WHEN TRUST MATTERS

Final Presentation:
NV Energy Residential Electric Vehicle Adoption Forecast (2023-2032)

April 26, 2022

Agenda

1	Model Overview
2	Top Line Results
3	Further Insights
4	Conclusions & Implications

1 Model Overview

Input Data

Inputs

Publicly Available Data

- National Household Transportation Survey (NHTS)
  - Comprehensive data on travel/transportation patterns
- American Community Survey (ACS)
  - Census tracts (~600-3,000 people each)

Data Specific to NV Energy Customers

- Residential customer data
  - Premise IDs, service point addresses
- 2022 NV Energy Residential Customer EV Survey data
  - Customer demographics and likelihoods to acquire an EV

Key Data Elements

- Vehicle population
  - Total mileage, vehicle age, fuel type
- Household characteristics
  - Income, composition

- Household population
  - Number of households, household locations
- Key customer characteristics
  - Consumer age, employment, income, etc.
- Likelihood to acquire an EV as next vehicle

Agent-Based Model (ABM): Overview

DNV's ABM approach allows us to simulate the influence of the environment and other customers on individuals' EV purchase considerations and to measure the aggregate emergent behavior of the system over time

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Picture: *"The Sims"* computer game.

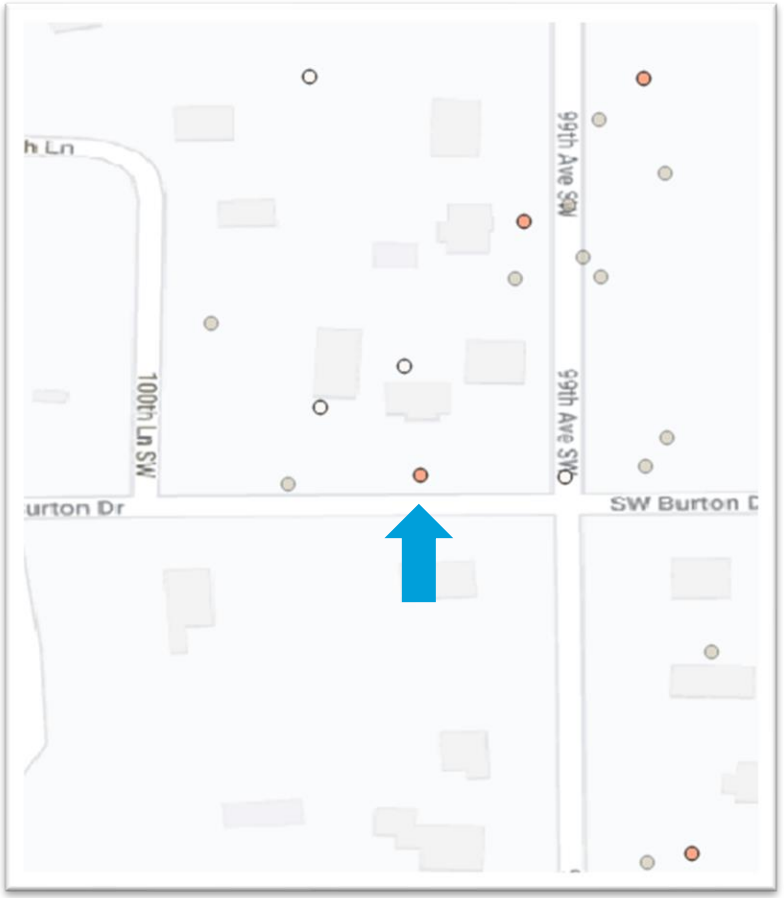
Agent State Charts in the Agent-Based Model (ABM)

- Detail how different types of agents evolve over time
- Describe how different types of agents interact
- Contain the probability functions influencing decisions

Agents programmed and active in model

- Households
- Consumers
- Vehicles

Synthetic Population & Agent Relationship



Households

HOUSEID	HOMEOWN	HHSIZE	HHVEHCNT	HHFAMINC	DRVRCNT	HHSTATE	URBAN	URBANSIZE	URBRUR	HH_RACE	HH_HISP	HBHUR	HBHTNRNT	HBPPOPDN	HBRES
30205830_7	1	2	1	8	2	WA	4	6	2	1	2	R	5	300	50
30145957_7	1	2	2	11	2	WA	4	6	2	1	2	R	5	50	50
30436290_20	1	2	2	8	1	WA	4	6	2	1	2	R	20	300	300
30221920_18	1	2	1	6	2	WA	4	6	2	4	2	R	5	300	300

Consumers

HOUSEID	PERSONID	R_AGE	EDUC	R_HISP	R_SEX	R_RACE	PRMACT	PAYPROF	YEARMILE	DISTTOWK17	DISTTOSC17	HHS
30205830_7	2	71	5	2	2	1	6	2	0	-9	-9	WA
30205830_7	1	74	4	2	1	1	6	2	5000	-9	-9	WA

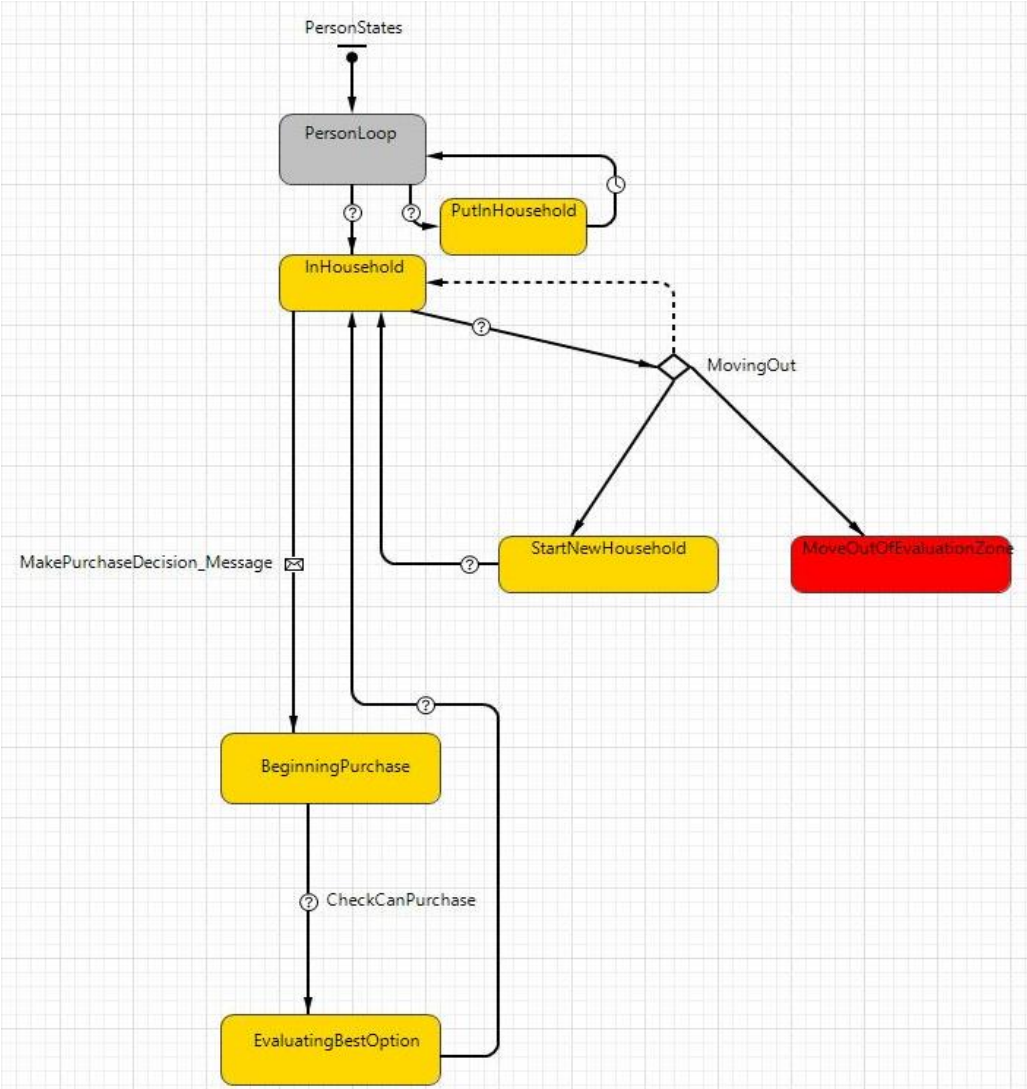
Vehicles

HOUSEID	VEHID	VEHYEAR	VEHAGE	MAKE	MODEL	FUELTYPE	VEHTYPE	WHOMAIN	OD_READ	HFUEL	ANNMILES	HYBRID	HHST
30205830_7	1	2013	4	2	2422	1	3	1	15197	-1	5000	2	WA

Household agents align with actual household locations based on NV Energy customer data.

