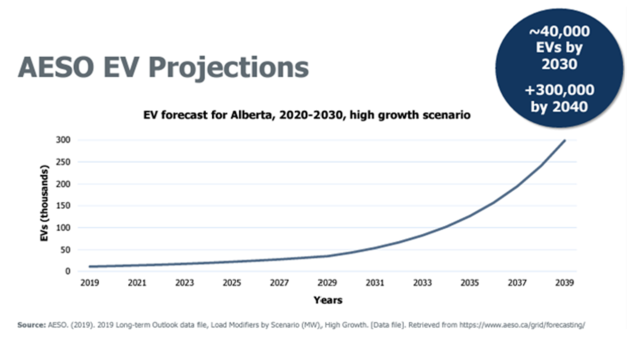
EZEV - Dynamic EV Charger Loading System

Problem Statement

- The increasing adoption of Electric Vehicles (EVs) poses challenges to ATCO's service territory, particularly concerning strain on transformers and underground cables.
- Current market solutions neglect the impact on transformers and are costly, highlighting the need for an affordable option that prioritizes transformer overload prevention.
- To address these challenges, the "Dynamic EV Charger Loading System" project aims to optimize transformer operation and enhance grid reliability through dynamic load management strategies.

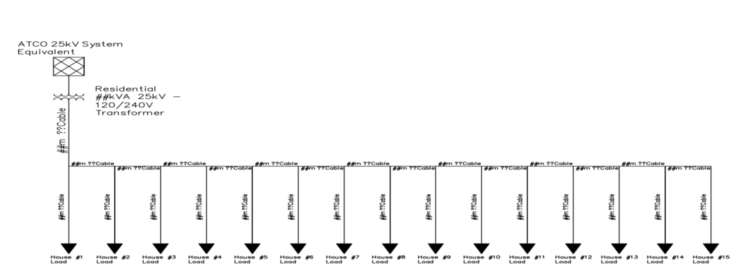


Our Solution

- Our solution considers EV growth, high-power charging demands, and loads such as ACs, to detect and mitigate transformer overloads.
- A machine learning model created to flag EVs.
- Our control scheme dynamically adjusts EV charger power, factoring in ambient & hotspot temperatures as well as State of Charge (SoC), to prevent overloads.
- Our proposed communication scheme streamlines interaction between the EZEV web app and smart EV chargers, utilizing existing market products for ease of implementation.

