



SURVEY REPORT

# Willingness to Use Vehicle-to-Everything (V2X)

2021 Pilot Survey

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# Purpose of the Survey

This survey was developed to measure Electric Vehicle (EV) users' willingness to use Vehicle-to-Grid (V2G) technologies and Vehicle-to-Everything (V2X) systems.

We asked questions about

1. Locations where EV owners may use bidirectional EV chargers
2. The time of the day when EV owners would more likely use bidirectional EV chargers
3. Main considerations and concerns about bidirectional charging

This is a pilot survey, which was carried out on a small scale to gain information to improve our main survey. The main survey is expected to launch in May 2022.



## Methods

The survey was administered via University of Colorado Denver Qualtrics (Provo, UT) between October 27, 2021 and November 12, 2021.

The survey was distributed through EV user groups, including Colorado Springs EV Club, EV Four Corners, and Nissan LEAF Owners Facebook Group.

In total, 55 responses were received. However, 8 responses were incomplete. Thus, 47 complete responses were used in this report.

## Pilot Survey.

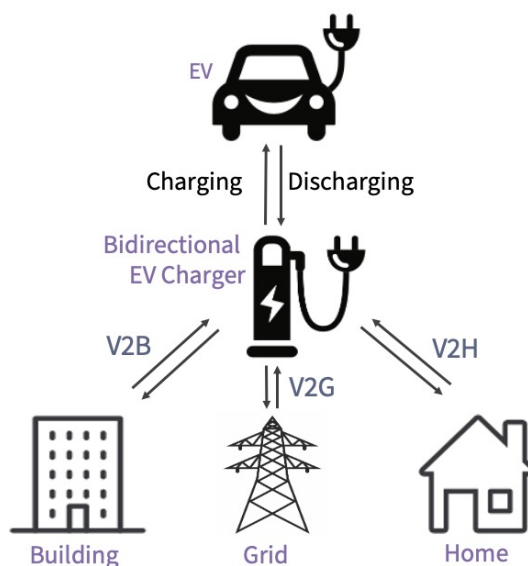
This pilot survey is designed to inform the main survey to be launched in May 2022.



## What is V2G and V2X?

V2G is a technology that enables energy to return back to the power grid from the battery of an electric vehicle (EV). With V2G technology, EV batteries can be charged or discharged based on energy generation and consumption at different times of the day.

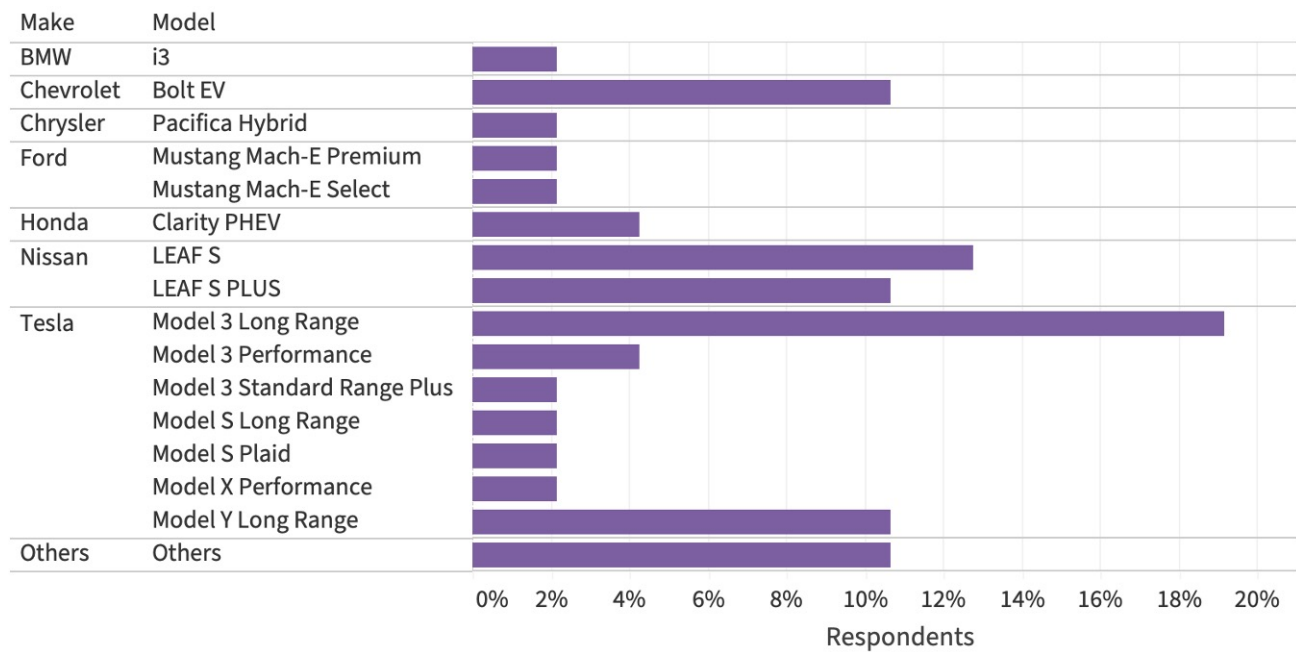
V2X is a system that can include various V2G use cases such as Vehicle-to-Building (V2B), transferring power from vehicle to building, and Vehicle-to-Home (V2H), enabling homes to draw power from EVs.



