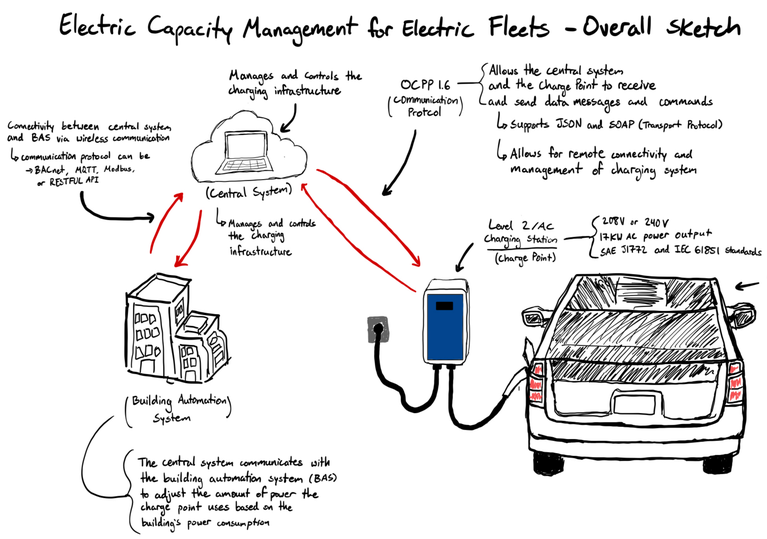
McKinstry Electrical Capacity Management for Electric Fleets

Project Introduction

- Dynamic EV Charging System monitors building power usage to charge EVs using available power
- Maximum power set by the building's transformer capacity (500kVA or more)
- As building power usage rises, system automatically reduces output to stay within transformer limits
- System requires continuous data monitoring and processing

Objectives

- Research chargers, industry-standard protocols, and building data (Open Charge Point Protocol, Building Management System, etc.)
- Build/Assemble a functioning Level 2/AC charging station
- Study and modify source code
- Implement test case scenarios given by mentors into the charger



Testcases

Given Building Scenarios:

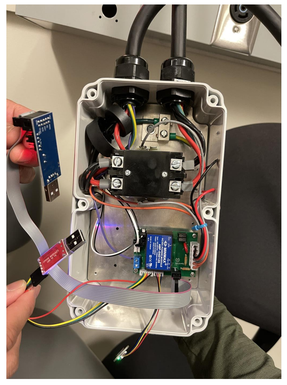
- Testcase 1: Building energy usage unusually low and stable. Could the meter be reporting inaccurately?
- Testcase 2: With clocks advancing one hour at 2:00AM for Spring Daylight Savings, will there be sufficient time to charge the fleet to the required SoC by the deadline?
- Testcase 3: If building energy usage unexpectedly increases, how will the system ensure the EV reaches its target SoC?

Power Management Logic

- Testcase 1: If building power usage is unusually low or unstable, assume a building usage value that allows for a safe overhead while still charging the vehicles
- Testcase 2: The EV charging session should start 1 hour earlier than when the charger indicates the following day is DST, which always falls on the second Sunday of March
- Testcase 3: Prioritizes high-power charging for low-battery cars and low-power charging for high-battery cars

Hardware

- Assembled a Level 2 AC Charger Kit – Guaranteed safety and reliability
- OpenEVSE Charger – For custom code integration via open-source software
- Specifications – Charger operates on 240V and can output a max of 48A
- USB SerialComm (red) – used for exchanging data between laptop and charger
- USB Programmer (blue) – used for uploading compiled code to charger
- Microcontroller – ATMega328p chip based on the AVR instruction set



