Behavioral Analysis of UCR Plug-in Electric Vehicle Users

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Introduction

- Efficient utilization and fast deployment of Electric Vehicle (EV) Charging Stations (CS) are required to accommodate the growth of PEV adoption.
- This project investigates the behavioral pattern of public PEV charging stations situated in a university campus community.
- A year-long data of 32 PEV charging ports are analyzed to find out the correlation between station occupancy, energy usage and charging activities.
- A generalized probabilistic load model is proposed to estimate the hourly aggregated PEV power consumption on a given day.
- The results show that aggregated PEV load demand highly depends on the station occupancy and charging session distribution.
- Higher PEV penetration results in higher aggregated load demand.
- Hourly based charging rate seems more beneficial for EV station owners than energy-based rates.
- The in-depth load demand and charging cost analysis will assist the policy makers during future CS integration.

Project Goals

- PEV CS data interpretation for a large university campus community to help the policy makers and CS owners.
- Providing a probabilistic and aggregated PEV load estimation for a large number of PEV users.
- Conducting feasible PEV penetration scenarios to assess the impact of overloading and possible revenues for CS owners.

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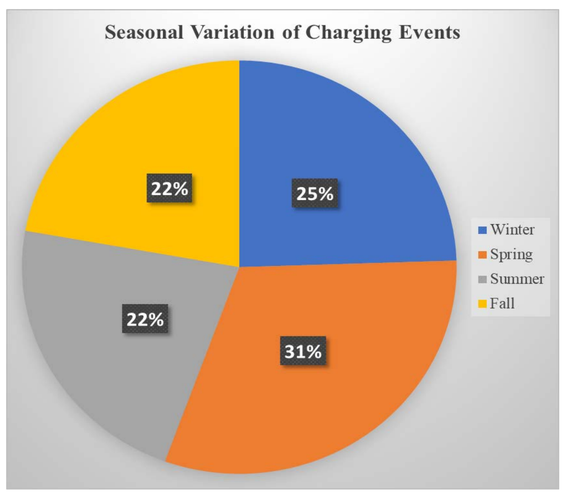
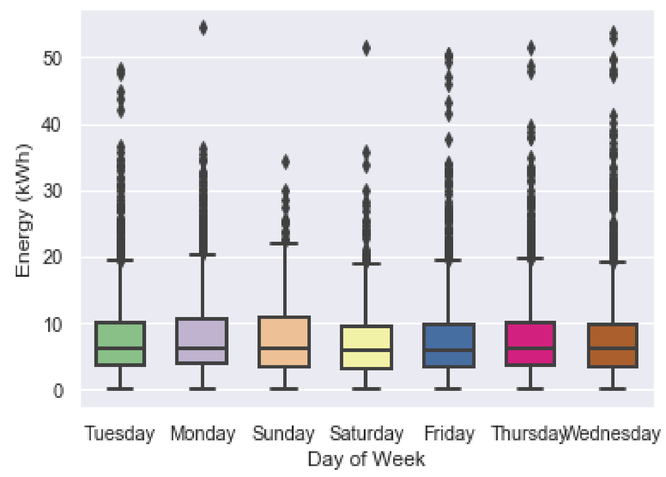


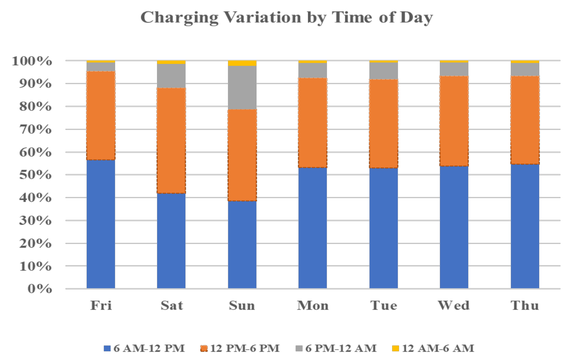
Data Collection & Analysis

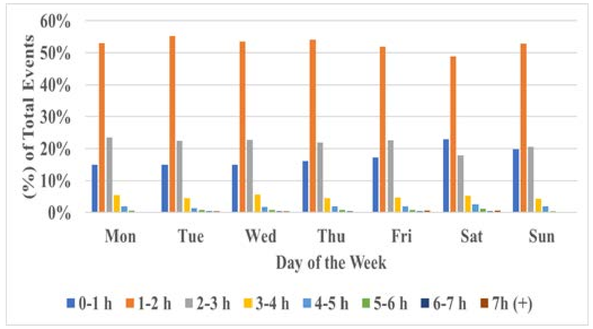
- 18 PEV charging stations exist which are supervised by Chargepoint. 2 of them are recently added.
- Each of the stations has 2 charging ports.
- 27746 charge sessions data were collected dispersed from Jan 2018-Jan 2019.
- Data includes station ID, charging session details and consumed energy.
- Spring is the busiest season and on an average 7.46 kWh energy is consumed per day for charging.

