NREL

Transforming ENERGY

Introduction to EVI-Equity

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Image: ARCGIS

Department of Energy's Alternative Fuels Data Center, and is up to date as of February 15, 2022.

Contents

EVI-X Modeling Suite

Leaders Rely on **EVI-X**

- Access to reliable **electric vehicle charging infrastructure** is the key to decarbonizing transportation.
- Our nation's leaders look to NREL for insights on strategic infrastructure deployment.
- The EVI-X modeling suite is the **definitive software** for forward-looking charging infrastructure analysis in the U.S.

Recent Public Policy Relying on EVI-X

Bipartisan Infrastructure Law

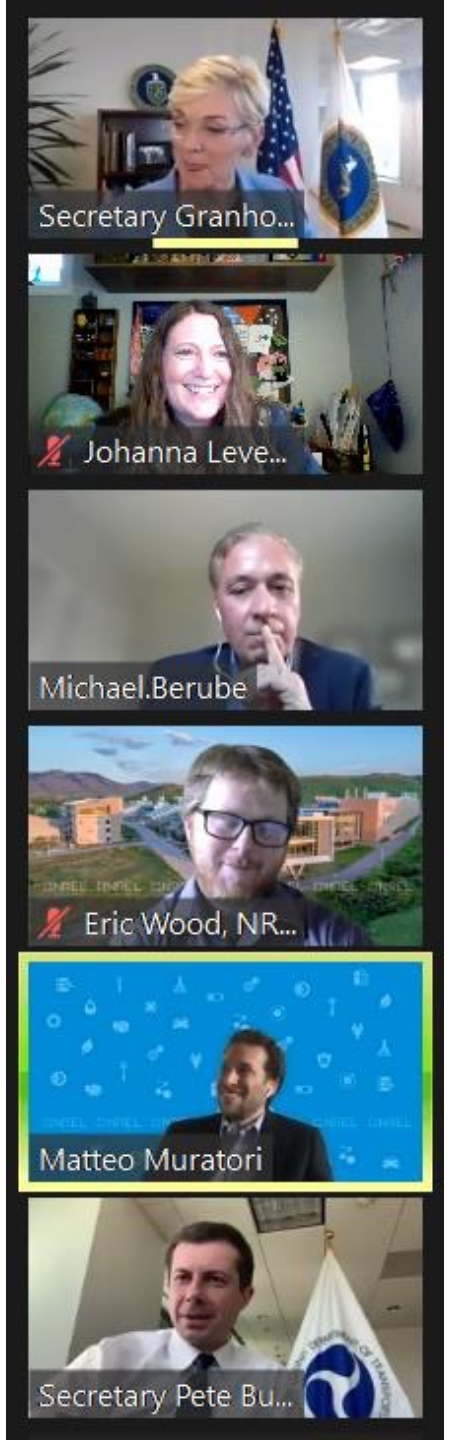
$7.5B investment in EV charging

California's Electric Vehicle Infrastructure Project

$1.4B investment in EV charging

EPA MY2027 and later vehicle GHG regulations

Projected to induce light-duty EV sales of at least 50% by 2030



EVI-X: Modeling Tools for Forward Looking Analysis

Network Planning Tools
How many ports are needed in my area? What kind? Where?

Electric Vehicle Charging Infrastructure Analysis
NREL's EVI-X Modeling Suite

Lite Version Available Online

Site Design Tools
What is the optimal configuration for my site? What is the expected load profile? Would I benefit from storage?

Network Planning

EVI-Pro
Charging infrastructure projection based on typical daily travel

EVI-OnDemand
Charging infrastructure demand modeling for ride-hailing services

EVI-RoadTrip
Charging infrastructure analysis for long-distance travel

EVI-Equity
Charging infrastructure accessibility from environmental-justice perspective

NEVI U-Finder
Charging infrastructure networking data

Site Design

EVI-Ratio
Planning the ratio and type of chargers to vehicles in a fleet

EVI-InMotion
Dynamic and quasi-dynamic charging infrastructure design

EVI-EnSite
Charging infrastructure energy estimation and site optimization

HEVII
Multi-fidelity telematics-enabled vehicle and infrastructure design

EVI-EDGES
Techno-economic evaluation of behind-the-meter storage

Financial Analysis

EVI-FAST
Charging infrastructure financial analysis (free to download)

EVI-LOCATE
Charging station installation design analysis and cost estimation

These financial analysis tools can integrate with any of the tools above.

Financial Analysis Tools
What does it cost to charge? How can this be reduced?