Consumer and vehicle agents are "synthetic," based on distributions from ACS and NHTS data.

Consumer Agent



Receive purchase signal from vehicle agent

Determine if EV is preferred based on consumer and household attributes

Determine if neighbor characteristics influence purchase decisions

Execute EV purchase if applicable

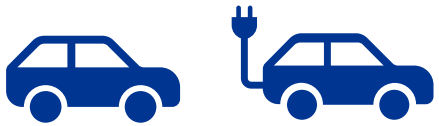
Time passage: age, move in / out, changes in attributes occur

Vehicle and Fuel Types in the Model

VEHICLE TYPES

All Light-Duty Passenger Vehicles

- Includes cars (sedans, coupes, station wagons, etc.), vans, minivans, SUVs, cross-overs, pick-up trucks
- Excludes motorcycles, mopeds, and motor scooters as well as ATVs and other nonroad vehicles



FUEL TYPES

1. Battery Electric Vehicles (BEVs)

2. All Other Fuel Types

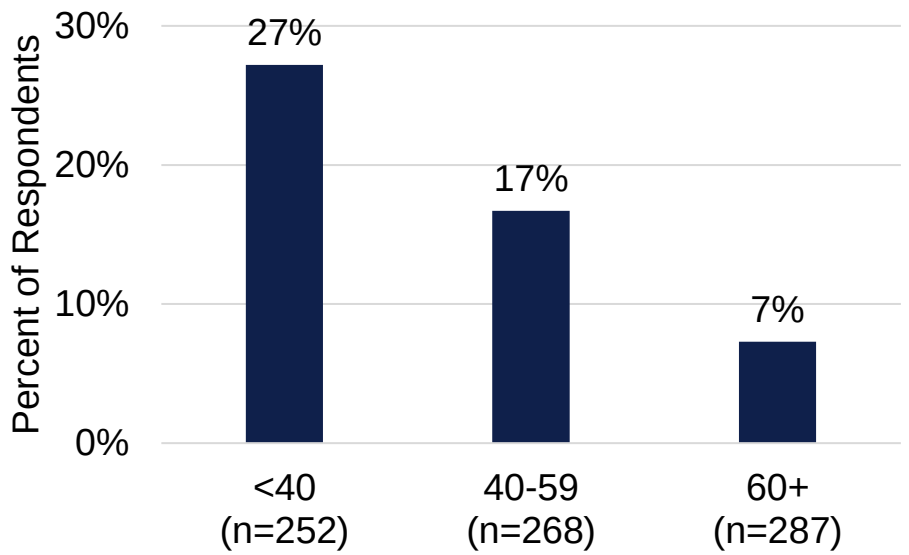
- Gasoline vehicles
- Diesel and biodiesel vehicles
- Traditional hybrid vehicles (non-plug-in)
- Plug-in hybrid electric vehicles (PHEVs)
- Other

EV Adoption Scenario Definitions

- High Scenario
  - Assumes EV share of passenger vehicles grows in line with consumer sentiment based on survey of NVE residential customers
  - Based on a model of that survey data, customers have **on average** a 17% chance of choosing EV (depending on demographic factors) as next vehicle
- Low Scenario
  - Assumes EV share of passenger vehicles follows recent growth trends (business-as-usual)
  - **On average** 4.5% chance of choosing EV (depending on demographic factors) as next vehicle
- **Mid Scenario**
  - **Our best estimate.** Splits between high and low scenarios, tempering with more realistic expectations of EV purchase behavior but assuming positive sentiment will drive increased growth in the EV market versus the business-as-usual low scenario
- All Scenarios
  - Likelihood of EV acquisition increases over time due to peer-to-peer influence as well as network effects from nearby EV chargers

"When you get your next passenger vehicle, how likely are you to buy or lease an EV?"

Percent "Very Likely" by Age Group



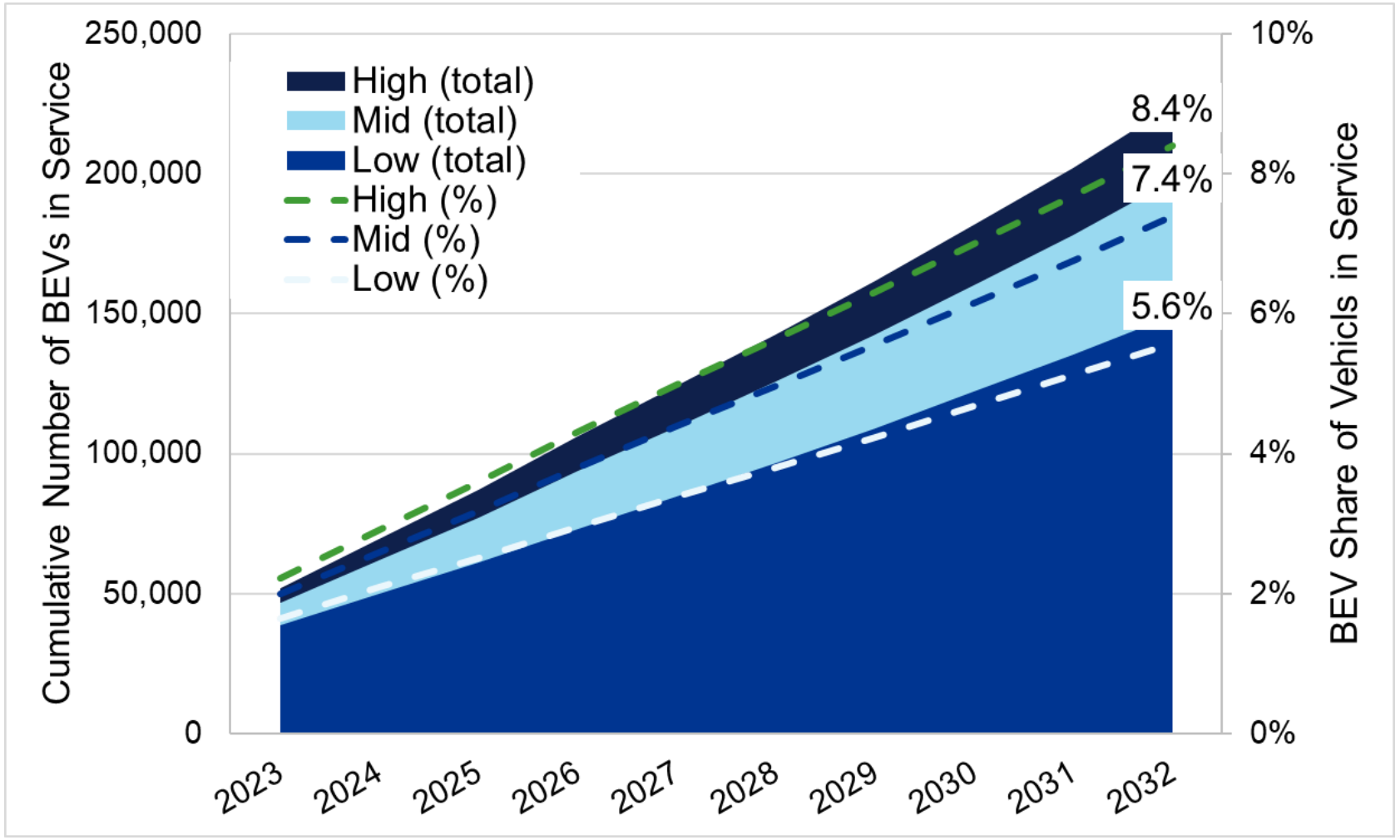
Source: NV Energy Residential Customer EV Survey (DNV, 2022)