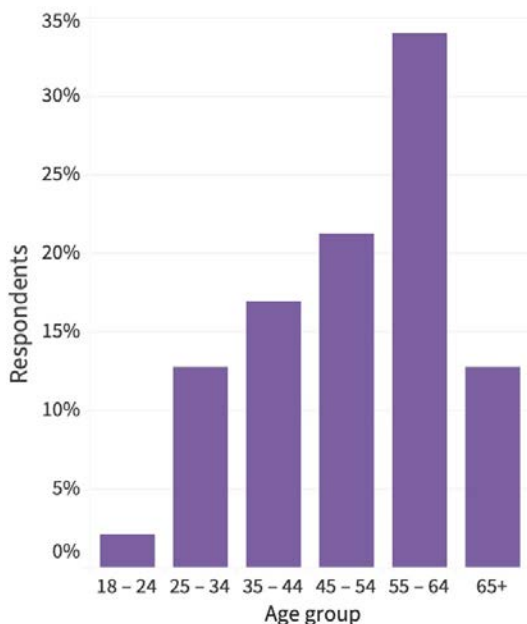
# Survey Respondent Profile

## Make and model of respondents' EVs

In total, respondents reported 15 different EV models in use. Total battery capacity of these models varies from 17kWh (Honda's Clarity PHEV) to 450 kWh (Tesla's Model Y Long Range). Average battery capacity of respondents' EVs is 316 kWh.



