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.
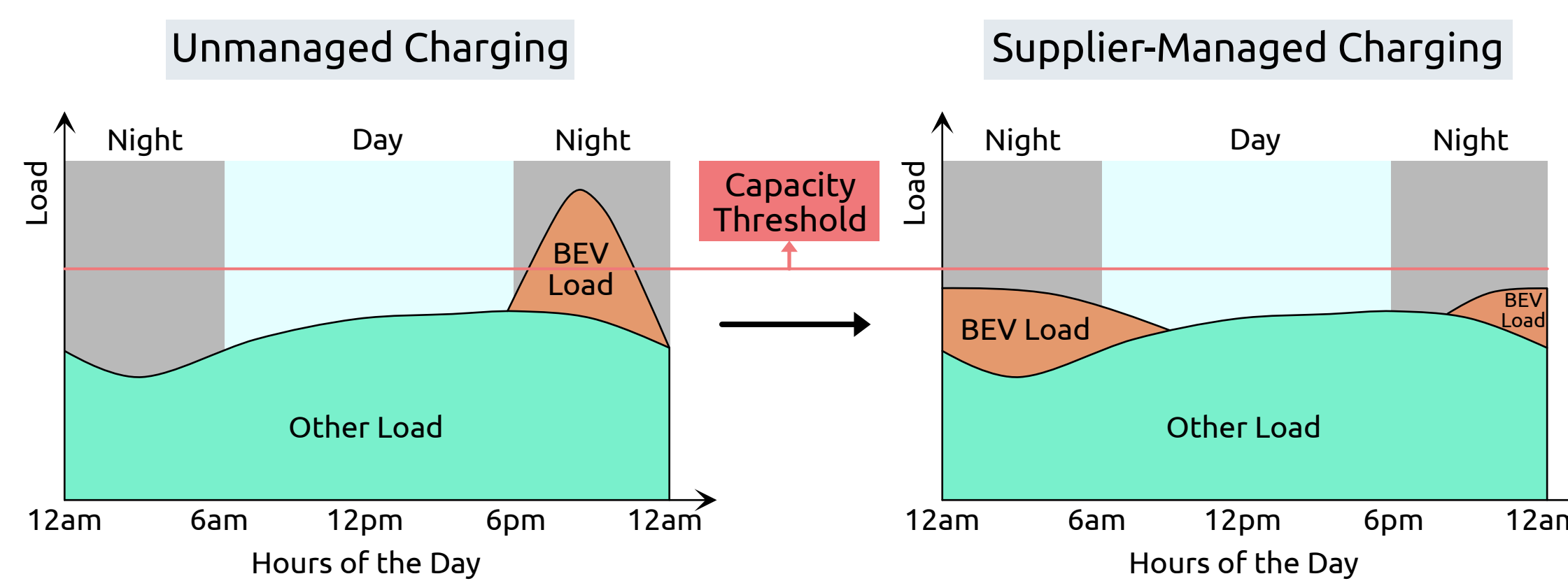
Objective