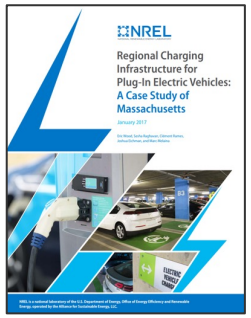
https://www.nrel.gov/transportation/evi-x.html

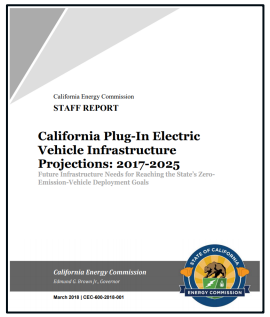
EVI-X: **Network Planning**

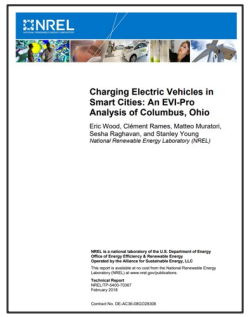
EVI-Pro is a simulation model that:

- Models **daily charging demands** for EVs
- Designs **supply of infrastructure** to meet demand

Models EV driver charging behaviors for a given set of assumptions around EVSE access and charging preferences.





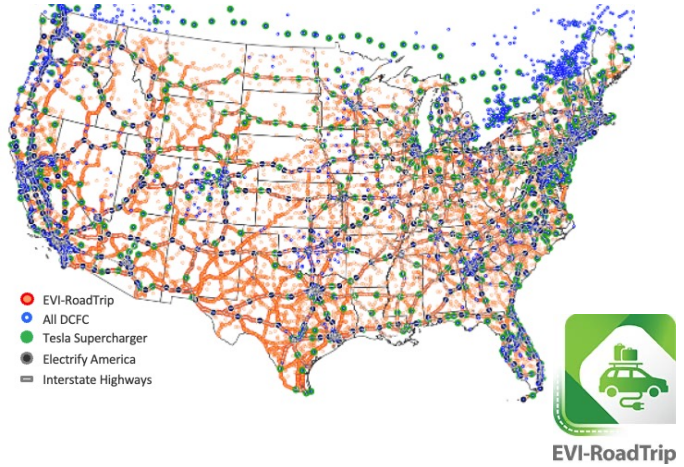


Originally developed through a collaboration with the California Energy Commission, EVI-Pro has been applied in multiple city-, state-, and national-level studies

EVI-Pro

https://www.nrel.gov/transportation/evi-pro.html

EVI-RoadTrip estimates EV charging demands along highway corridors for long-distance travel (road trips).

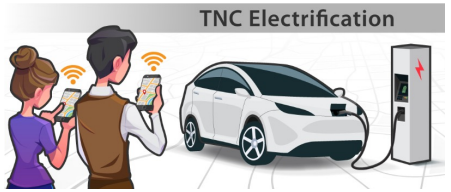


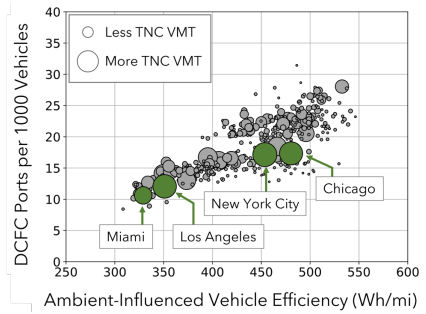
EVI-RoadTrip

https://www.nrel.gov/transportation/evi-roadtrip.html

EVI-OnDemand estimates DC fast charging infrastructure requirements for ride-hail EVs considering:

- Local weather/driving conditions
- Typical driver shift lengths
- Home charging access for ride-hail drivers