## Characteristics of the respondents



**Age** | Primary age group was between 55 – 64 (inclusive) which represented 34% of respondents.

**Housing type** | 83% of respondents live in single-family households.

**Solar panel at home** | 38% of respondents have residential solar panels.

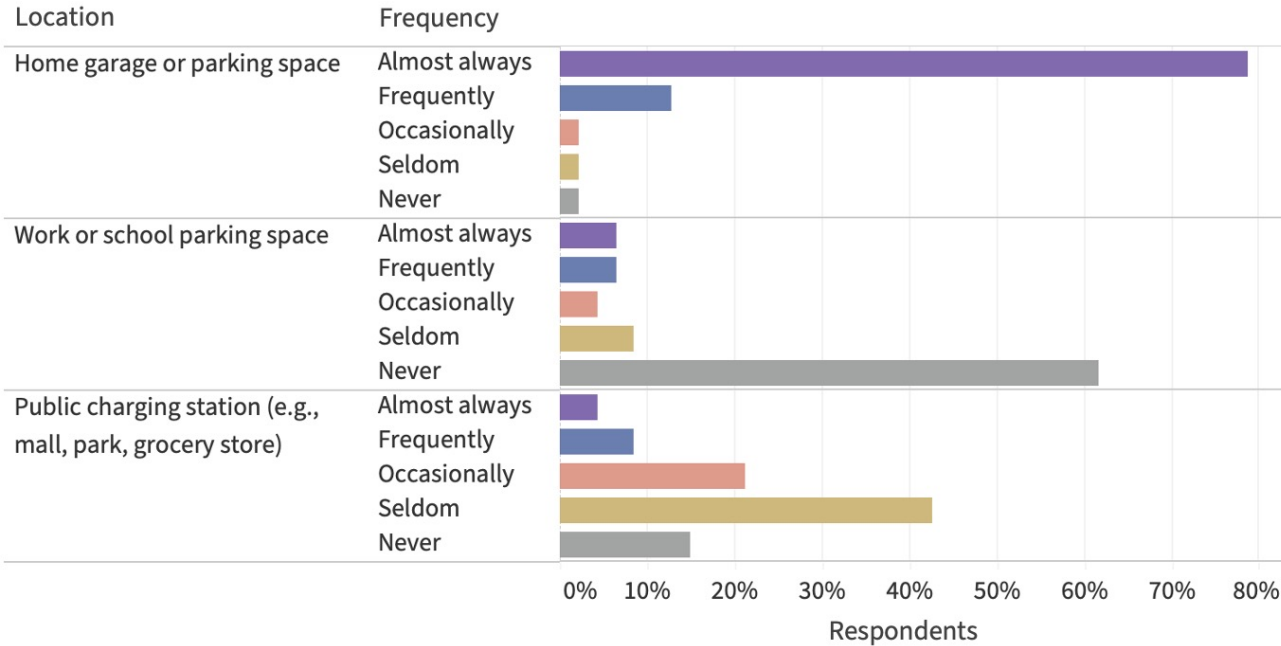
**Multiple cars at home** | 68% of respondents have multiple cars in their household.

**Working from home** | 61% of respondents work from home more than 3 days a week.

**Median household income** | The average median household income of respondents' neighborhoods (Census block group) is \$89,400.

