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.
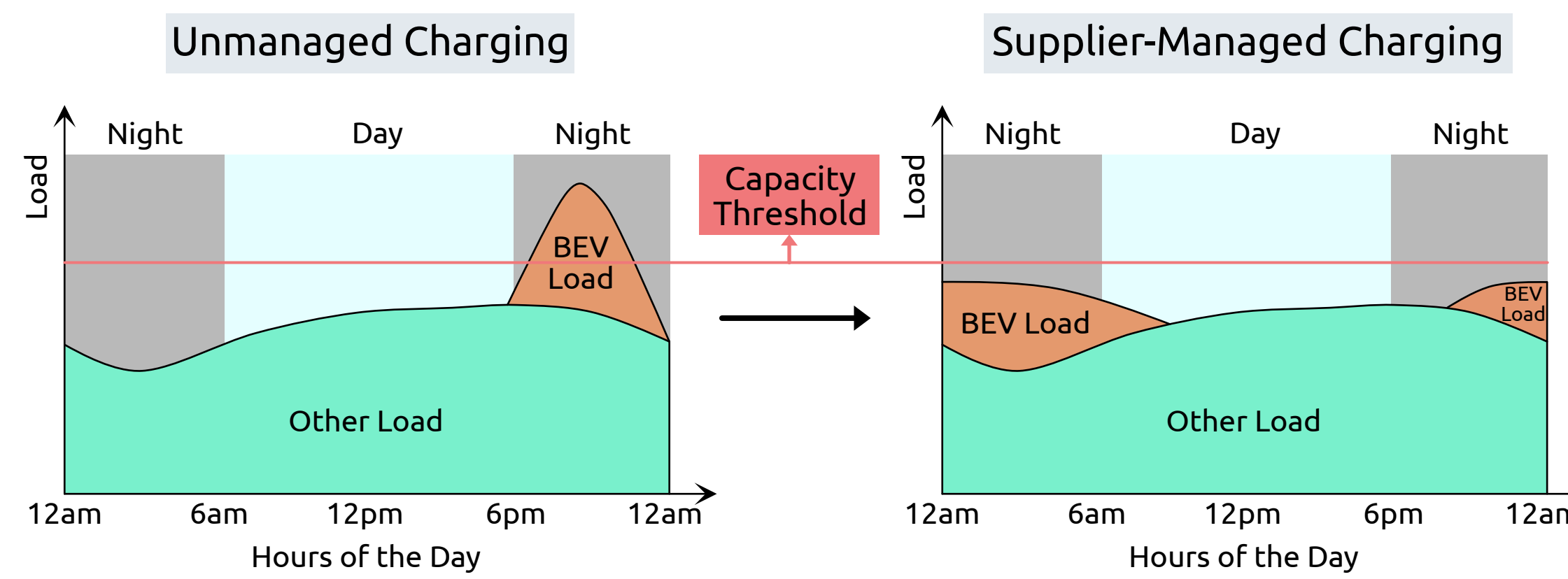
Objective