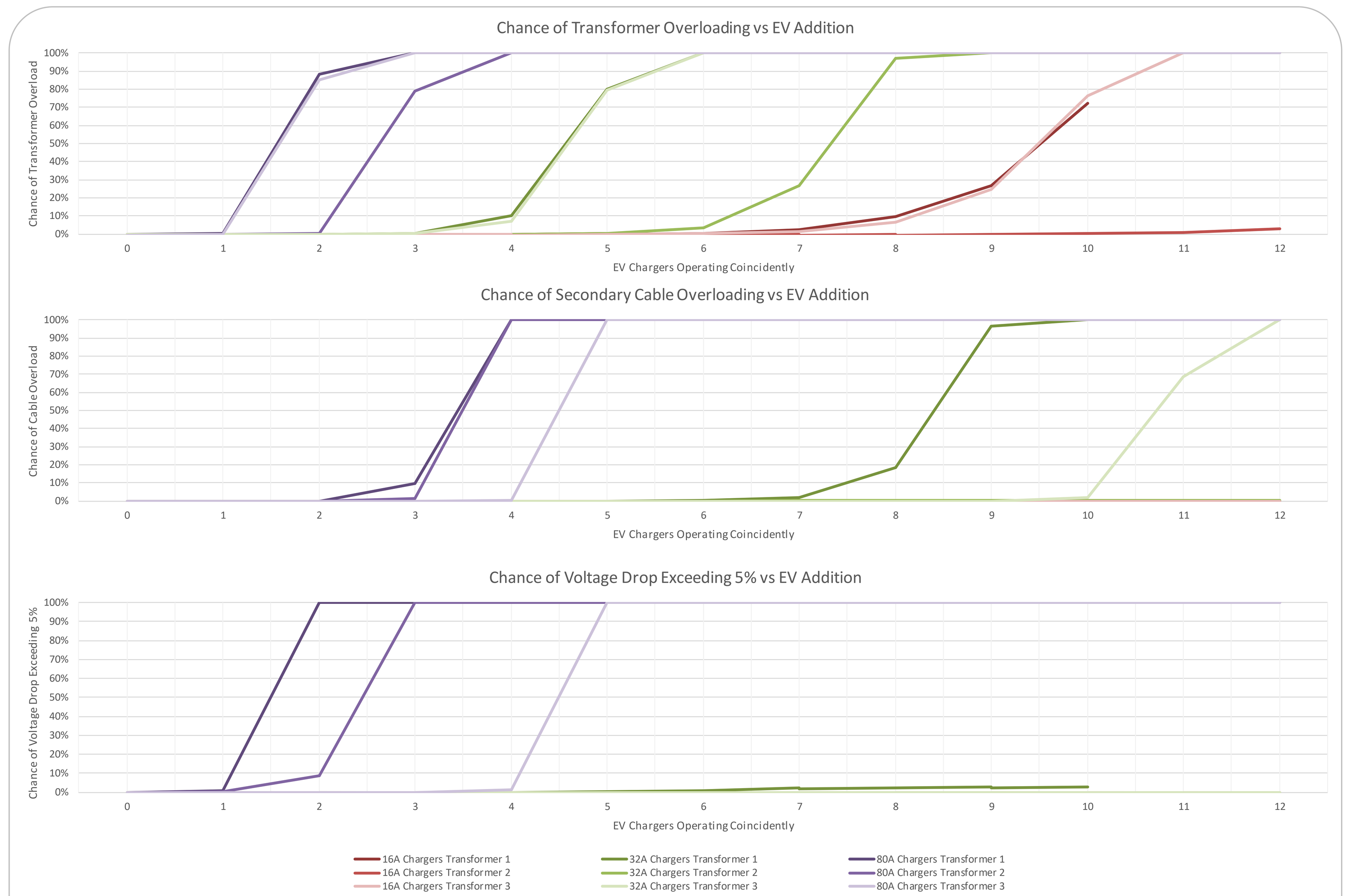
Methodology

- **Study:** To evaluate the impact of EV chargers on residential transformers, we modeled three transformers and their secondary network, added EV charger loads, and noted the results.



- **Control:** To load share EV chargers on the network, we created a dynamic scheme that shares power load based on EV's state of charge and transformer hot spot temperature.

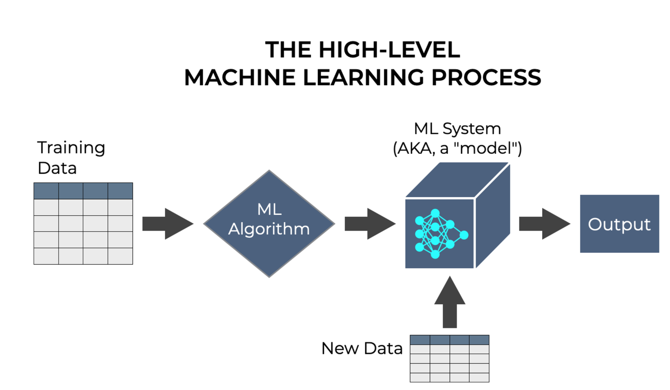
System – Study

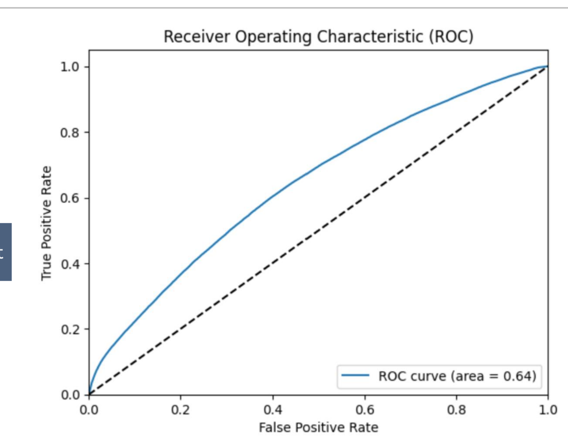


- Current EV adoption projections forecast that 26% of vehicles registered in Alberta will be EVs by 2032 [1]. To account for clusters of EV adoption due to socioeconomic and other factors, we considered and adoption rate 20% higher than expected as our maximum realistic adoption rate.
- The Coincidence factor for EVs decreases as more are considered, within a subdivision, a coincidence factor of 60% for 5 EVs, dropping to 45% for 10 EVs [2] can be considered realistic.

