY STAR program set ChargePoint apart from the other EV charging products.

Together, these factors made the choice of technology for this project clear. Within the ChargePoint family of products, the University chose the ChargePoint CT-4023 stations, which are Level 2 chargers with dual ports.

Charging Station Installation, Phase 4

The students had suggested that the number of charging stations on campus be increased and that parking spaces that are specifically reserved for EVs be placed adjacent to the charging stations to allow EV commuters to easily move their vehicles once they are finished charging. After speaking with a select number of EV commuters, the students found that most EV commuters were squatting in the parking spaces designated for charging in order to take advantage of the premium parking spaces. Due to this finding, sustainNU drew up a plan to both expand the number of charging stations on campus and also convert several of the surrounding parking spaces to EV specific spaces. Facilities Management and Safety & Security's Transportation & Parking office approved the change in parking space designation.

Northwestern issued a request for proposal for the installation of the charging stations and selected a local electrical contractor to complete the electrical installation. Over a three-week period, both the North and South parking garages had the electrical conduit upgraded to support the required increase in demand. The new charging stations were installed, the ground painting was completed, and signage was installed to assist EV commuters with acclimating to the new chargers. Signs were posted on EV designated parking spaces, and the parking time limits associated with cost-free charging were included in signage.

Throughout the implementation phase of the project, the Transportation & Parking Office issued periodic communications about the new EV charging installations and new policy implementation. Messaging was issued to all University parking permit holders. This ensured all affected parties remained informed throughout the project. Continuous and transparent communication ensured minimal disruption to Northwestern's EV commuters as well as minimal confusion on the user end.

Project Timeline

Winter Quarter, February-March 2017

IEMS Senior Design students select the EV charging infrastructure upgrade project for their quarter-long project.

Summer 2017

EV Charging Policy language is drafted by sustainNU Transportation Working Group members. The policy goes through several rounds of drafts with stakeholders before being finalized.

September 2017

New EV charging stations are purchased and RFP for electrical contracted work is sent out. EV Charging Policy is sent to the Northwestern University Policy Review Committee.

November 2017

A communications plan outlining the construction timeline and the details of the project is sent out to the North and South parking garage users, with a specific message sent to EV commuters alerting them to the fact that the chargers will be inaccessible during construction. EV charging policy is approved by the University's Policy Review Committee and is communicated to all Northwestern parking permit holders.

Late November/Early December 2017

Electrical work for installation of new charging stations begins. sustainNU releases a newsletter article describing the project from start to finish and explaining how to use the new charging stations and where users can find the new EV Charging Policy.

Mid-December 2017

Electrical work is finished and installation is complete. Stations are initiated and connected to the online dashboard that visualizes the data collected from the charging stations.

Financing

The bulk of the project was internally funded by the University. The students' research was done in conjunction with the IEMS senior design course, resulting in no cost. The financing for the EV charging stations and the contracted electrical work for installation was sourced by sustainNU. The financing for the painting and the signage needed to delineate that the parking spaces are reserved for EVs was financed by Facilities Management, Operations. The income realized from the EV charging stations will be placed in a fund that is used explicitly for sustainable transportation initiatives. The distribution of responsibilities and costs between units was key to the project's successful and swift implementation.

Results

After installation, the charging stations were well received by the University's EV community. There were no issues with turnover from the older stations to the upgraded stations. The changes were communicated to the affected parties, resulting in clarity and understanding once the new charging stations were operational.

The issue of squatting that was detected with the original EV charging stations has been almost completely eradicated. The combination of the charging stations' ability to automatically regulate users that park in the space for over three hours by charging a nominal fee, in addition to the placement of EV premium parking spaces adjacent to the EV charging stations, has kept the average charging session length to 2 hours and 5 minutes. The accessibility of the charging infrastructure to the Northwestern EV community has increased greatly with an average of 52 unique drivers utilizing the charging stations each month.

Within the first four months of installation, the upgraded EV charging stations avoided 3,990 kg of greenhouse gas emissions, which is the equivalent of planting 102 trees and letting them grow for ten years. The EV charging infrastructure upgrade project resulted in more equitable use of resources on campus, while encouraging sustainable modes of transportation, engaging students in a valuable experiential learning opportunity, and supporting the University's objectives.

Lessons Learned

A valuable lesson learned from the success of this project was the value of collaboration and support from several different units at the University. Students, faculty, and staff were all involved from start to finish. Connecting with and working collaboratively with multiple units made this project a true team effort with input and agency from all knowledgeable parties.

Additionally, transparent communication executed throughout the lifecycle of the project kept the campus community informed about installation disruptions and expected changes. This level of communication helped the project run smoothly with limited confusion.

Lastly, sustainNU learned that working hand in hand with students to see a project to completion empowers the students to have a stake in University sustainability projects. This shared ownership not only fosters buy-in and support for the University's sustainability program, but also connects to the University's goal of serving the student population and providing experiential learning opportunities.

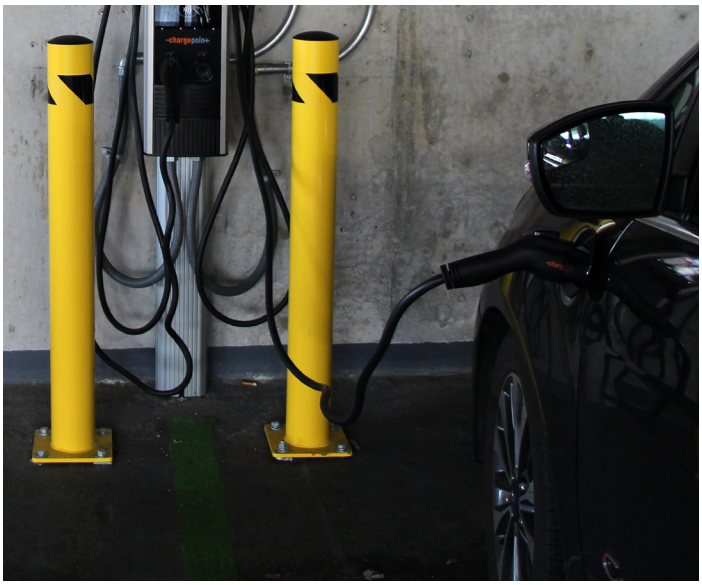
Resources

IEMS Course Listing
www.mccormick.northwestern.edu/industrial/courses/descriptions/393-1.html

EV Charging Policy
www.northwestern.edu/transportation-parking/evanston-parking/policies/electric-vehicle-charging.html

sustainNU Sustainable Transportation Resources
www.northwestern.edu/sustainability/take-action/travel-sustainably/index.html

ChargePoint and ENERGY STAR®
www.chargepoint.com/blog/chargepoint-teams-energy-star-cost-efficient-ev-charging-solutions-home-ct4000-cpf25/



For More Information

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