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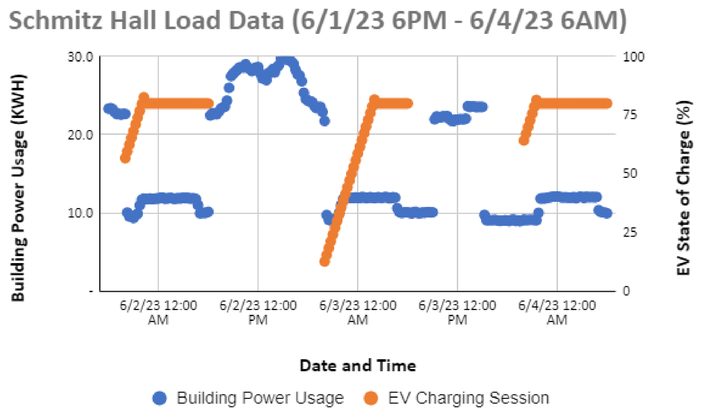
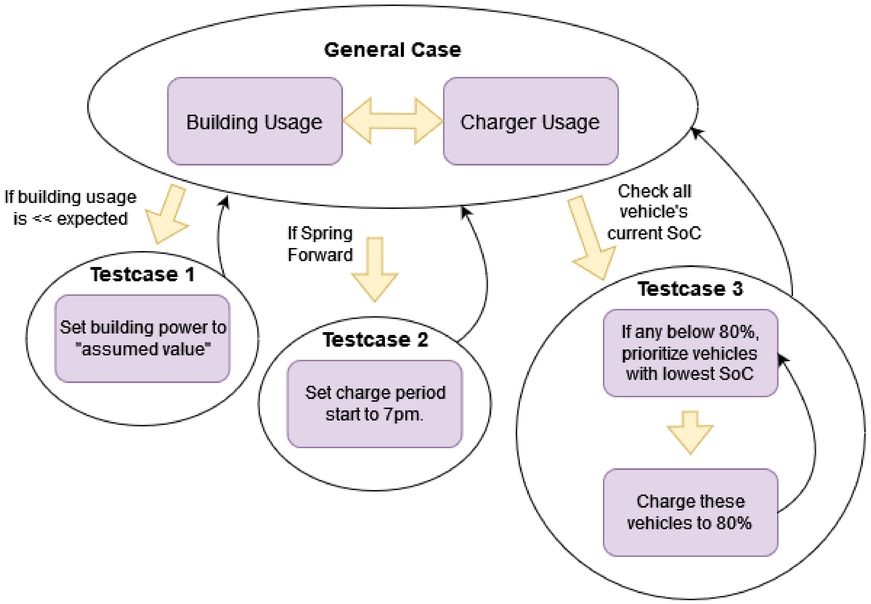
Software

- Simulate real-world scenarios in CMS (charging management software) using a year's worth of power consumption data for different buildings, recorded at 15-minute intervals
- Use Visual Studio Code IDE and Platform IO to update and deploy code that dynamically adjusts charging rates
- Compile and run simulation tests using C++, displaying results in the VS Code terminal



Results

- Successfully assembled charger and powered it on
- Testcase 1 detects power meter instability and assumes an appropriate power usage value
- Testcase 2 identifies specific date DST Spring forward is to occur each year
- Simulation created to demonstrate DST charge scenario logic of testcase 2
- Testcase 3 prioritizes cars based on available power and the fleet's current SoC



Future Work, References, and Acknowledgments

Learned:

- Multiple factors influence load consumption and usage (charge rate, load capacity, availability, charge curves, etc.)
- Using an unfamiliar IDE, coding language, and undocumented source code required significantly more time (than expected)

Future Work:

- Further improvements to testcase solutions and implementing into source code
- Further documentation of functionalities and features for the charger

Faculty: Jim Ritcey
Students: Angelo Herrera, Mussie Tsegay, Nic Bohac, Riley Yuasa, WooJae Lee, Zeyad Ahmed, Zhenyang Li

[1] OpenEVSE, 'open_evse,' GitHub repository, OpenEVSE, 2024.Available:https://github.com/OpenEVSE/open_evse/tree/master/firmware/open_evse.
[2] Arduino Team, 'Creating a low-cost EV charging station with Arduino,' Arduino Blog, April 23, 2024. Available: https://blog.arduino.cc/2024/04/23/creating-a-low-cost-ev-charging-station-with-arduino/.
[3] "The OCPP handbook (2024)," AMPECO, https://www.ampeco.com/guides/complete-ocpp-guide/#:~:text=4.-,How%20OCPP%20works,and%20data%20with%20each%20other

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ADVISERS: BRENDAN O'DONNELL, JUSTIN LEE, JIM RITCEY, ROSE JOHNSON

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