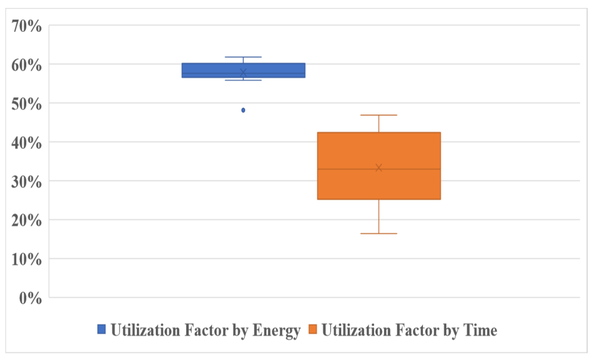


Charging Sessions Scenario & Station Utilization

- More than 90 percent users charge their PEVs during morning and afternoon on a typical weekday.
- Most of the charging sessions end before 3 hours.
- The average values of UF_{Energy} and UF_{Time} are 58 and 33 percent respectively.

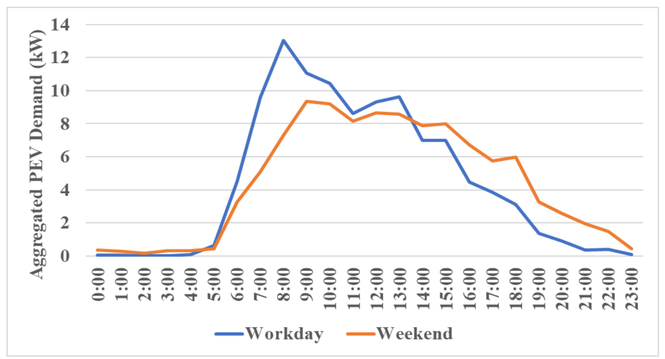


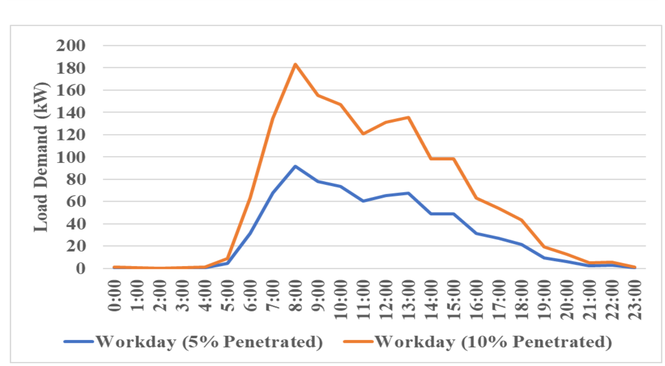


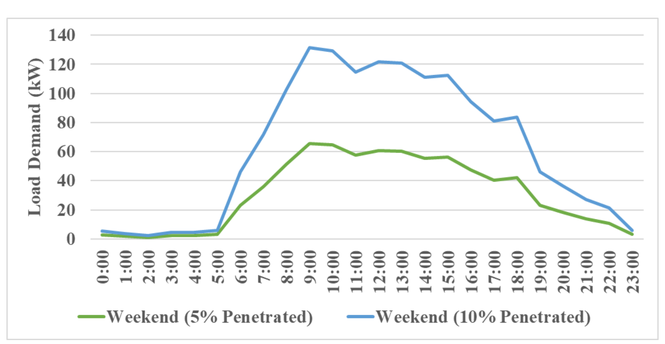


Aggregated PEV Load Estimation

- Maximum 13 kW PEV load demand can be generated at any point of time by charging activities.
- Aggregated load estimation is 91 and 183 kW for 5 and 10 percent penetration on any workday.
- The load estimation for weekends are 66 and 132 kW respectively.







Cost Analysis

- The hourly based charging policy largely differs from the common charging policies based on energy (kWh) usage.
- 91 percent charging events are finished by 3 hours which means maximum revenue is $3.5 and $6.5 for UCR and non UCR affiliates respectively in most cases.
- This policy is a disadvantage for EV owners who have EVs of lower charging level capacity (e.g. PHEV).

	Monthly ($)	Yearly ($)
PEV Owners Charging Cost	3,020-6,894	36,241-82,738
Utility Cost	1,476	17,712
Minimum Revenue	1,544	18,528

Conclusions

- Charging behavior and energy consumption analysis will provide insights to the policy makers to establish new charging infrastructures.
- Information of EV users in the campus and their travel profiles can help to estimate the necessity of establishing fast charging EV stations.

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