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.
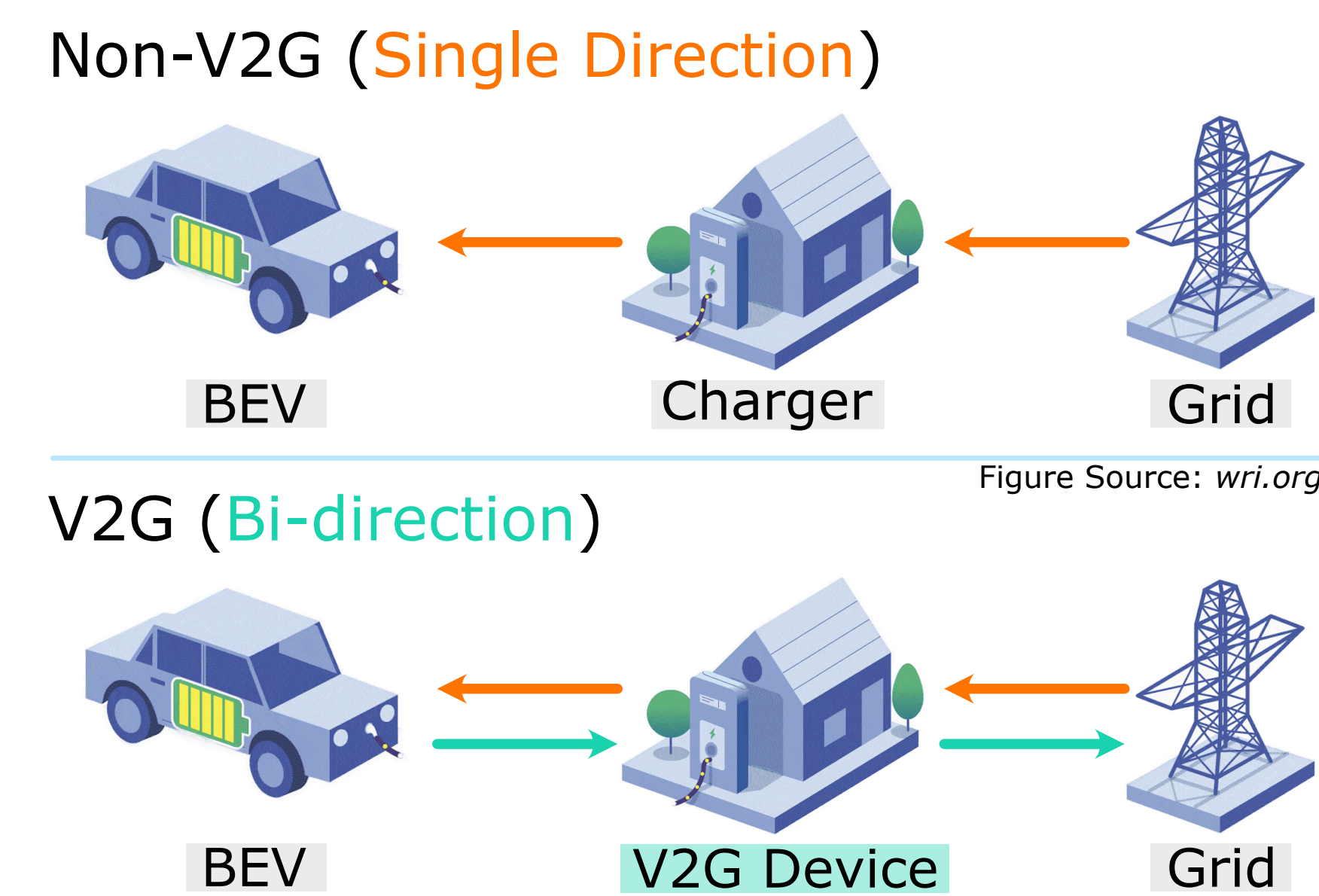
The Smart Charging Programs

SMC (Supplier-Managed Charging)