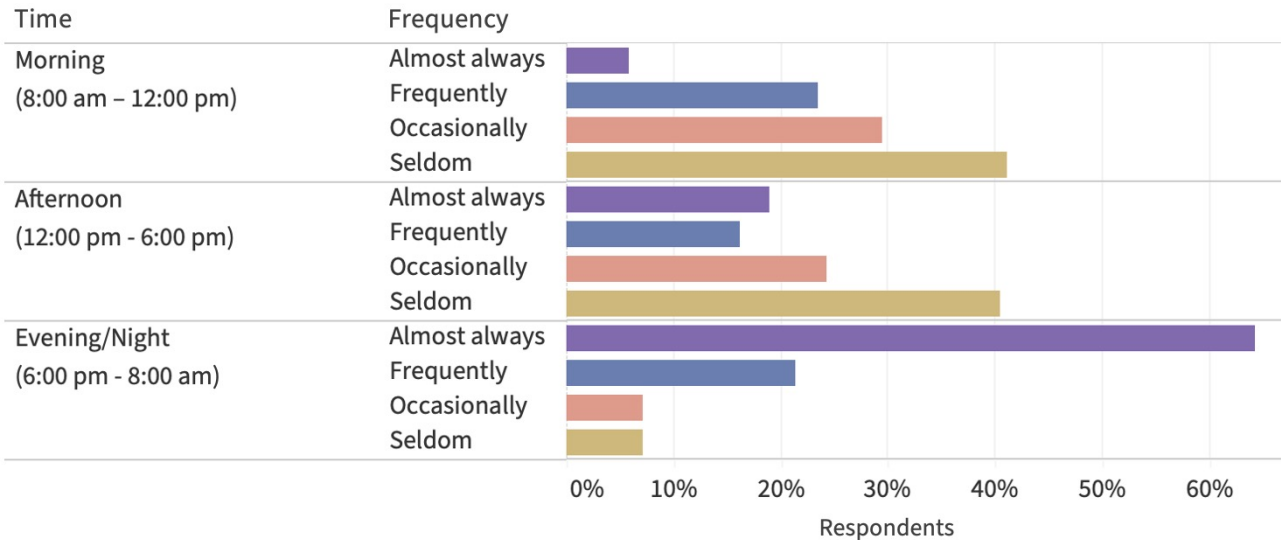
## EV charging locations

Most EV users charge their EVs at their home garage or parking spaces. Only 12% of respondents regularly use EV charging stations at work or school parking spaces.



## EV charging time of the day

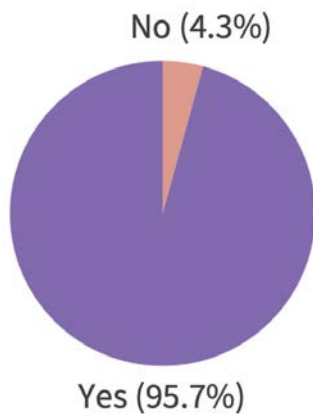
Most EV users charge their EVs at evening and night times. Less than 30% of respondents regularly charge their EVs during the morning time.



# Willingness to Use V2X

## Q1. Are you willing to use V2X?

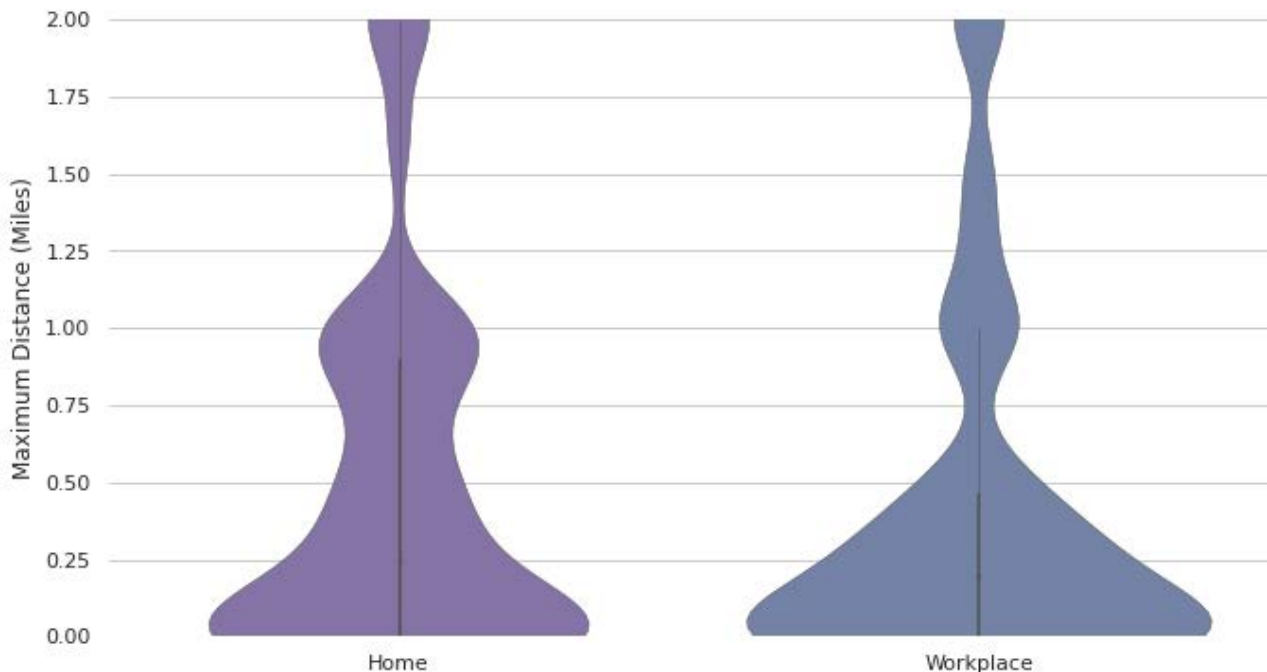
About 96% of the respondents indicated that they are willing to consider using bidirectional EV charging stations.