2 Top Line Results

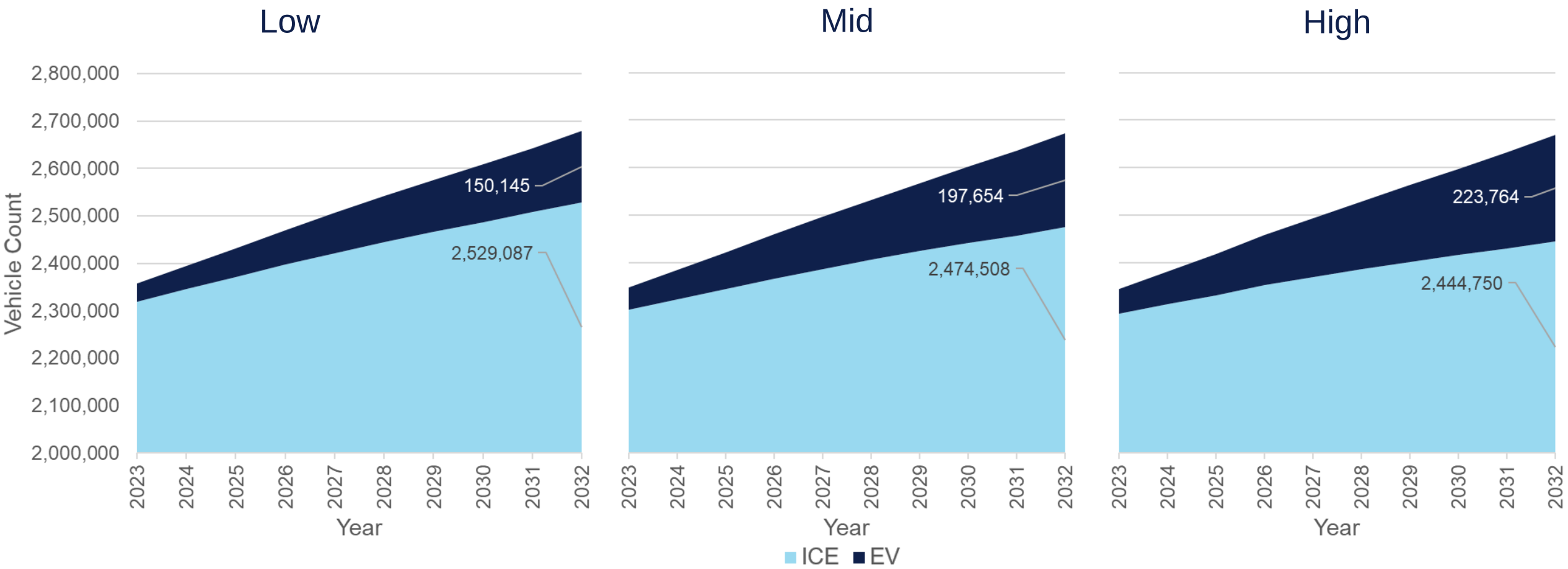
Forecast of BEVs in Service

Our best forecast of cumulative EV adoption by EOY 2032 shows:

- 197,654 EVs in service
  - 46,928 at EOY 2023
- 7.4% of vehicles in service will be EVs
  - 2.0% at the EOY 2023
  - Compare to 0.75% at EOY 2021 (from DMV data provided by NVE)



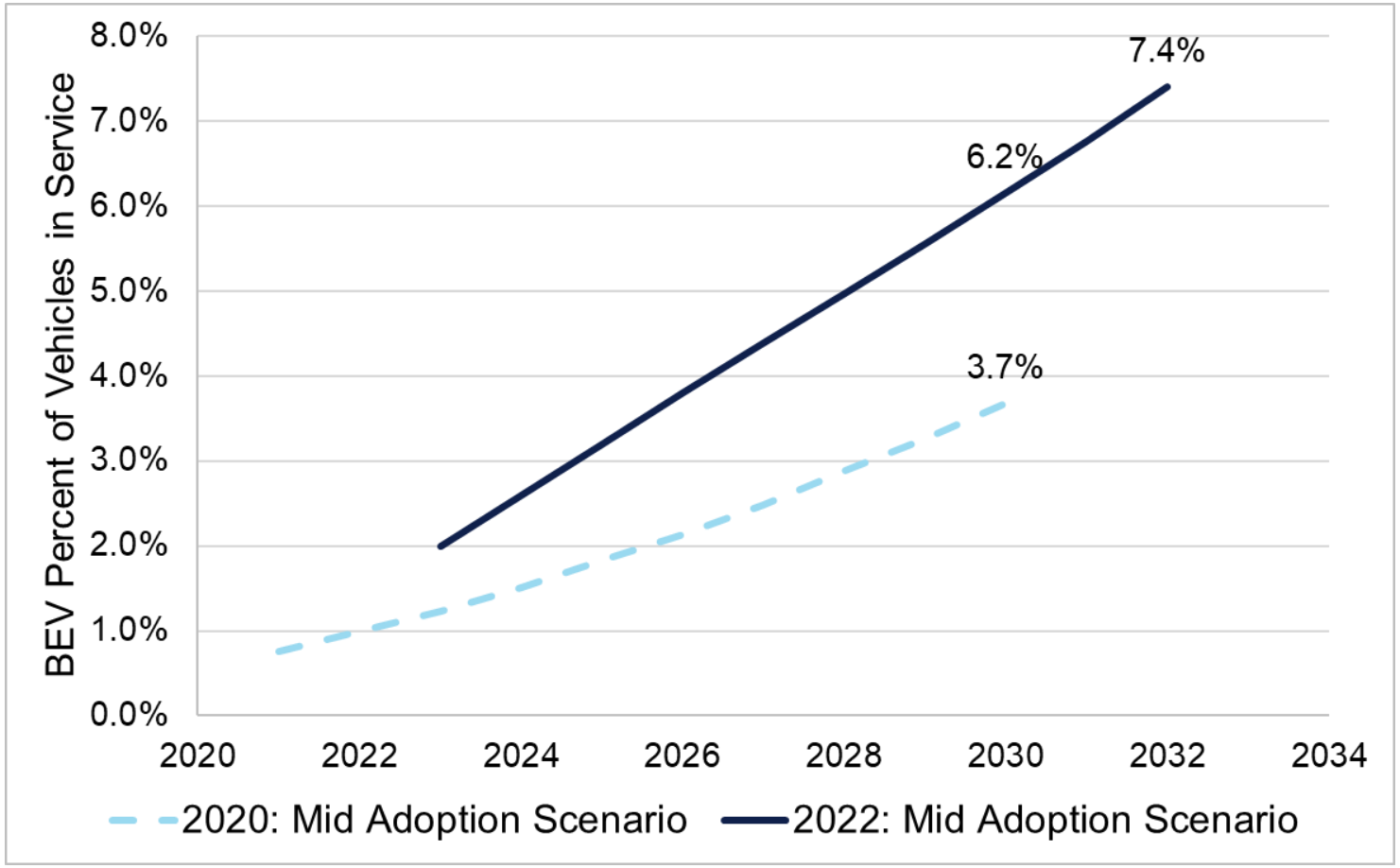
Vehicles in Service: BEVs vs. ICEs



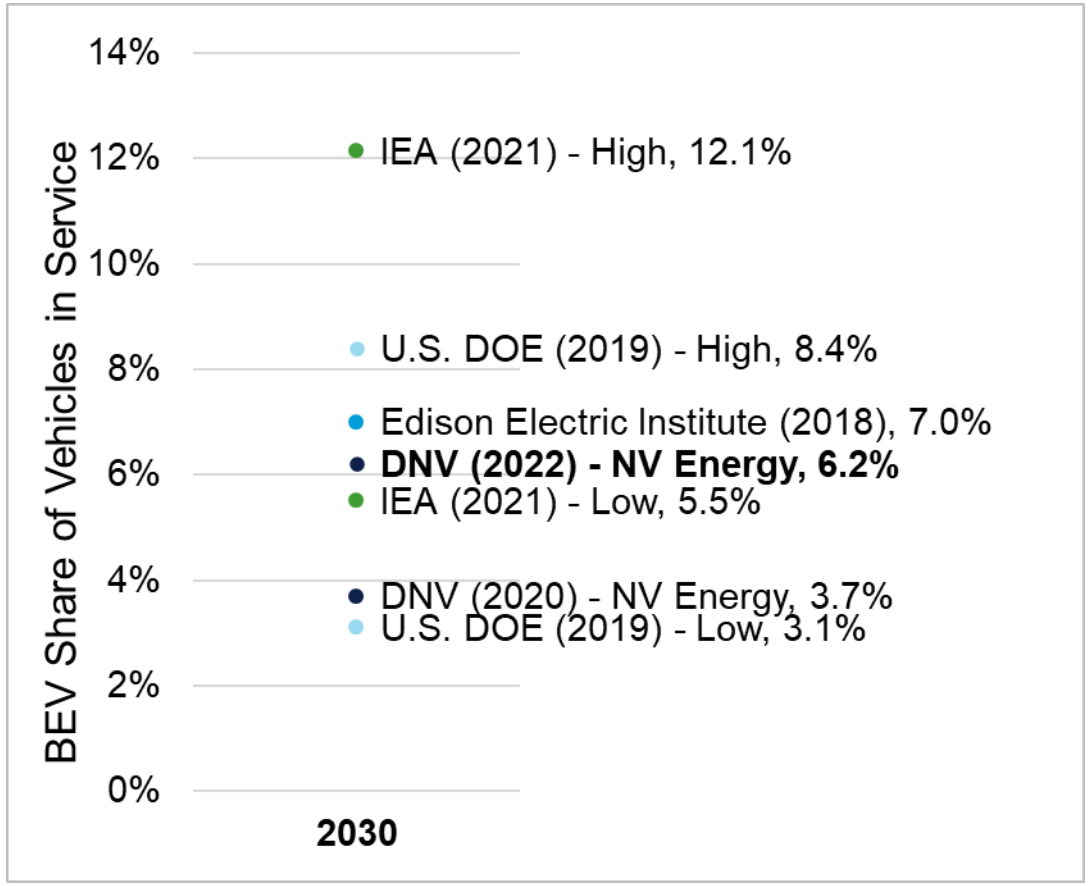
- Note simultaneous growth in both ICEs and EVs; EVs represent larger share of new vehicle growth in progressively higher scenarios
- All three scenarios show vehicle population approaching 2.7M by 2032