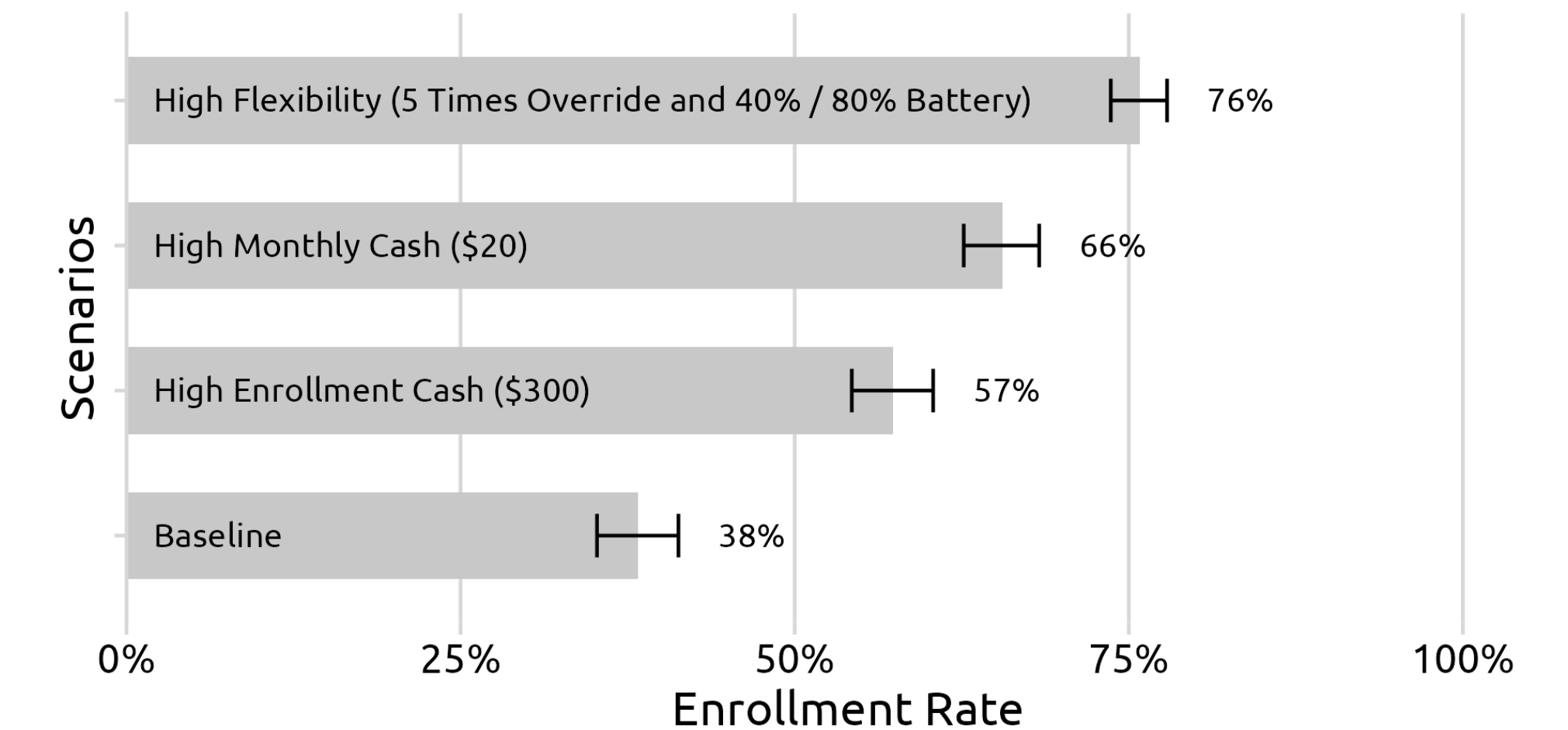Supplier-managed charging avoids overload caused by BEV charging.
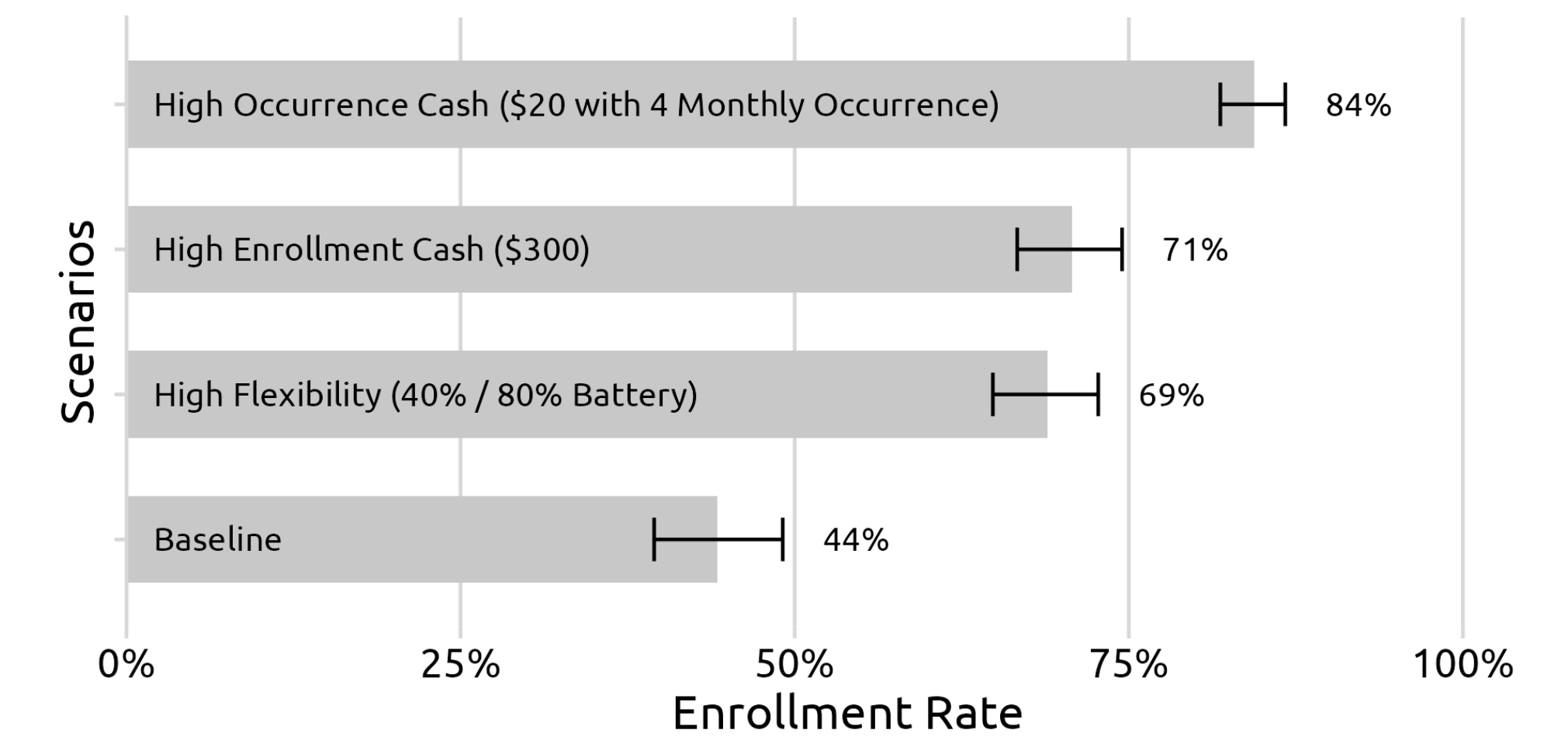
V2G (Vehicle-to-Grid)