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.
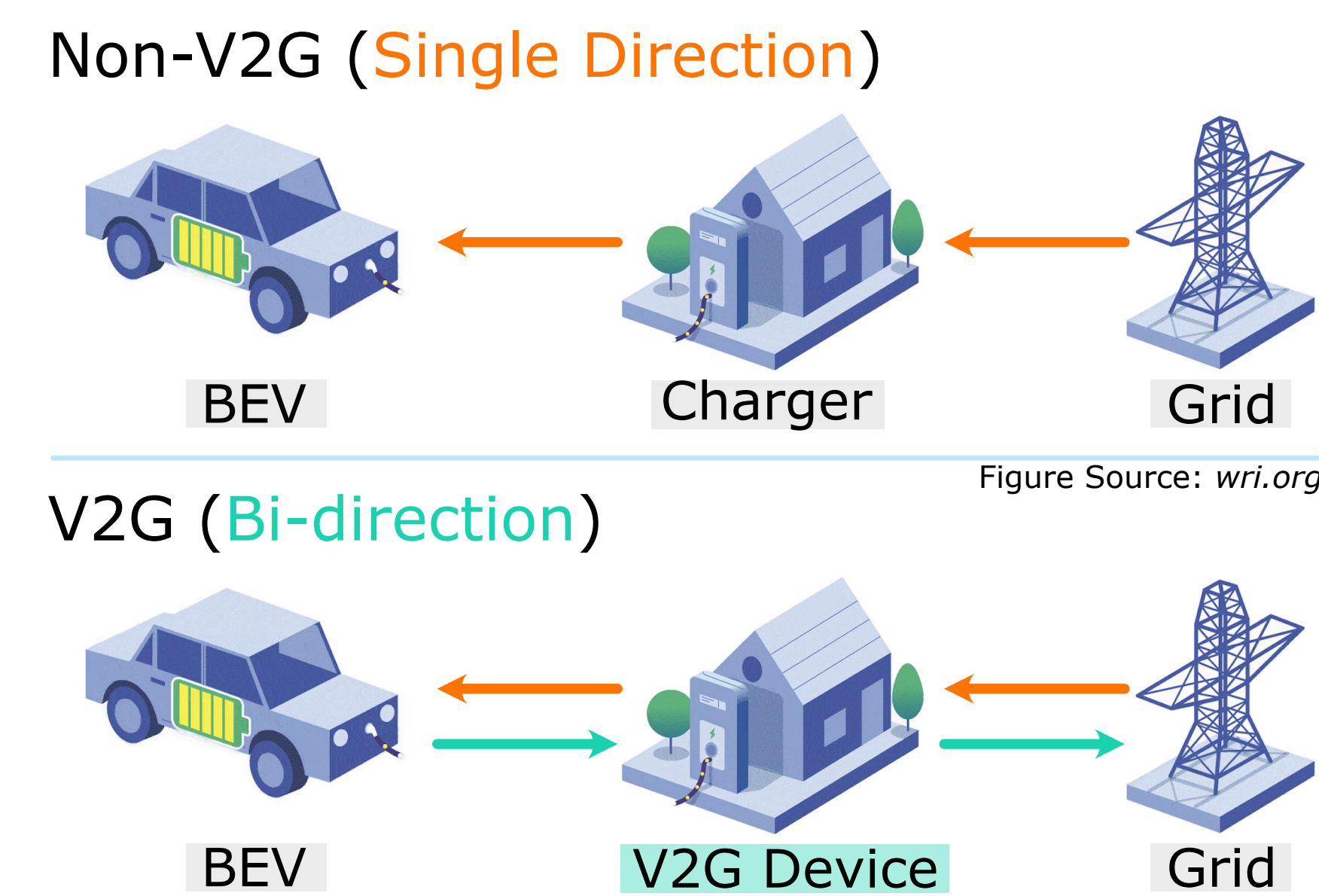
The Smart Charging Programs

SMC (Supplier-Managed Charging)

Supplier-managed charging avoids overload caused by BEV charging.

V2G (Vehicle-to-Grid)

Non-V2G (Single Direction)

BEV — Charger — Grid

Figure Source: *wri.org*

V2G (Bi-direction)

BEV — V2G Device — Grid

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

Method

Conjoint Survey

- Attributes are randomized.
- Participants choose the full package.
- Acquired over 800 results from Meta.
- Personal and demographics data are collected for heterogeneity purposes.