Comparison to 2020 Forecast Results

- Mid scenario market penetration **by 2030:**
  - 6.2% (2022 forecast)
  - 3.7% (2020 forecast)
- Takeaways:
  - 2022 forecast shows accelerated pace of adoption
  - Aligns directionally with findings from 2022 surveys
  - If back-casted, EOY ‘22 EV penetration in both forecasts is approximately 1%
- Opportunity: re-run annually to track changes over time and probe reason(s) for shifts



Benchmarking Against Other Studies – Share of Vehicles in Service



Takeaways:

- Results align with those produced by other reputable organizations in recent years
- DNV's updated mid scenario forecast of 6.2% BEVs in 2030 is the median of all forecasts

Caveats:

- Other forecasts typically at national-level
- Some benchmarks may include PHEVs
- Each benchmark reflects different base assumptions and methods
- Relatively few publicly-available forecasts of share of vehicles on the road

3 Further Insights

Key Drivers of BEV Adoption

First Cost

Vehicle Retirement

“Aspiration to Adoption” Conversion Rate

Key Drivers of BEV Adoption

First Cost

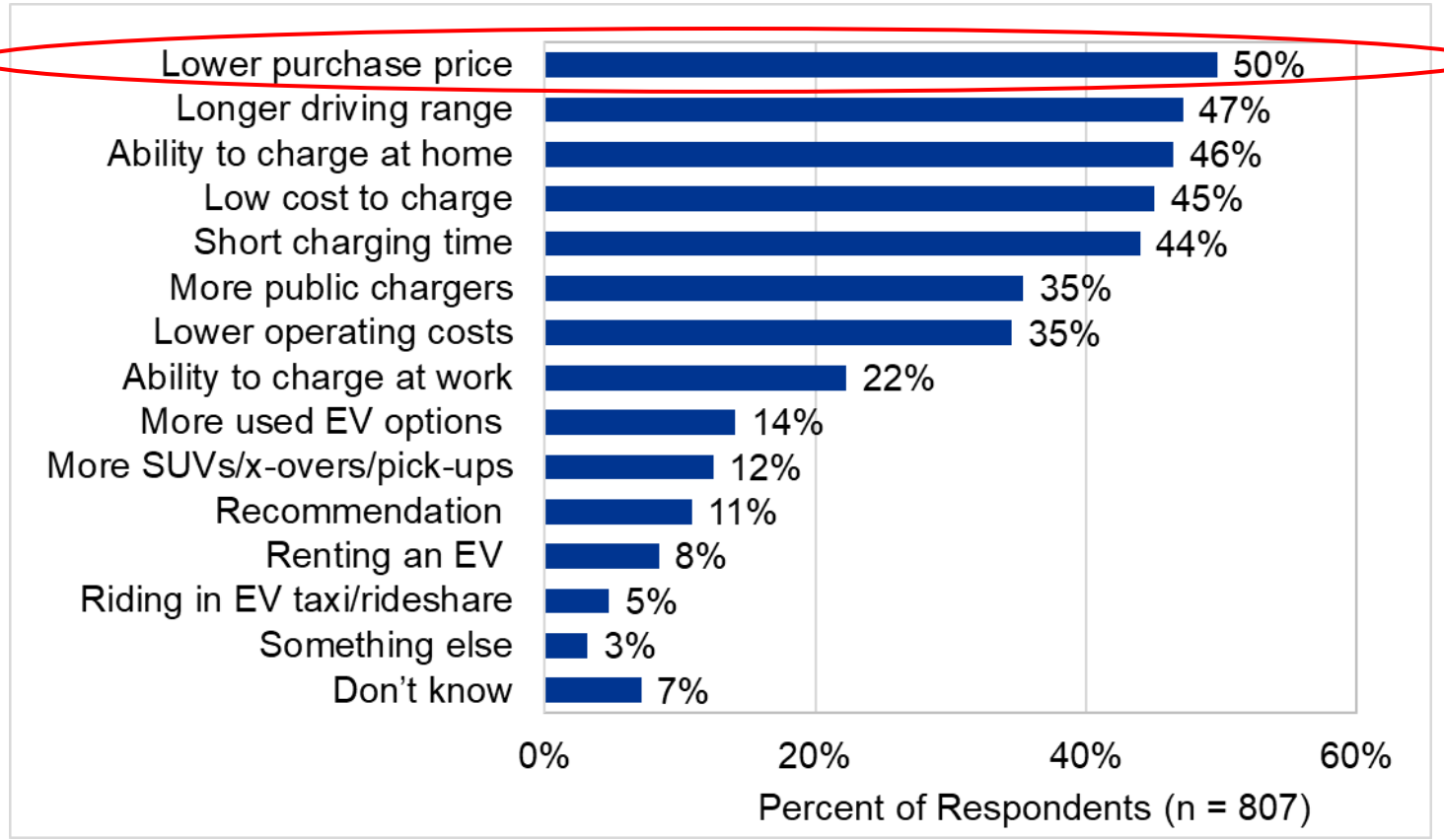
Vehicle Retirement

“Aspiration to Adoption” Conversion Rate

First Cost is the Primary Barrier to EV Adoption

- **First cost** is the primary barrier to EV adoption for NV residents
  - Consumer perceptions of EV first cost are "baked in" to survey responses indicating likelihood to acquire an EV
- Reductions in EV purchase price over time (among other factors) will drive increased adoption
  - May flow from:
    - Future EV cost declines
    - Increased incentives
    - Marketing/education efforts better aligning perceptions with actual costs

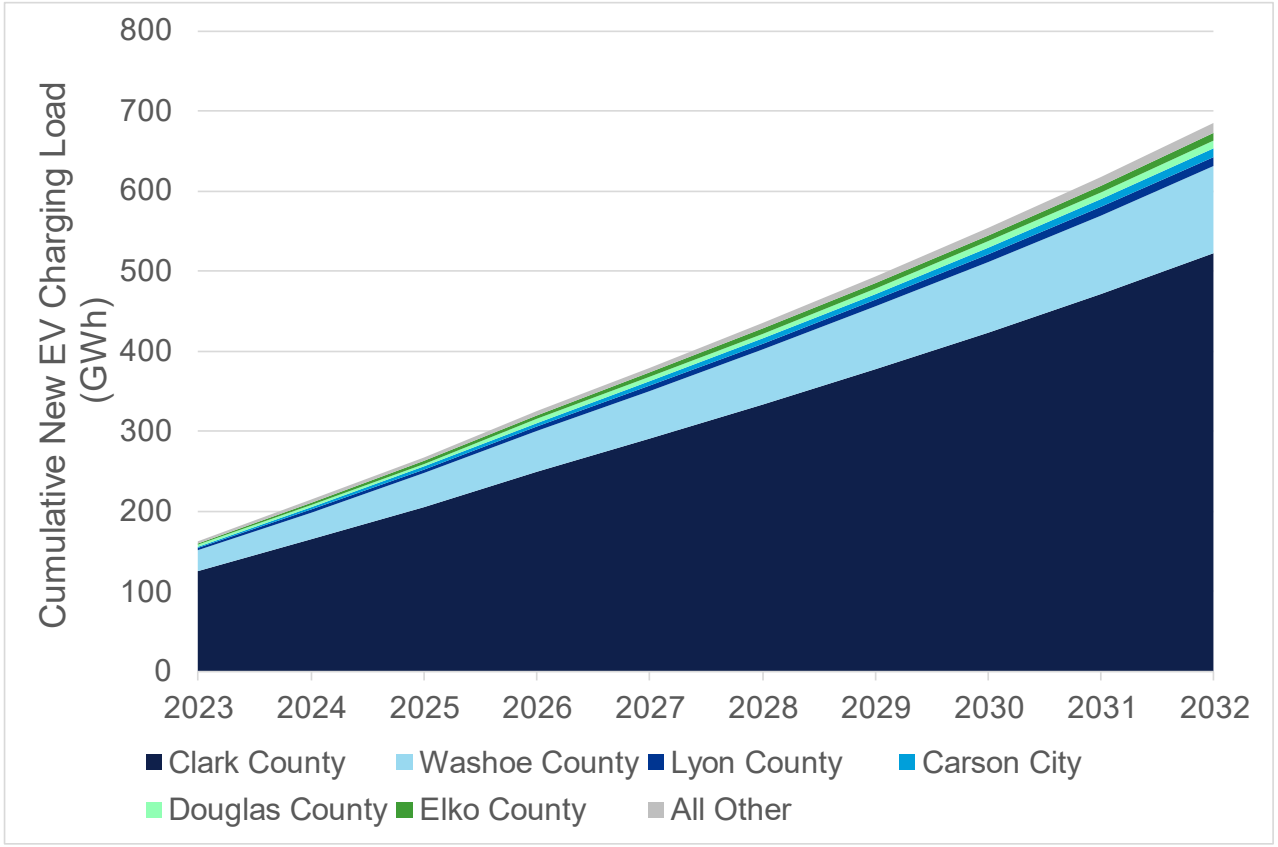
"Which of the following would make you more likely to buy or lease an electric vehicle?"