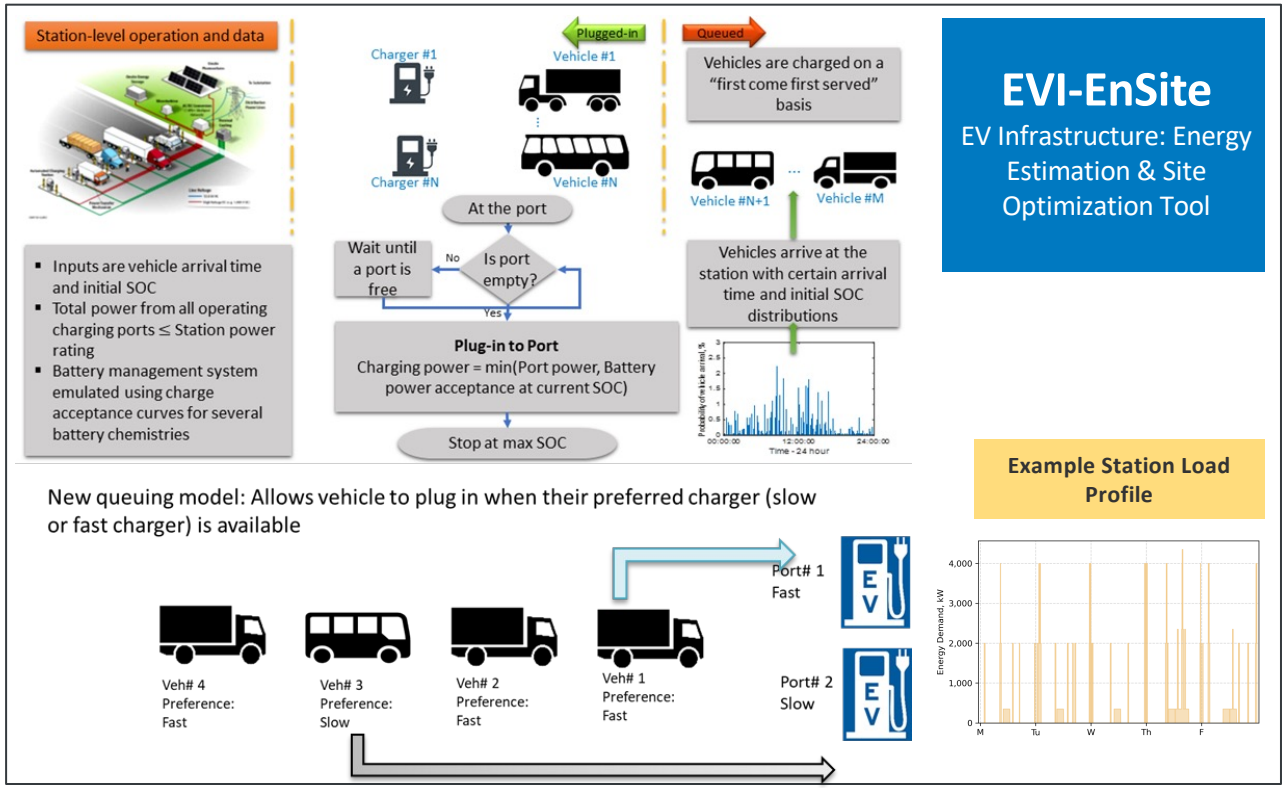


EVI-X: **Site Design**

EVI-EnSite – agent-based charging station modeling and analysis tool to investigate site operating requirements.

https://www.nrel.gov/transportation/evi-ensite.html

- **Charging Station design parameters**:
  - Station power capacity
  - Number of ports
  - Port power capacity
- **Used to answer questions such as:**
  - How should EV charging stations be designed?
  - How much queuing is expected at a proposed station?
  - What site-level control policies can reduce grid requirements while limiting inconvenience?
  - What is the average utilization of a station?
  - What is the total power demand of a station?



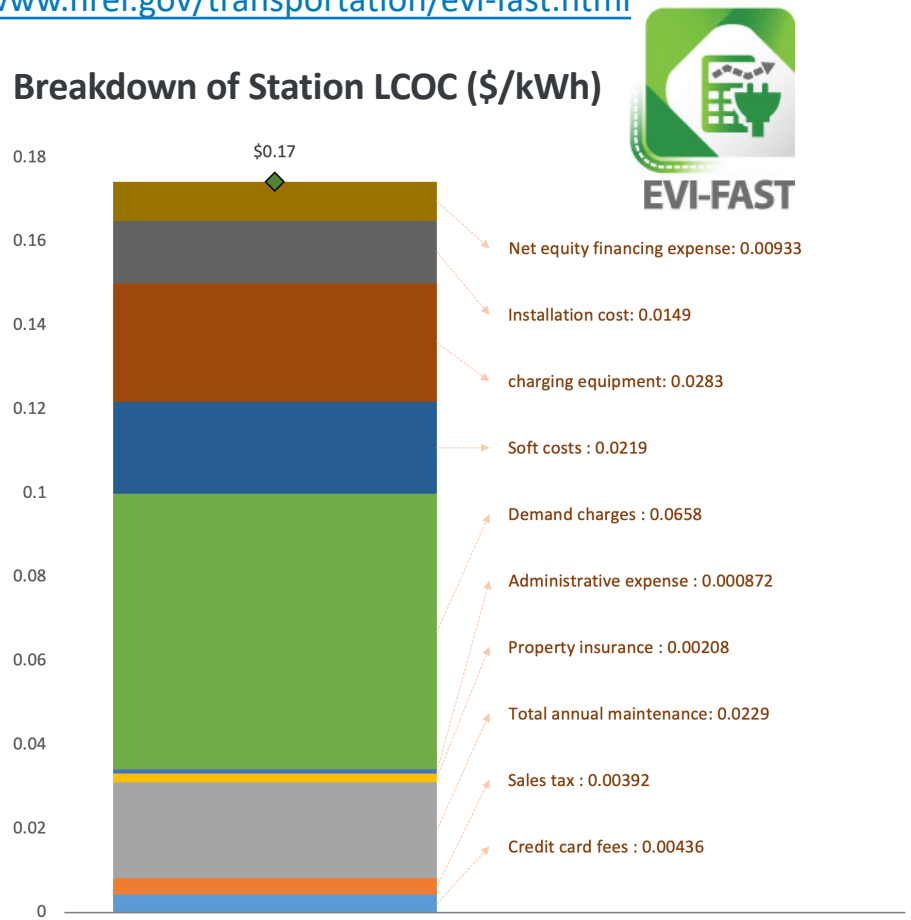
EVI-EnSite simulates EV station operations, producing site load profiles and performance metrics like station peak and average power demand, energy delivered by port type, and vehicle queuing statistics.