Over **95%** of the respondents are interested in using V2X.

## Q2. How many miles would you be willing to travel to use V2X?

Typical (median) respondents are willing to travel up to 0.25 miles from home and 0.2 miles from workplace to use a bidirectional charging station. On average, people are more willing to walk from/to public bidirectional charging stations near their home than from/to their workplace.



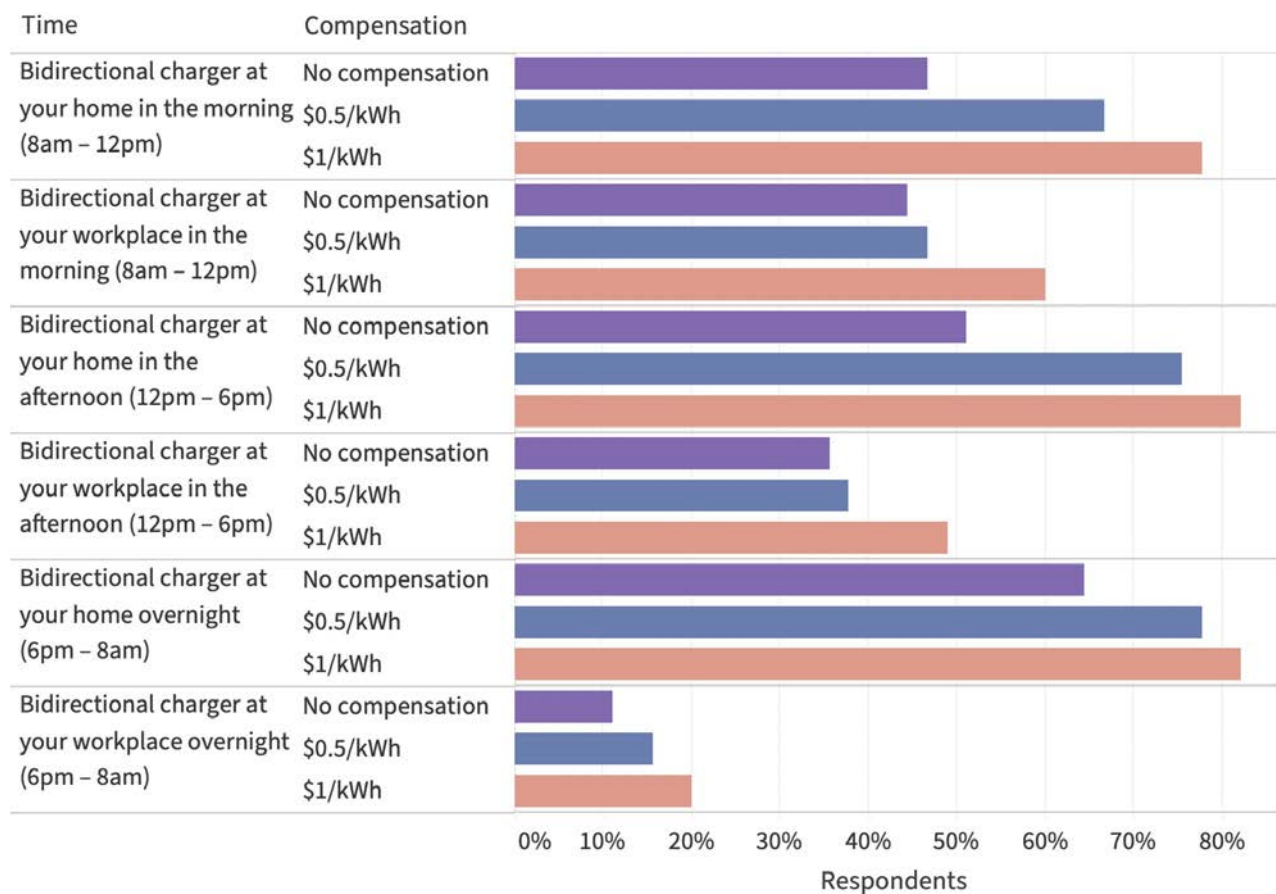
Note. The width of the colored areas indicates the proportion of respondents at the maximum distance.