Source: 2022 NV Energy Residential Customer Survey (DNV)

BEV Adoption Drives Load Growth

- In 2032, mid scenario:
  - 67 GWh of additional grid load added by 19,415 EVs in year*
  - Net 626 GWh new grid load by EOY 2032 from total of 197,654 new EVs*
- EV adoption – and grid impacts – will not happen uniformly
  - Typically, demographics dictate higher adoption in metro areas
  - For NV Energy, this means hot spots in Las Vegas and Reno

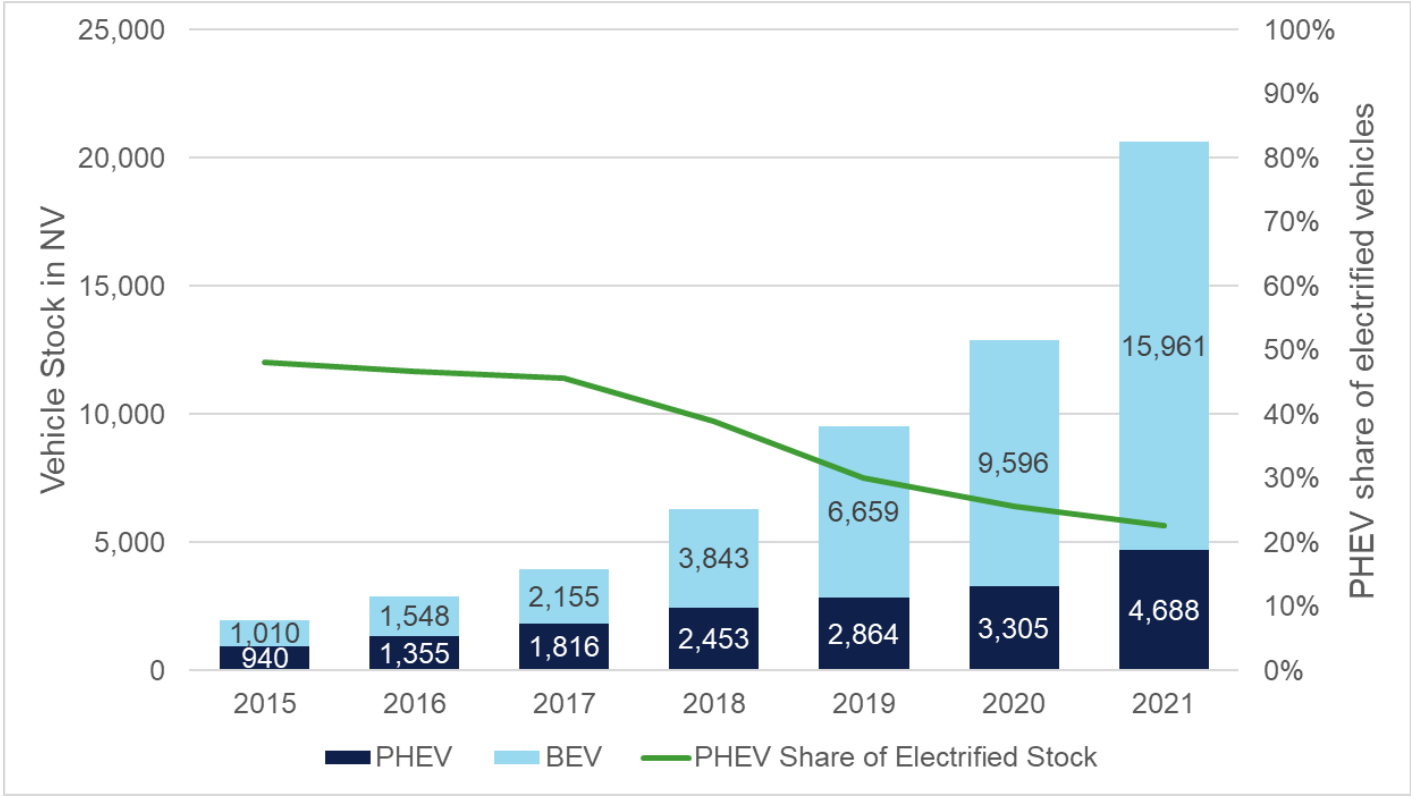


*Assumptions:

- EV efficiency: 35.1 kWh / 100 miles (avg. of all new EV models from 2020-2022; EPA data)
- No efficiency gains over forecast horizon
- Annual mileage: 9,870 miles per vehicle per year (from NVE 2022 Residential Customer Survey)

BEV vs. PHEV Load Impacts

- EOY 2021 NV sales data shows:
  - 9 GWh from PHEV charging* (vs. 55 GWh from BEVs)
  - PHEVs just 14% of total charging load
- We expect PHEVs to represent a shrinking share of EV charging load
  - Diminishing share of electrified stock
  - Not all miles driven electric
  - PHEVs consume 53% less charging energy than BEVs (109 vs. 233 kWh/vehicle-month, per National Grid study)
- Our model forecasts only BEV adoption
  - PHEVs are considered ICEs
  - No mechanism driving PHEV adoption



Source: Alliance for Automotive Innovation data, accessed April 2022

*Assumptions:

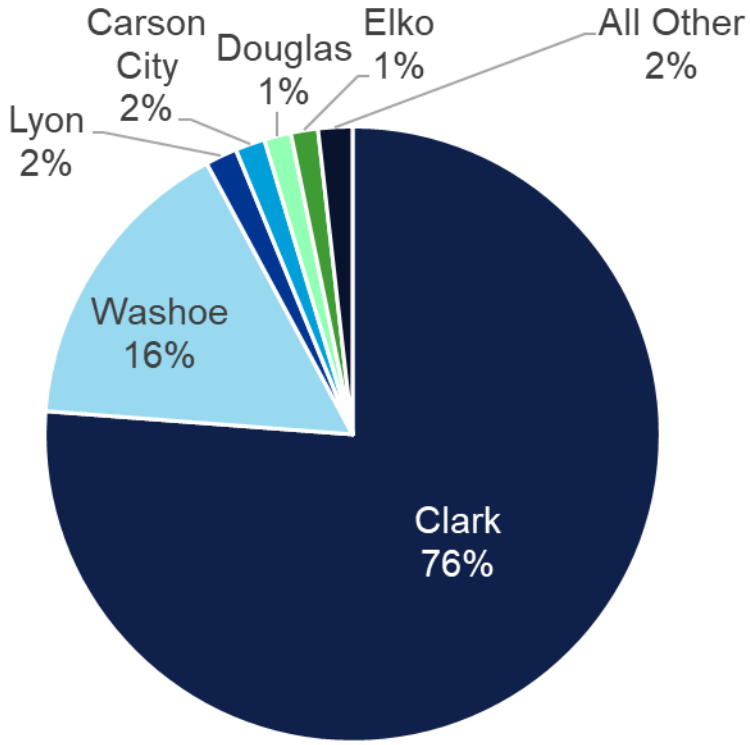
- PHEVs have same efficiency and annual mileage as previous slide
- PHEVs drive 53% of miles in all-electric mode (utility factor = 0.53); Source: Electrive