System – EV Flagging

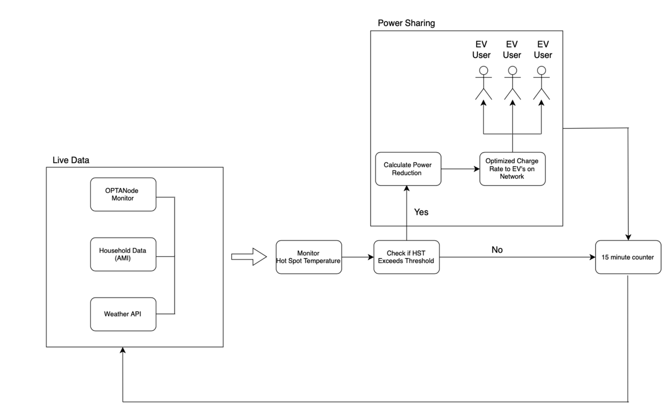
[3]

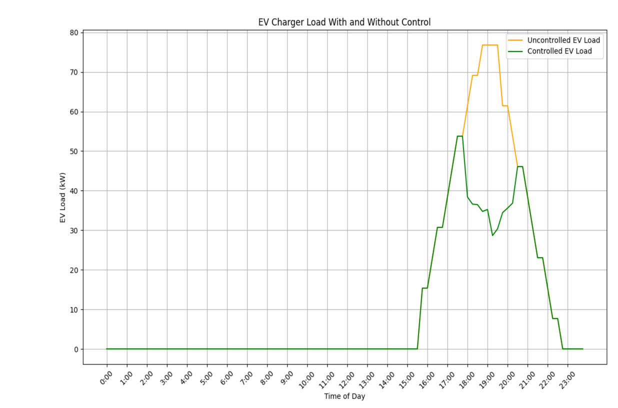




- A dataset was labeled to identify EV presence.
- Random Forest model was created focusing on total energy as the key predictive feature.
- A F1 Score of 0.77 for non-EV houses vs 0.30 for EV houses and an AUC of 0.64, indicating model needs improvements.
- We can enhance model performance by adding time-based metrics and addressing data imbalance by integrating more data.

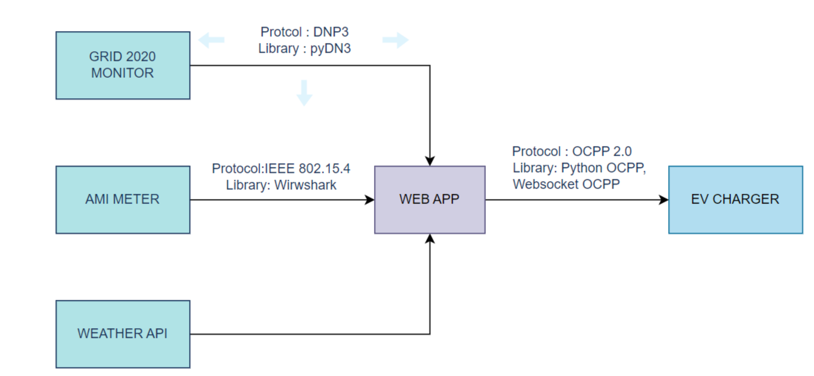
Load Sharing – Control Scheme





- Our proposed control scheme actively processes live data every 15 minutes.
- It calculates a reduced charge rate for each user's vehicle when the hot spot temperature threshold is met.
- This reduction in charge rate is optimized via overall load and state of charge of user's vehicle.

Load Sharing – Communication Scheme



- To link the web application with control variables, we conducted a study of the various device communication protocols.
- Based on the study, we proposed libraries and protocols to integrate into the web app.
- Our proposal outlines the OSI protocols and latency times involved.

Future Work – Web App

- A proposed EZEV web application offers homeowners the ability to activate our control scheme, while also providing basic visibility features to encourage its use.

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References

[1] "Albertans charging ahead with EVs as Calgary dealerships report record sales," Calgary, Nov. 07, 2023. https://calgary.ctvnews.ca/albertans-charging-ahead-with-evs-as-calgary-dealerships-report-record-sales-1.6634771 (accessed Mar. 18, 2024).
[2] J. Bollerslev et al., "Coincidence Factors for Domestic EV Charging From Driving and Plug-In Behavior," IEEE Transactions on Transportation Electrification, vol. 8, no. 1, pp. 808–819, Mar. 2022, doi: https://doi.org/10.1109/tte.2021.3088275
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