EVI-X: **Network/Station Economics**

https://www.nrel.gov/transportation/evi-fast.html

EVI-FAST – EV station financial analysis tool

- **Publicly accessible** tool for in-depth financial scenario analysis of EV charging stations.
- **Highly configurable** – inputs include station design (power capacity), utilization, costs (equipment, installation, and operating), incentives, and financing assumptions.
- Calculates financial performance metrics including **investor payback period**, **net present value**, and the **levelized cost of charging** ($/kWh) for each station scenario.
- Used in multiple recent DOE analyses[1,2]



EVI-FAST estimates the levelized cost of charging (i.e., the breakeven cost of charging inclusive of capital expenses (e.g., EVSE), operating costs (e.g., electricity purchases), and financing assumptions) for EV charging stations.

[1] Borlaug et al., 2020, "Levelized Cost of Charging Electric Vehicles in the United States"

[2] Bennett et al., 2022, "Estimating the Breakeven Cost of Delivered Electricity to Charge Class 8 Electric Tractors"

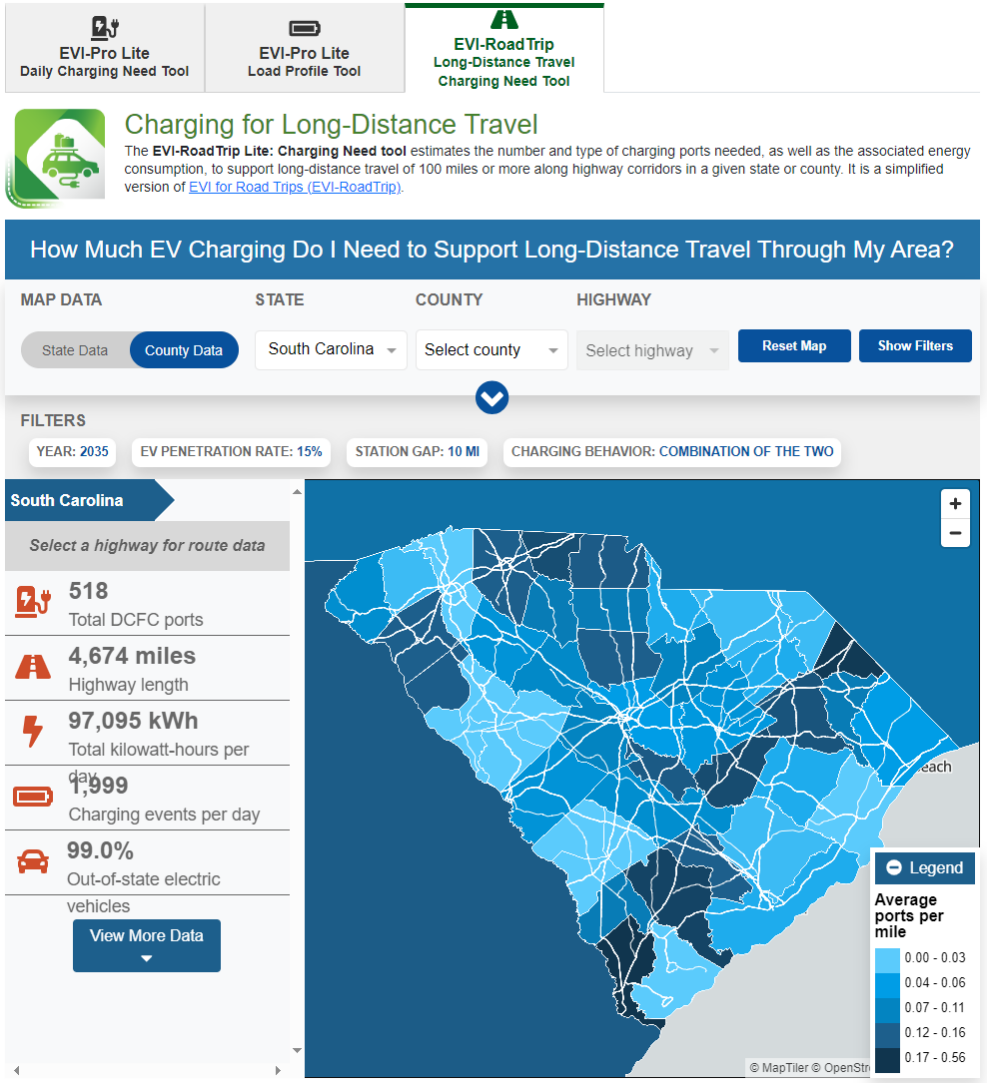
EVI-X Web Tools Provide Local Impact at Scale