BEV Adoption by County

Number of BEVs in Service

Mid Scenario

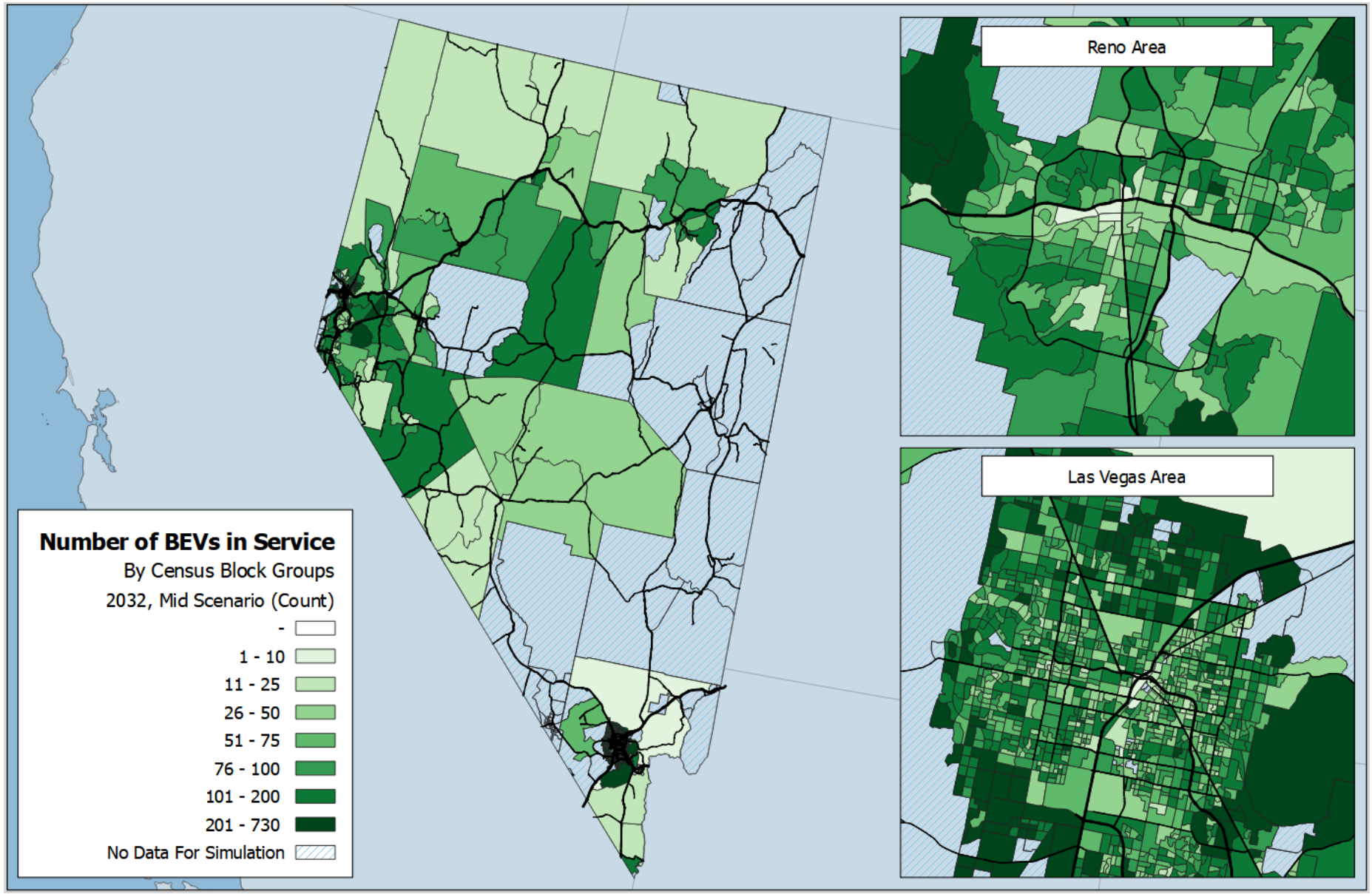
	2023	2028	2032	2032 BEV Share of Vehicles in Service
Clark County	36,235	96,150	150,618	7.8%
Washoe County	7,308	19,914	31,504	6.7%
Lyon County	736	2,095	3,292	5.6%
Carson City	680	1,937	3,095	5.9%
Douglas County	640	1,730	2,772	4.9%
Elko County	571	1,724	2,814	6.6%
All Other	754	2,132	3,555	5.3%



- Highest levels of BEV adoption forecasted in Clark (Las Vegas) and Washoe (Reno) counties
- Other counties will support limited adoption due to a combination of lower population and demographic variations

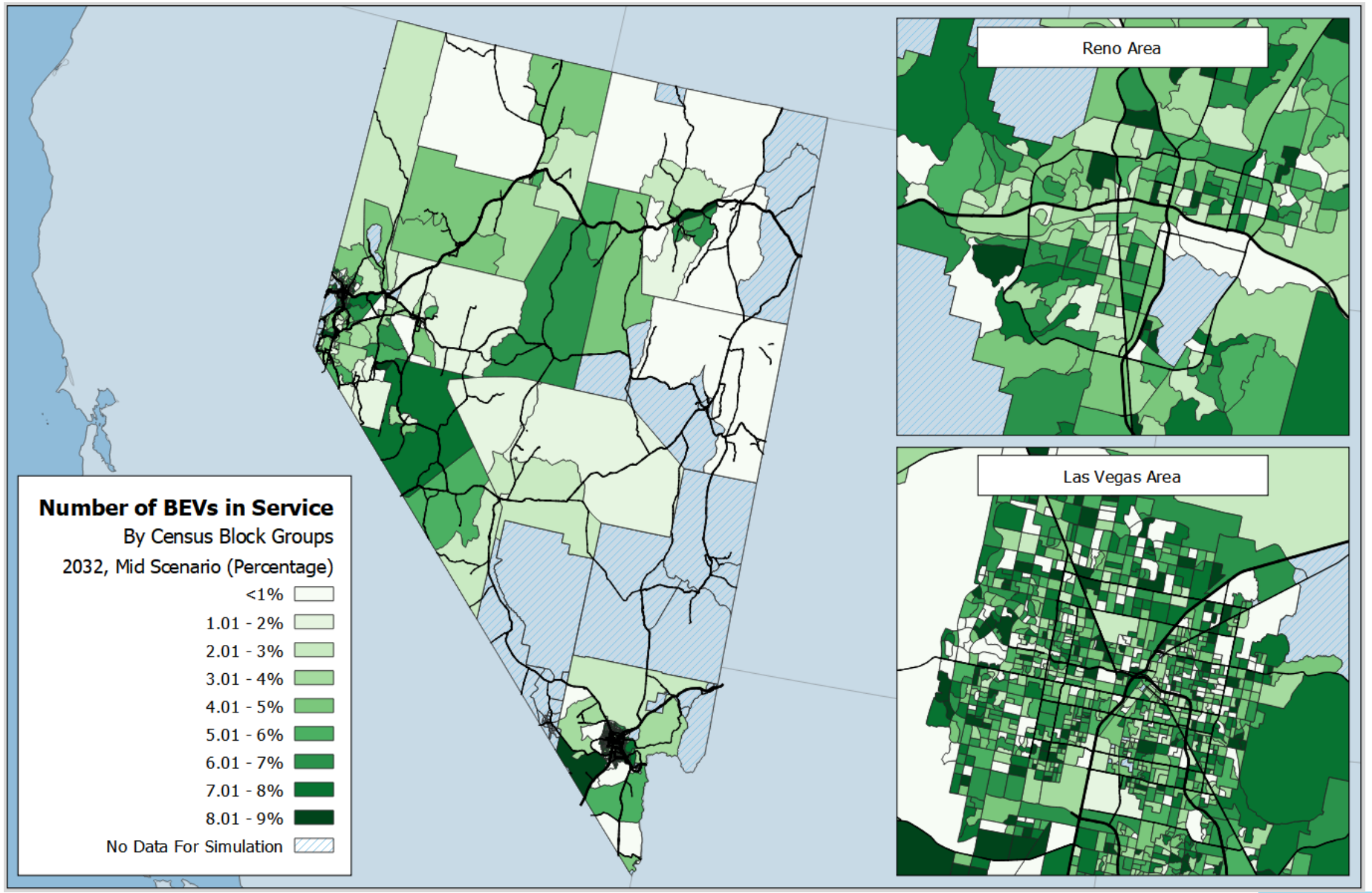
Number of BEVs in Service by Census Block Group, 2032