### Q3. Would you be more willing to consider V2X if compensated?

People’s willingness to use V2H is consistently higher than their willingness to use V2B at the workplace under any scenario.

For V2H, \$0.5/kWh compensation significantly enhances people’s willingness to discharge their EVs in the morning (willingness increases from 47% to 67%) and in the afternoon (willingness increases from 51% to 76%). The effects of the \$0.5 compensation increase are greater for the \$0.5/kWh scenarios than the \$1/kWh scenarios, indicating diminishing marginal returns of compensation on willingness.

For V2B at the workplace, however, the marginal effects of the \$0.5 compensation increase are greater for \$1/kWh compensation (willingness increases by 29.4% in the afternoon) than \$0.5/kWh compensation (willingness increases by 6.3% in the afternoon), suggesting higher compensation rates might be more likely to be effective for V2B than V2H.

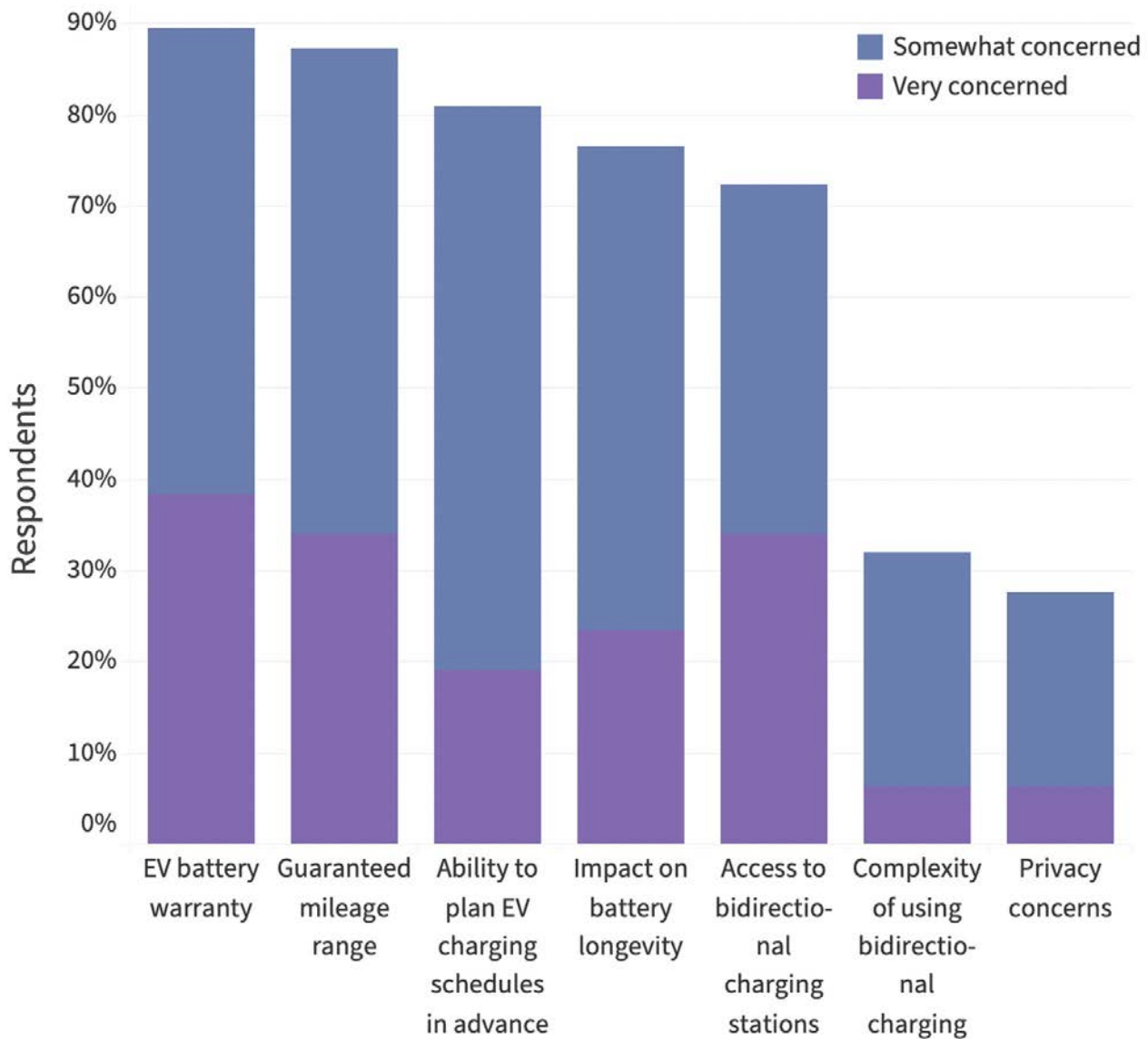


- Note 1. In this pilot survey questionnaire, per-hour compensation was mistakenly used instead of per-kWh compensation. For ease and clarity of interpretation, we use kWh in this survey report.
2. Considering the time-of-use (TOU) rates for on-peak hours (e.g., 3pm - 7pm in Colorado) are much higher than the TOU rates for off-peak hours (e.g., 7pm - 1pm in Colorado), the main survey will ask V2X willingness separately for on-peak, mid-peak, and off-peak hours, based on the TOU rate program available to each respondent.
  3. The main survey will set more realistic compensation rates ranging from \$0.01/kWh to \$0.7/kWh.



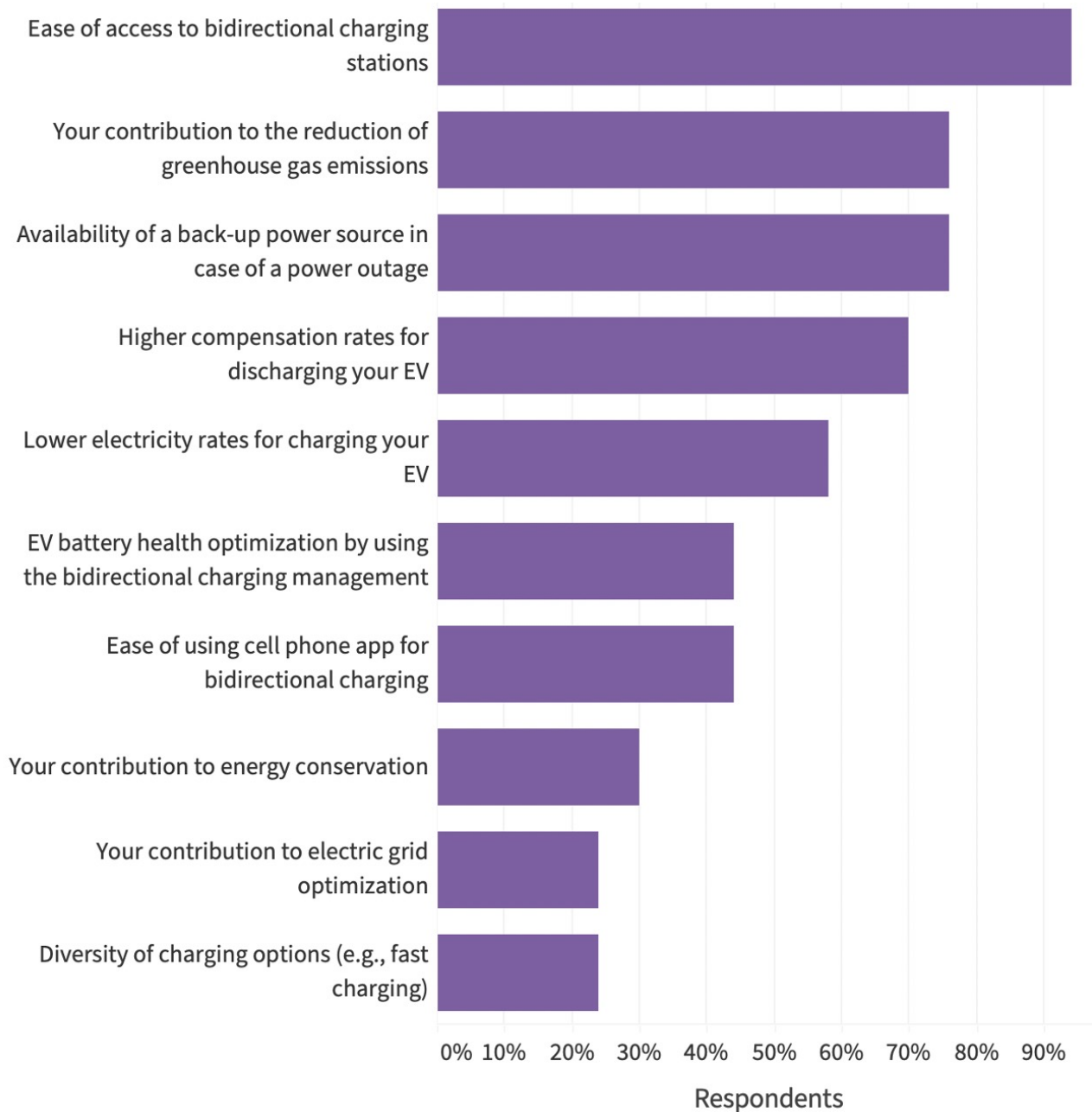
## Q4. What are your concerns about using V2X?