- Access to EVI-X via online tools **empowers users** with research-grade analysis through a fast and intuitive interface
- Scale of web traffic surpasses what researchers could support via ad hoc requests and underscores **real-world impact**

Impact

Originally launched in 2018, web traffic for online EVI-X tools has increased every year

FY23: 40,000 pageviews and 660,000 API hits (160% increase)



https://afdc.energy.gov/evi-x-toolbox

EVI-Equity

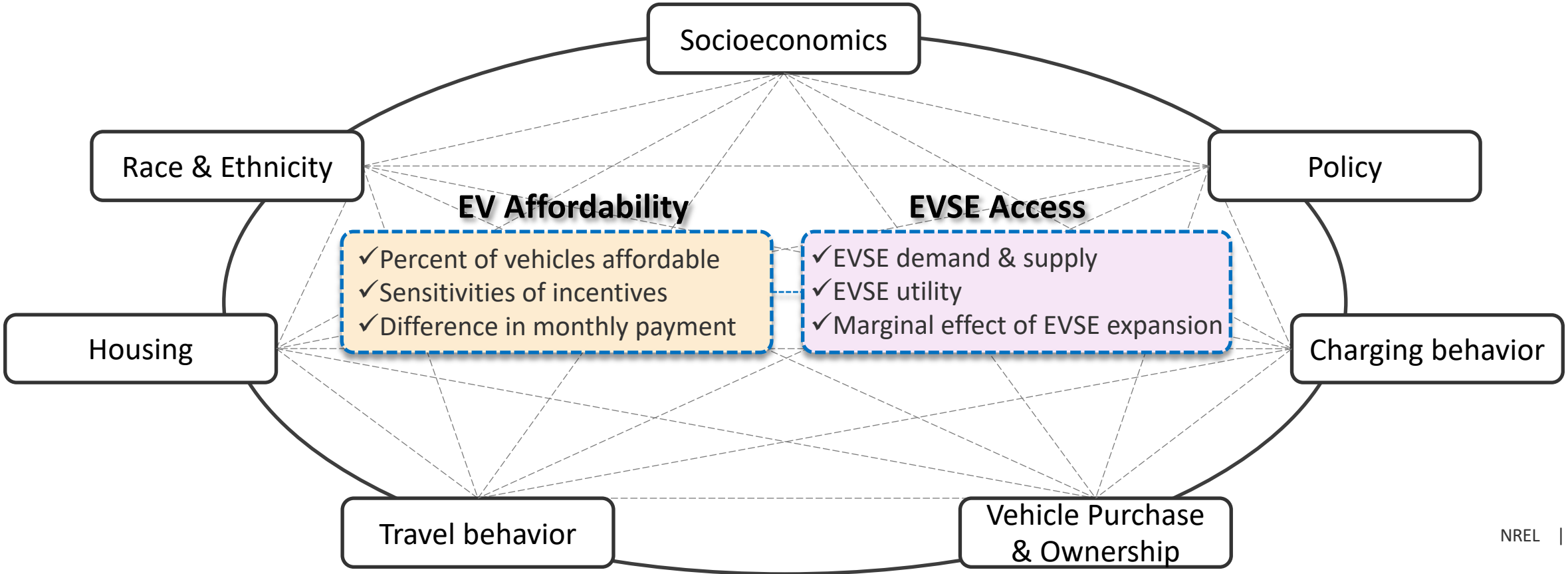
EVI-Equity: Analysis for Equitable EV and EVSE Access

EVI-Equity is a cross-cutting and multi-disciplinary analysis tool for evaluating **equitable EV adoption and EVSE deployment**.