- Mid Scenario



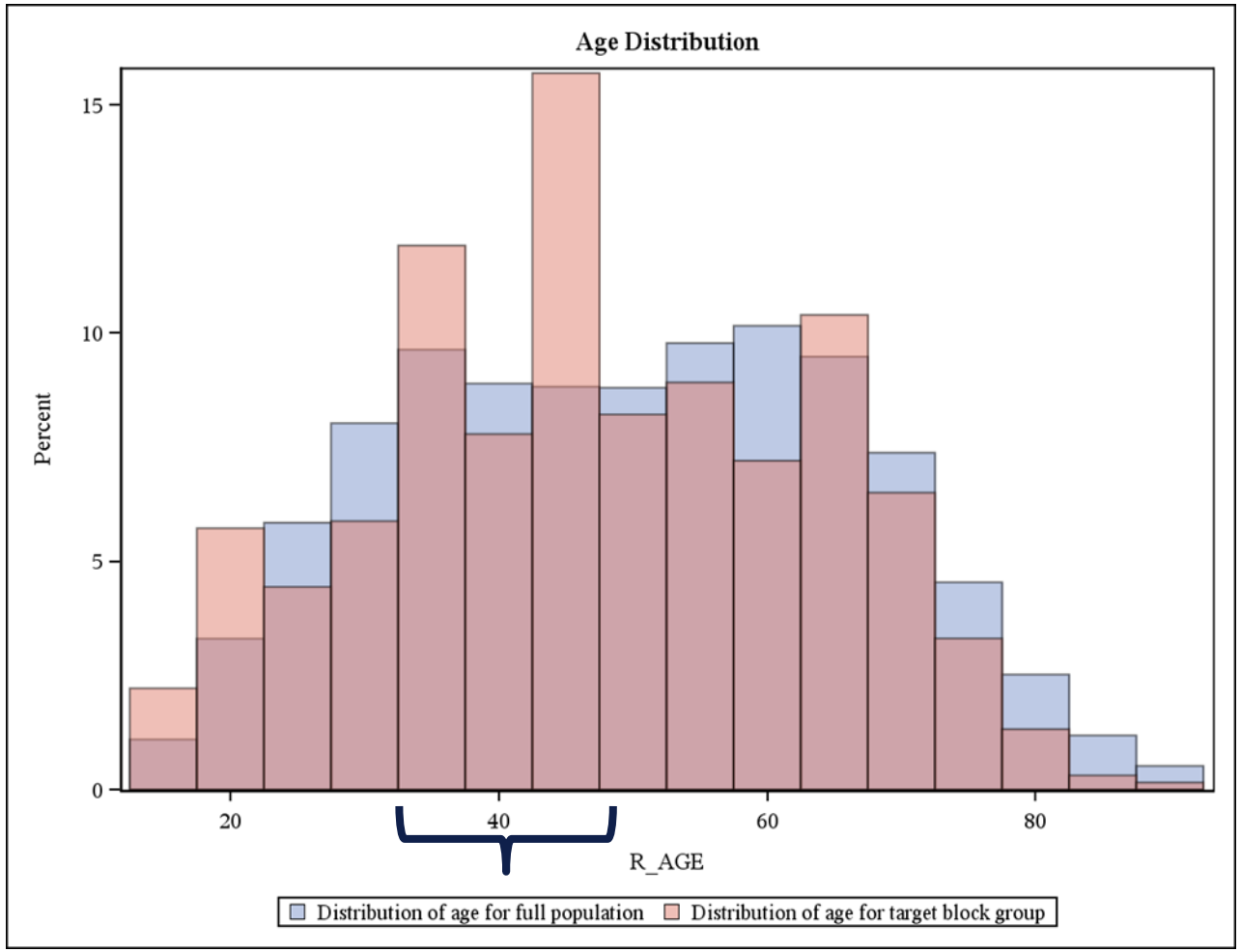
BEV Share of Vehicles in Service by Census Block Group, 2032

- Mid Scenario



Drilling down on key block groups

- Non-uniformity in initial synthetic population demographics drives differences in adoption
  - People: Household income, home ownership vs. renting, gender, education, age
  - Vehicles: Age, mileage
- Demographics flow from the ACS and map to adoption likelihoods, gleaned from surveys
- Complex, multi-attribute interactions mean it is not possible to determine causality for observed adoption levels
- However, we will talk about trends and expectations based on initial demographics in key block groups



EV adoption drivers and barriers: Example

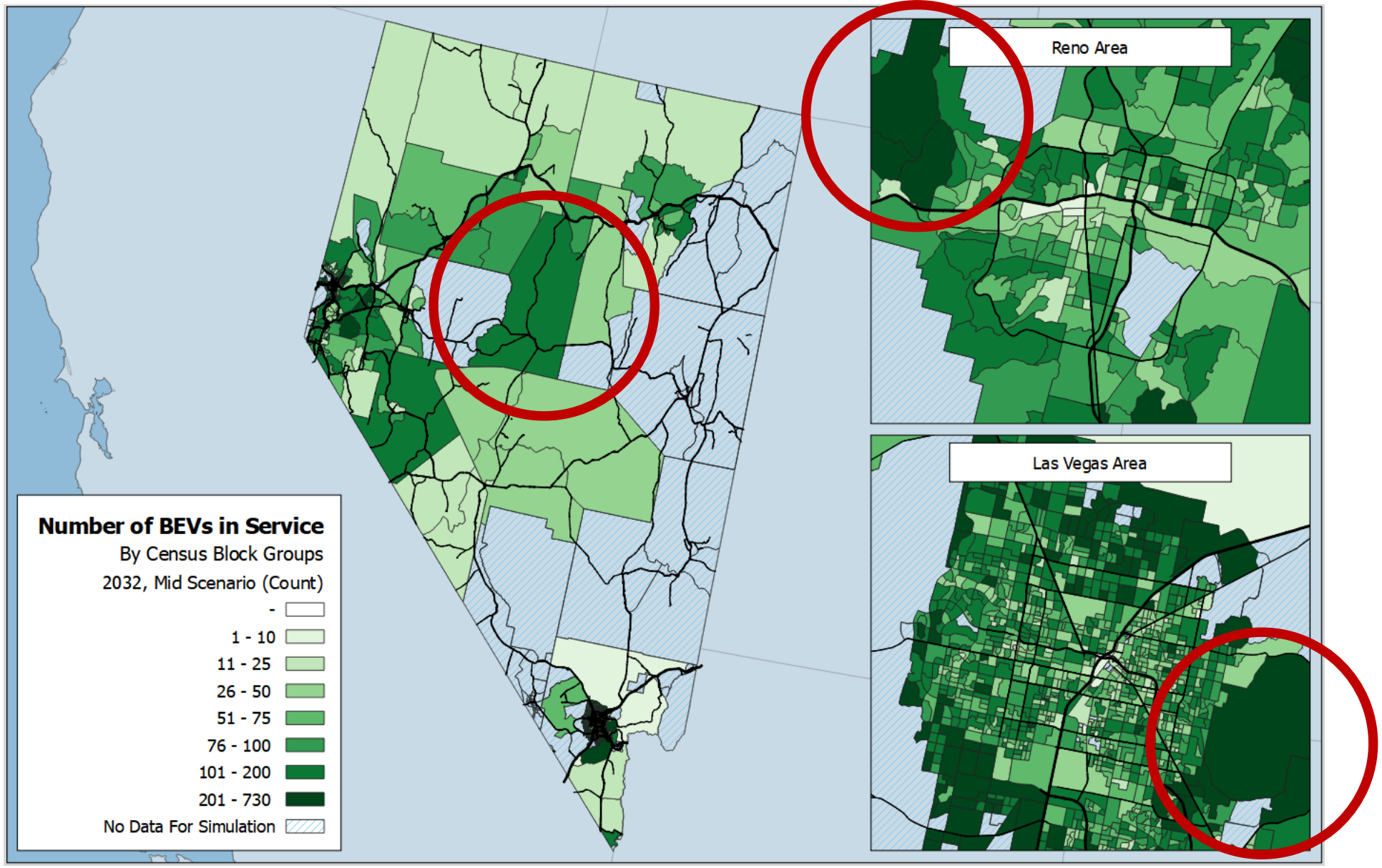
Attribute	*Value*	*Impact on EV Adoption Likelihood*
Household income	Lower income	↓
	Higher income	↑
Home ownership	Rent	↓
	Own	↑
Education	Lower	↓
	Higher	↑
Sex	Male	↑
	Female	↓
Age	Younger	↑
	Older	↓

- Consider someone with the following characteristics:
  - Age: 60+
  - High income
  - Renter
  - Female
  - Graduate degree
- What is their likelihood to adopt?
  - High income and education increase likelihood
  - Age and rental status decrease it, all else equal
  - The “net” likelihood for each agent is probabilistic
- Respondent location (city) may further increase likelihood due to denser neighbor influence

Drilling down on key block groups

Number of BEVs in Service by Census Block Group, 2032

- Mid Scenario



Demographic Overview of Key Block Groups

Income

- More people in high income brackets, fewer in lower brackets
- High concentration in $75k+ brackets

Home ownership

- Higher home ownership rates
- 79% vs. 71% in Las Vegas

Sex

- Higher concentration of men than women
- These are typically relatively minor deviations