The most significant concern of V2X is the risk that auto manufacturers will void the EV battery warranty for participating in V2G. Range anxiety (guaranteed mileage range) is the second most significant concern.



## Q5. What are the three most important considerations for using V2X?

The three most important considerations for using V2X are **easy access** to bidirectional charging stations, **environmental benefits** (contribution to the reduction of greenhouse gas emissions), and **resilience benefits** (availability of a back-up power source in case of a power outage). Financial benefits of V2X, such as high compensation for discharging and lower rates for charging, follow.



Note. Respondents ranked the three (3) the most important considerations. Responses were weighted by the importance ranked by each respondent.



# Summary

## High willingness to use V2X

01. Majority of EV users are interested in participating in V2X.
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## Rate structure matters for V2X

02. Monetary compensation can increase willingness to use V2X. The effectiveness of monetary compensation depends on the type of V2X (i.e., V2H vs V2B) and the time of the day.
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## Concerns on battery warranty

03. EV users are concerned if the factory warranty on batteries is void for participating in V2X. Guaranteed mileage range is also another significant concern.
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## Considerations for environmental and resilience benefits of V2X

04. EV users recognize not only economic benefits but also environmental and resilience benefits of V2X.





## Suggested Citation

Serena Kim and Hilary Haskell. 2021. *Survey Report: Willingness to Use Vehicle-to-Everything (V2X) 2021 Pilot Survey*. Denver, CO: University of Colorado Denver.

## Research Product (So far)

Hilary Haskell. 2021. *Assessment of Willingness to Accept and Return on Investment of Bidirectional Charging Programs in Colorado*. School of Public Affairs MPA Capstone Project, University of Colorado Denver.

## Next Steps

We are currently revising the survey questionnaire. The main survey is expected to launch in May 2022. If you wish to provide insight on improving this survey, please reach out to [serena.kim@ucdenver.edu](mailto:serena.kim@ucdenver.edu).

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## Human Subject Research

This study has been approved by the University of Colorado Institutional Review Board (IRB), as protocol # 21-4596 (Principal Investigator: Serena Kim).

## Disclaimer

The views and opinions of authors expressed herein do not necessarily state or reflect those of the University of Colorado and any other organizations.

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