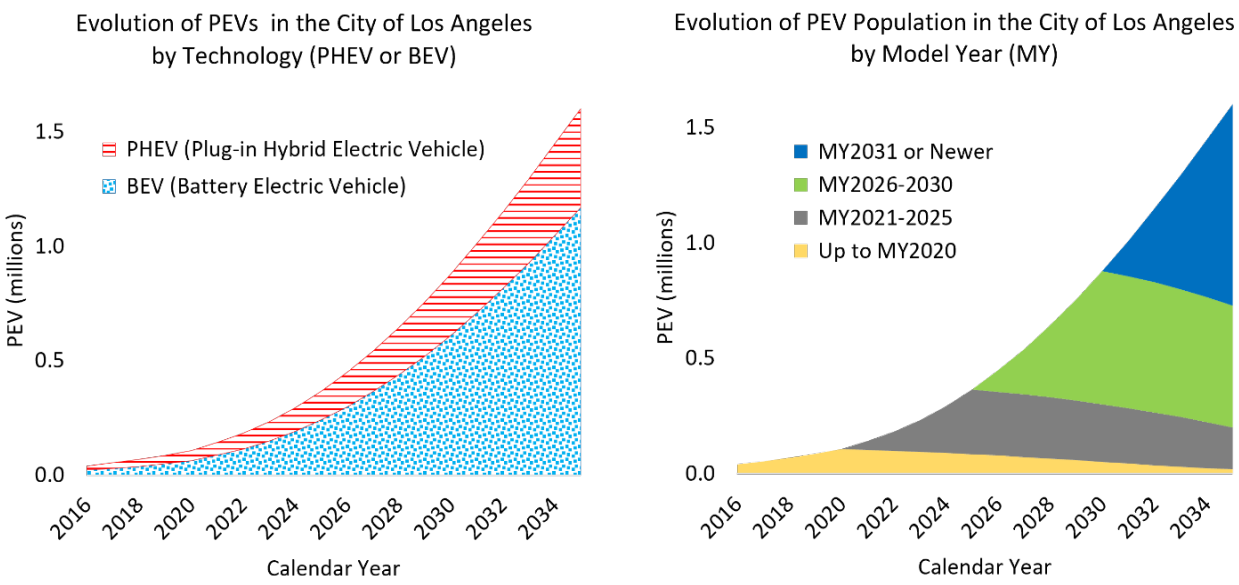
- **Scope**: Entire U.S.
- **Spatial resolution**: Census block group (CBG) or Census tract
- **Basic building block**: Individual households in each CBG

EVI-Equity

https://www.nrel.gov/transportation/evi-equity.html



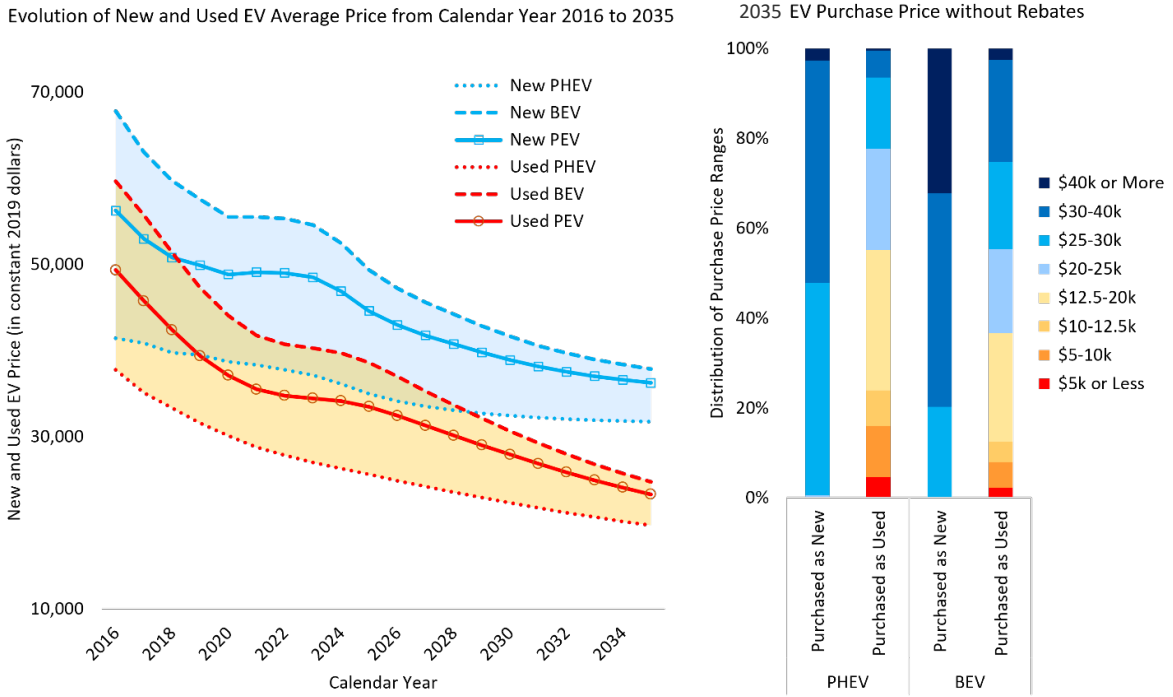
LA100 case study: EV Stock and Price Prediction



EV stock in Los Angeles by technology (PHEV versus BEV) and model year (Source: EVI-Equity; MY = model year)

- By 2035, it is anticipated that Los Angeles will host approximately 1.6 million plug-in EVs
- The majority of EVs will be BEVs, with about half of all EVs being no more than 5 years old