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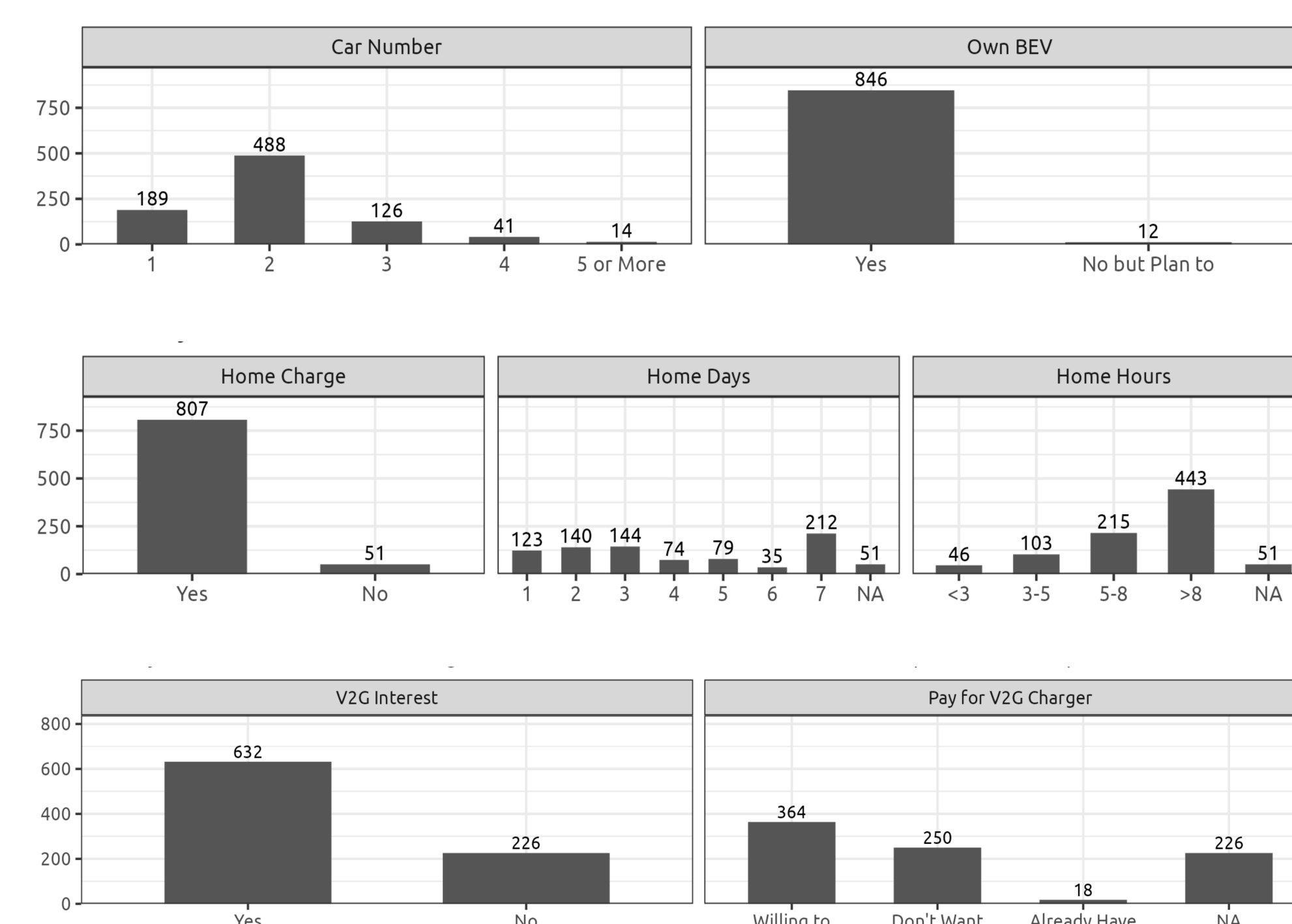
$$P_j = \frac{e^{v_j}}{e^{v_j} + e^{v_k}}$$