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.

Conjoint Survey

Example Question

Option 1	Option 2	Option 3
Enrollment Cash: $50	Enrollment Cash: $300	
Monthly Cash: $2	Monthly Cash: $20	Not Interested
Override Allowance: 0 per month	Override Allowance: 5 per month	

Battery Thresholds (in Miles)

Attributes are randomized for both options.

Enrollment Sensitivities

A) Supplier-Managed Charging (SMC)

Attribute		
Monthly Cash	$2	$20
Override of 5 Days	No	Yes
Enrollment Cash	$50	$300
Override of 3 Days	No	Yes
Guaranteed Threshold	60%	80%
Override of 1 Day	No	Yes
Minimumn Threshold	20%	40%

B) Vehicle-to-Grid (V2G)

Attribute		
Occurrence Cash	$2	$20
Enrollment Cash	$50	$300
Guaranteed Threshold	60%	80%
Lower Bound	20%	40%
Occurrence of 4	No	Yes
Occurrence of 3	No	Yes
Occurrence of 2	No	Yes

Multinomial logit model used for marginal preference estimation.

Demographic Results

N = 1356

Category	Value	Count	Percentage
Gender	Male	986	73%
	Female	355	26%
	Non-Binary	7	1%
	Did Not Report	8	1%
Age Group	≤ 30	61	4%
	31-40	213	16%
	41-50	280	21%
	51-60	296	22%
	61-70	315	23%
	> 70	183	13%
	Did Not Report	8	1%
Party	Democratic	778	57%
	Republican	187	14%
	Independent	330	24%
	Did Not Report	61	4%
Climate Awareness	Not	37	3%
	Somewhat	94	7%
	Neutral	65	5%
	Believe	323	24%
	Very	837	62%
Work Status	Student	14	1%
	Part-time	250	18%
	Full-time	691	51%
	Looking	22	2%
	Retired	339	25%
	Disabled	8	1%
	No Job	32	2%
Household Size	1	134	10%
	2	607	45%
	3	252	19%
	4	253	19%
	> 4	101	7%
	Did Not Report	9	1%
House Ownership	Own	1222	90%
	Rent	126	9%
	Did Not Report	8	1%

Scenario Simulations

A) Supplier-Managed Charging (SMC)

Scenarios	Enrollment Rate
High Flexibility (5 Times Override and 40% / 80% Battery)	76%
High Monthly Cash ($20)	66%
High Enrollment Cash ($300)	57%
Baseline	38%

B) Vehicle-to-Grid (V2G)

Scenarios	Enrollment Rate
High Occurrence Cash ($20 with 4 Monthly Occurrence)	84%
High Enrollment Cash ($300)	71%
High Flexibility (40% / 80% Battery)	69%
Baseline	44%

- Multinomial logit model.
- 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.

Ongoing Work

- Shift from social media to survey panels. Working closely with Dynata.
- Grouped modeling based on demographics.
- Comparisons and trade-offs on MNL model vs MXL models.
- Journal paper composition.

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