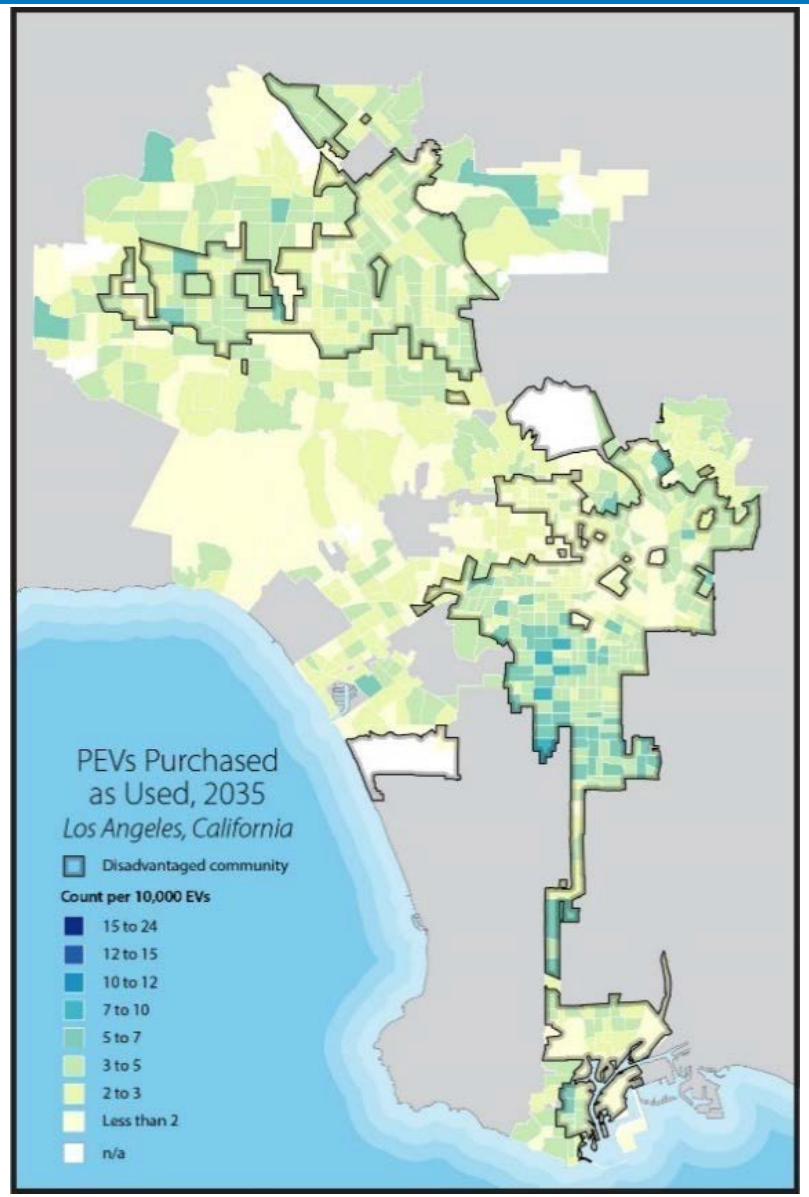
- The cost of EVs is expected to decrease over time.
- By 2035, the projected buying price* for EVs in LA is anticipated to be $35,000 for new EVs and around $23,000 for used EVs