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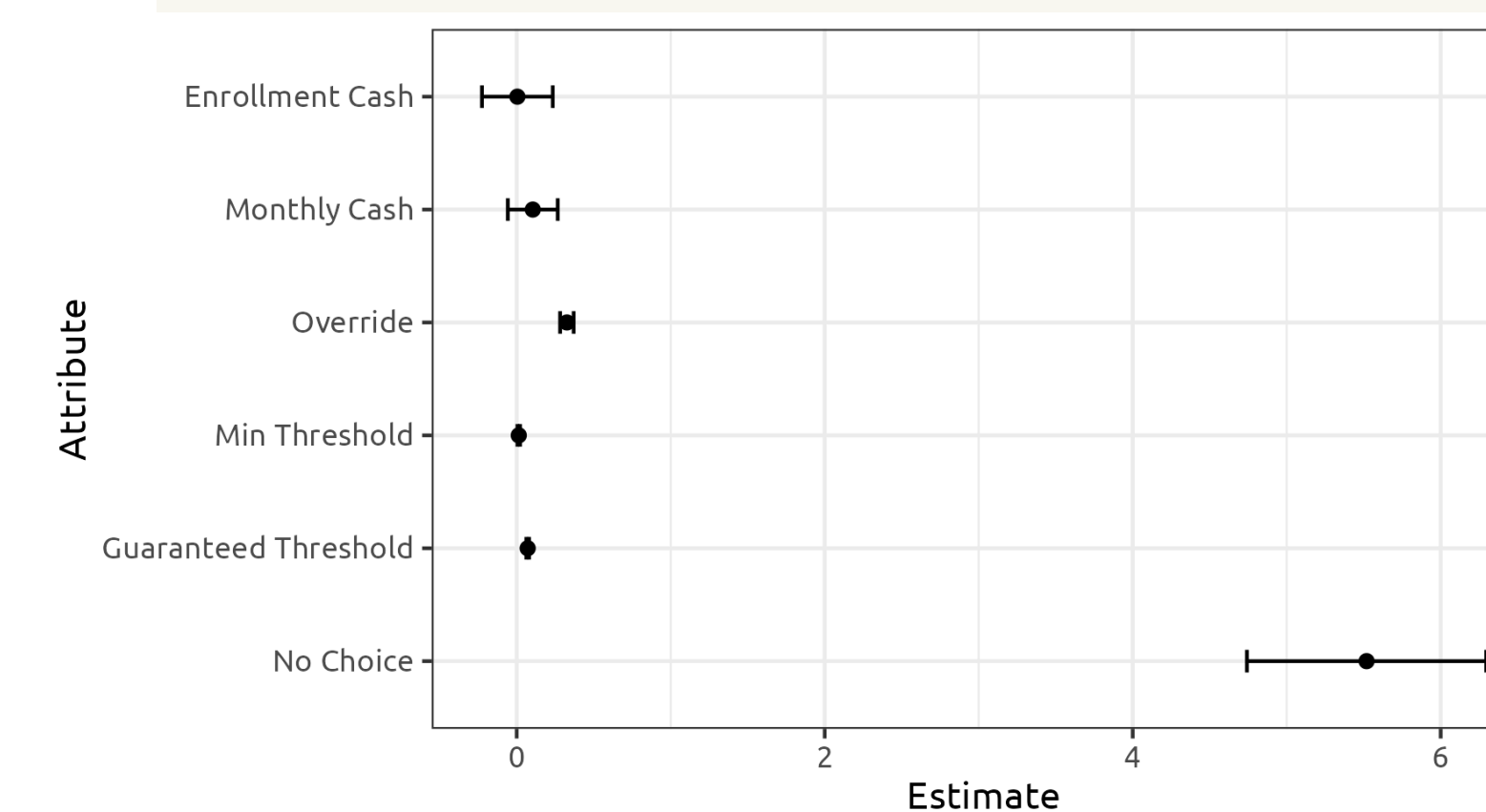

- Respondents tend to quit if no benefit.
- All attributes are contributive to enrollment.
- Coefficients need to multiply with values. For example, cash back coefficients should multiply with cash.

Personal & Demographic Results

- Most respondents have 2 or more cars, with at least one being BEV, and regularly charge at home.
- Most respondents manage charge with App or SMC.
- Most respondents are interested in V2G and want to pay for V2G charger.
- Most repondents have ages of 41-70.
- Major household income is 100-200k.
- Tesla ownership is about 1/3.

