The BEV Smart Charging Adoption Project

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Introduction

- **BEV** (Battery Electric Vehicle) helps to reduce carbon dioxide and air pollution. As BEVs gain popularity, managing their load on the grid will become increasingly important.
- With **smart charging**, utilities can smooth out this demand to avoid overload caused by BEV charging, and integrate more renewable energy.
- There are 2 ways of smart charging. **SMC** (Supplier-Managed Charging) monitors and controls the timing of charging, and **V2G** (Vehicle-to-Grid) enables BEVs to send power back to the grid.
- To enable smart charging, utilities must educate and incentivize BEV owners to participate in these programs. A **conjoint survey** is a great approach to collect users' willingness.

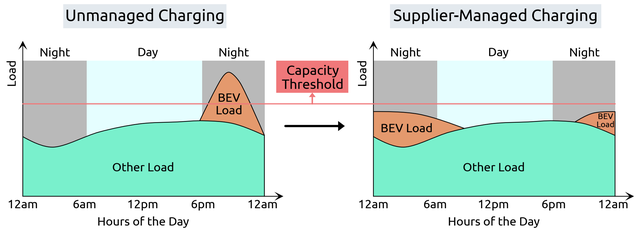
Objective

This project aims to understand **BEV** owners' preferences to **participate** in the **smart charging** programs to improve **grid** resilience and enable greater integration of **renewable** energy onto the grid.

The team will conduct a **simulation** with the grids to see theoretical results of smart charging implementation.

The Smart Charging Programs

SMC (Supplier-Managed Charging)



Supplier-managed charging avoids overload caused by BEV charging.

V2G (Vehicle-to-Grid)

Non-V2G (Single Direction)

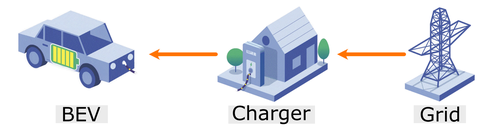


Figure Source: *wri.org*

V2G (Bi-direction)

In a V2G event, BEVs can charge the grid when necessary.

Method

Conjoint Surveys

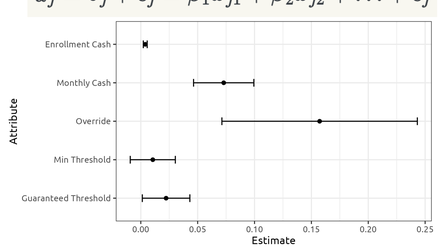
Option 1	Option 2	Option 3
Enrollment Cash: $50 Monthly Cash: $2 Override Allowance: 0 per month Battery Thresholds (in Miles): Min, Guaranteed; 0, 60, 180, 300	Enrollment Cash: $300 Monthly Cash: $20 Override Allowance: 5 per month Battery Thresholds (in Miles): Min, Guaranteed; 0, 120, 240, 300	Not Interested

- Conjoint surveys pack attributes. Users make choices based on their preferences.
- Fielding strategy includes survey panels, social medias, and EV forums.
- We also collect ownership, charging preferences, and demographics data.

Logit Models

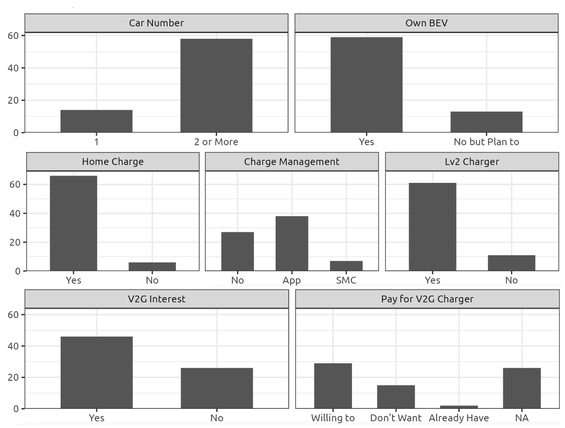
$$P_j = \frac{e^{v_j}}{e^{v_j}+e^{v_k}}$$

$$\tilde{u}_j = v_j + \tilde{\epsilon}_j = \beta_1 x_{j1} + \beta_2 x_{j2} + \ldots + \tilde{\epsilon}_j$$



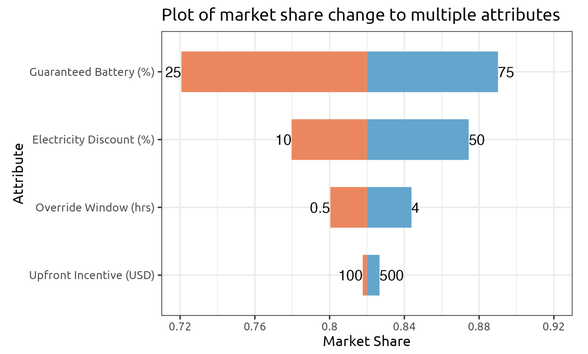
- Highest coefficient: **No choice**.
- Most significant: **override** and **monthly cash**.
- Compare every utility with no choice.
- Correlation between no choice and other attributes.

Demographic Results



- Survey panels: Incentivize for fast response.
- Social medias: Users are willing to share voluntarily.
- Most users have 2 or more cars, with at least one being BEV, and regularly charge at home.
- Most users have charge management approaches using App or SMC.
- Most users are interested in V2G and want to pay for V2G charger.

Conjoint Results



- This is the result of the pilot study.
- Range anxiety is the top most attribute that affects users' adoption.
- Recurring cash back is more important than one-time payment.
- Override allowance is somewhat important but not vital.

Future Work

User Preference Modeling:

- Complete survey analysis and data cleaning.
- Unobserved heterogeneity will be revealed by mixed logit model.
- Observed heterogeneity is detected by interaction model.
- Latent class model is a detective model to indicate the maximum possible interactions considering heterogeneity.

Discussions:

- What can we learn from the summary statistics?
- How to move forward to smart charging program simulation for the grids?

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