Education

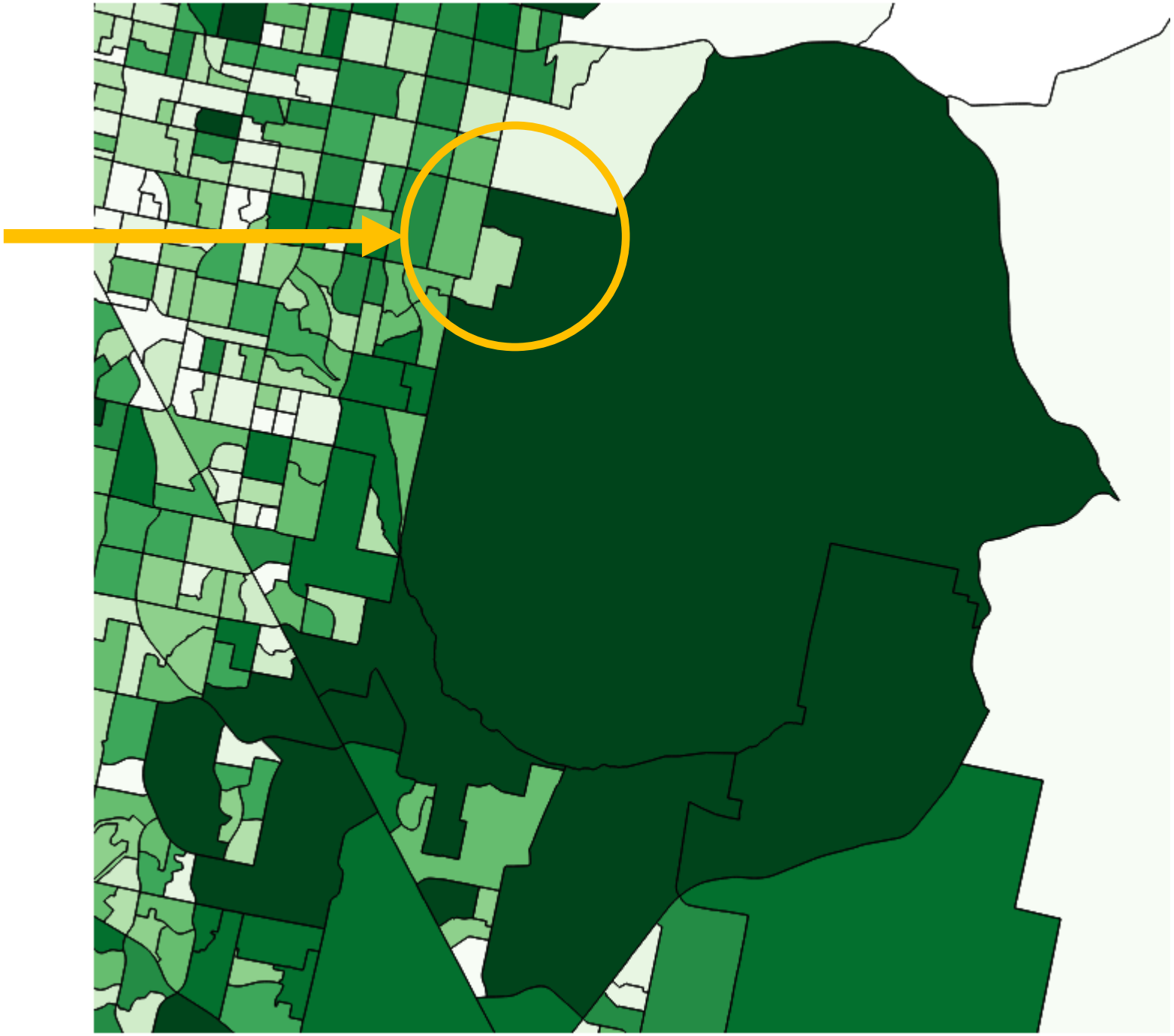
- Las Vegas/Reno: More advanced or bachelors degrees
- Central NV: More people with “some college”

Age

- Consumers: High concentration of residents in younger age bins, though not in all block groups
- Vehicles: Las Vegas and central NV have older, higher mileage vehicles

Note: Comparisons for Las Vegas and Reno were made to the statewide demographic average; comparisons for the central block group were made to the statewide average as well as its neighboring block group

Area of interest

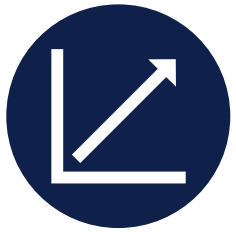


Area of interest

Area of interest

4 Conclusions & Implications

Conclusions



- Strong residential EV adoption growth in mid scenario
  - 197,654 cumulative EVs (7.4% of all vehicles) by EOY 2032
  - 19,415 EVs adopted *in 2032*

- Consistent load growth
  - Cumulative 626 GWh by EOY 2032 (net of current adoption)
    - 2% of statewide total (as of 2016)
  - 67 GWh new load added *in 2032*

- Geographically non-uniform adoption and load impacts
- Load focused in major urban pockets
  - Aligns with demographics and population density

- Granular geospatial insights offer opportunities for targeted MEO, strategic network buildout
- Adoption hotspots represent challenge (clustering) as well as opportunity (load flexibility)

Implications

Grid Planning + Load Flexibility

- 626 GWh/yr total new grid load by 2032 (mid)
  - Neighborhood clusters: Adoption hotspots may cause local reliability concerns (L2 charging)
  - A portion of future EV adoption could provide load flexibility or resiliency via vehicle-to-grid (V2G)
    - Note, however, that this capability is OEM- and EVSE-dependent and not yet ubiquitous
  - Managed charging can unlock additional flexibility

Customer Engagement

- Results reflect anticipated adoption, but targeted market interventions could further bolster EV adoption
  - Support to improve access to charging and/or offset initial purchase price
  - Addressing customer (mis)perceptions regarding BEVs (see Res. Customer Survey results)
  - Opportunity to geographically target if desired
    - Historically underserved communities (HUCs)
    - Strategically locate proposed charger buildouts to serve multiple segments

Thank you!

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Mid Scenario – Draft Forecast Results

Year	Total ICEVs	Total EVs	Total Vehicles	Percent ICEV	Percent EV
2023	2,301,043	46,928	2,347,971	98.0%	2.0%
2024	2,323,168	61,864	2,385,032	97.4%	2.6%
2025	2,344,542	77,123	2,421,665	96.8%	3.2%
2026	2,367,097	93,689	2,460,786	96.2%	3.8%
2027	2,387,209	109,500	2,496,709	95.6%	4.4%
2028	2,406,681	125,686	2,532,367	95.0%	5.0%
2029	2,424,643	142,549	2,567,192	94.4%	5.6%
2030	2,441,326	160,048	2,601,374	93.8%	6.2%
2031	2,457,254	178,239	2,635,493	93.2%	6.8%
2032	2,474,508	197,654	2,672,162	92.6%	7.4%

Low Scenario – Draft Forecast Results

Year	Total ICEVs	Total EVs	Total Vehicles	Percent ICEV	Percent EV
2023	2,319,128	38,641	2,357,769	98.4%	1.6%
2024	2,345,286	49,665	2,394,951	97.9%	2.1%
2025	2,370,588	60,707	2,431,295	97.5%	2.5%
2026	2,397,377	72,872	2,470,249	97.1%	2.9%
2027	2,421,573	84,579	2,506,152	96.6%	3.4%
2028	2,444,574	96,545	2,541,119	96.2%	3.8%
2029	2,466,285	109,006	2,575,291	95.8%	4.2%
2030	2,487,072	122,193	2,609,265	95.3%	4.7%
2031	2,507,569	135,619	2,643,188	94.9%	5.1%
2032	2,529,087	150,145	2,679,232	94.4%	5.6%

High Scenario – Draft Forecast Results

Year	Total ICEVs	Total EVs	Total Vehicles	Percent ICEV	Percent EV
2023	2,292,941	51,789	2,344,730	97.8%	2.2%
2024	2,312,535	69,076	2,381,611	97.1%	2.9%
2025	2,332,126	86,639	2,418,765	96.4%	3.6%
2026	2,352,311	105,763	2,458,074	95.7%	4.3%
2027	2,369,878	123,760	2,493,638	95.0%	5.0%
2028	2,386,777	142,261	2,529,038	94.4%	5.6%
2029	2,402,348	161,477	2,563,825	93.7%	6.3%
2030	2,416,319	181,292	2,597,611	93.0%	7.0%
2031	2,430,139	201,800	2,631,939	92.3%	7.7%
2032	2,444,750	223,764	2,668,514	91.6%	8.4%