Conjoint Results
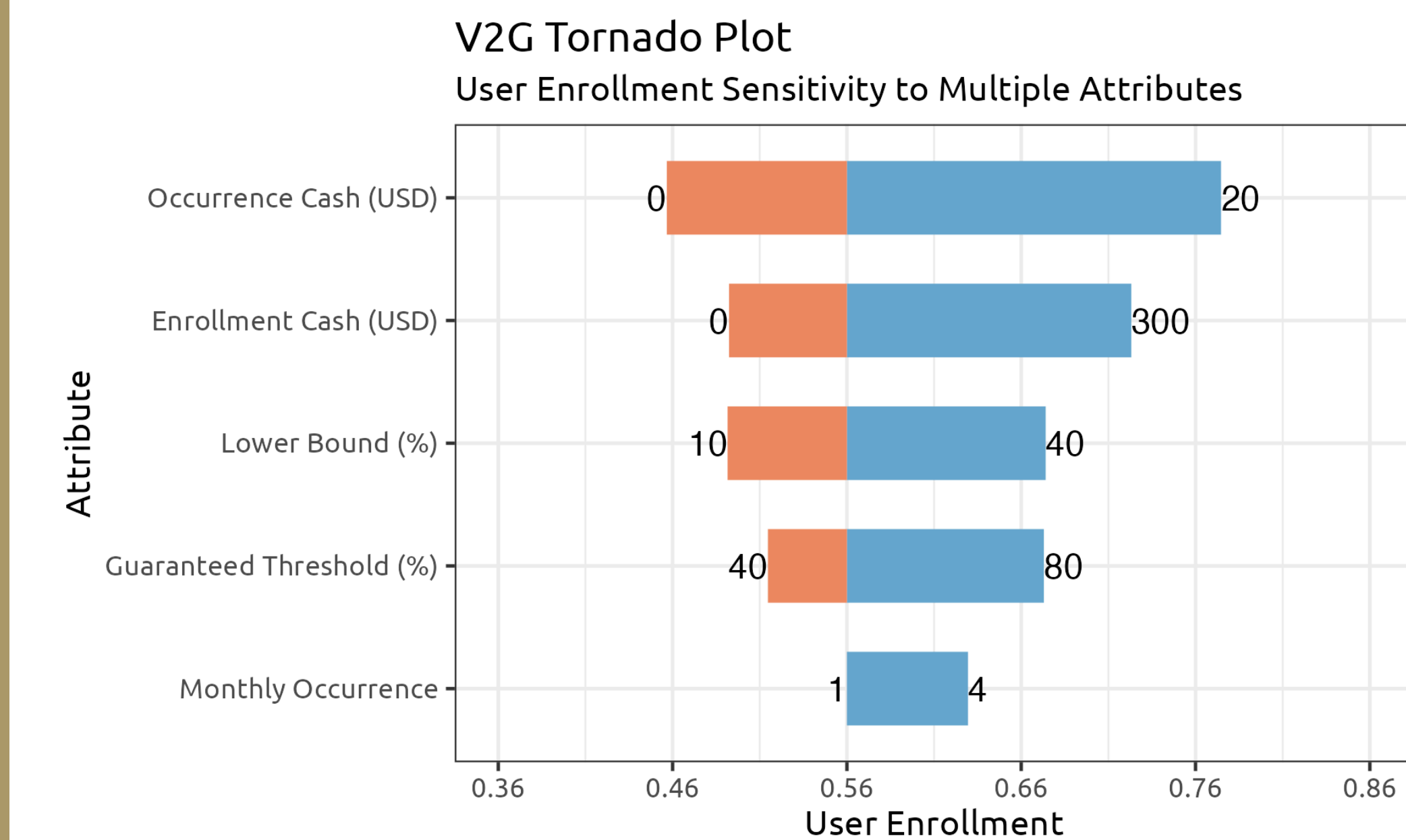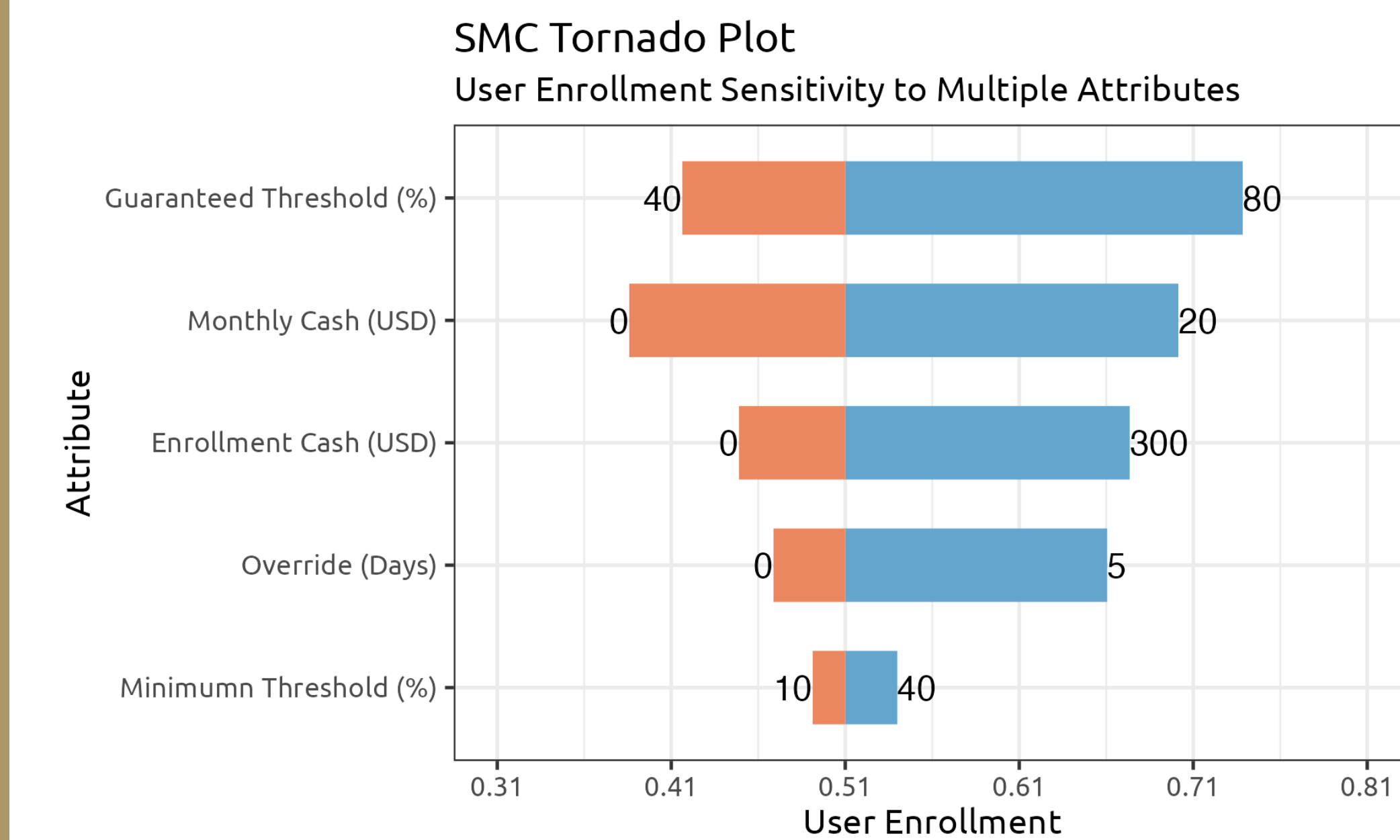
- Monetary incentives are important.
- Recurring incentive is more important than one-time.
- For SMC, range anxiety is vital, since it happens regularly.
- For V2G, usability is compromised.
- Diminishing returns exist.

Future Work

- More data from social media and survey panels.
- Grouped modeling based on demographics.
- Shift to latent class model. It is a detective model to indicate the maximum possible interactions considering heterogeneity.

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