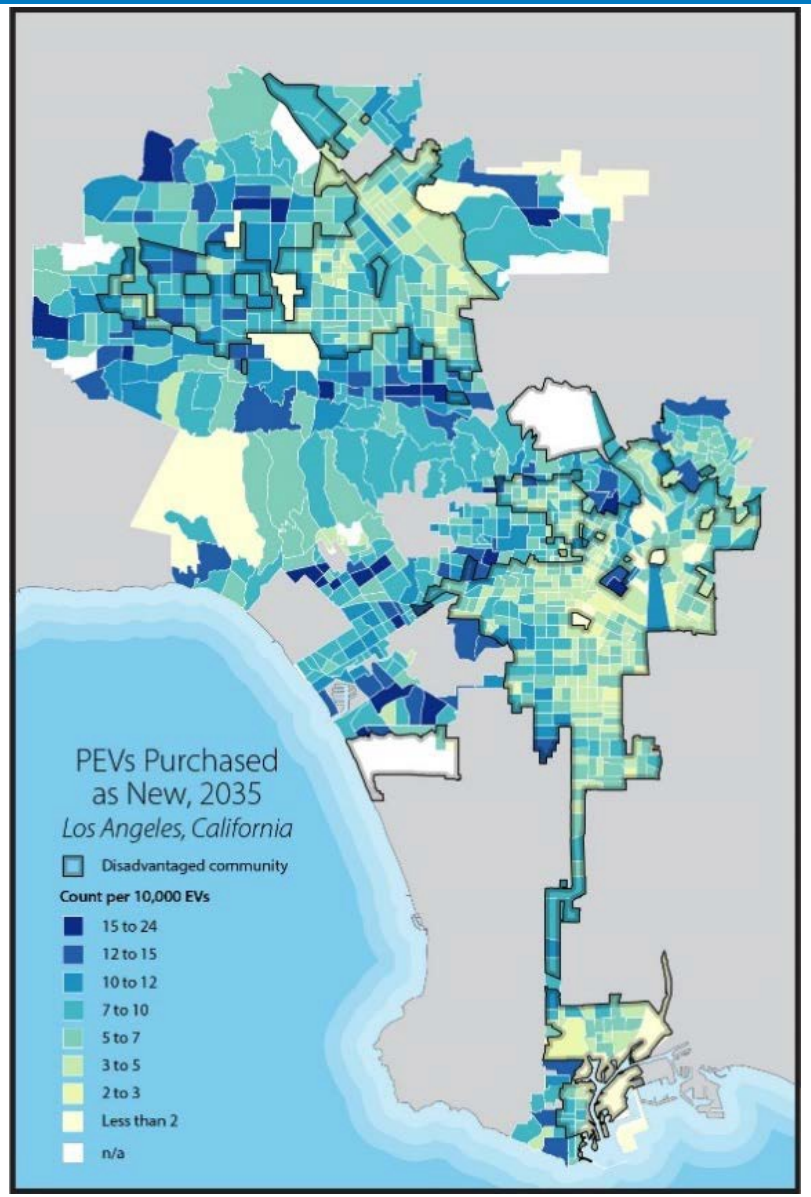


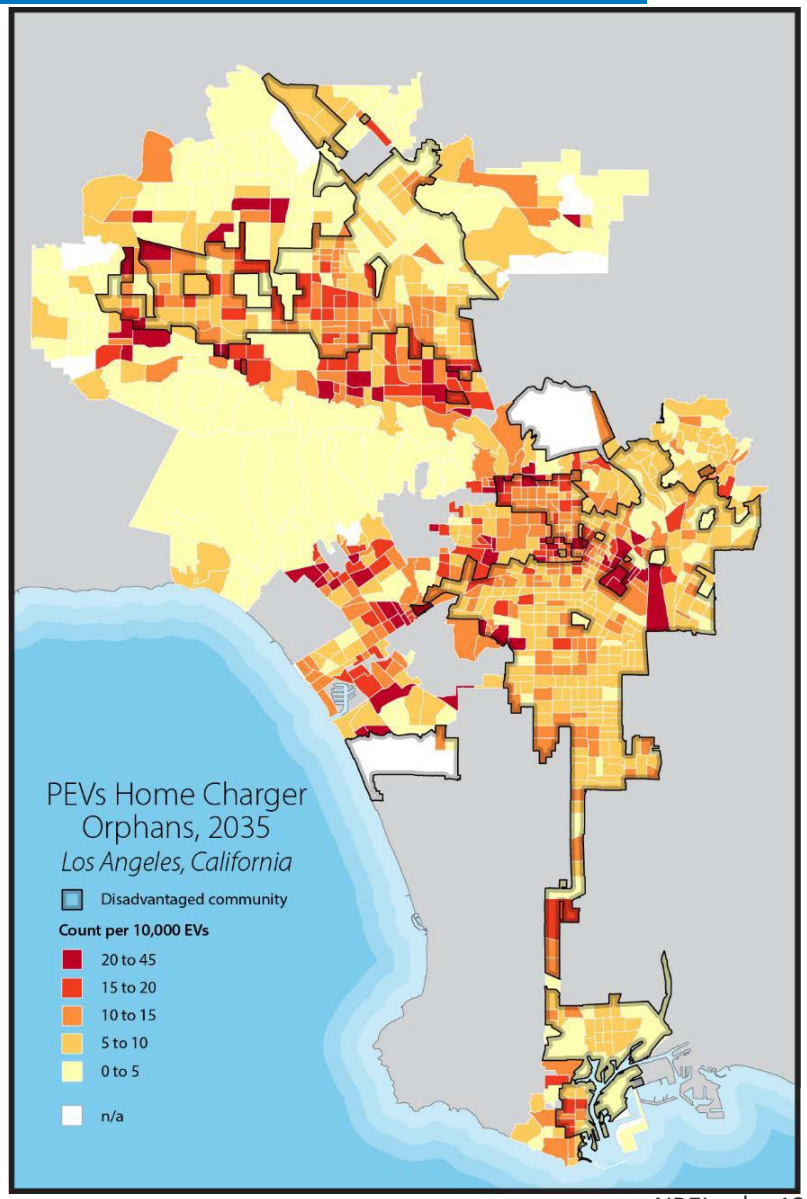
Projected purchase price for new and used EVs; EV/PEV = plug-in electric vehicles, including both BEVs and PHEVs; Source: EVI-Equity

* Price is the projected cumulative sales-weighted average buying price

LA100 case study: Projected Spatial Distributions

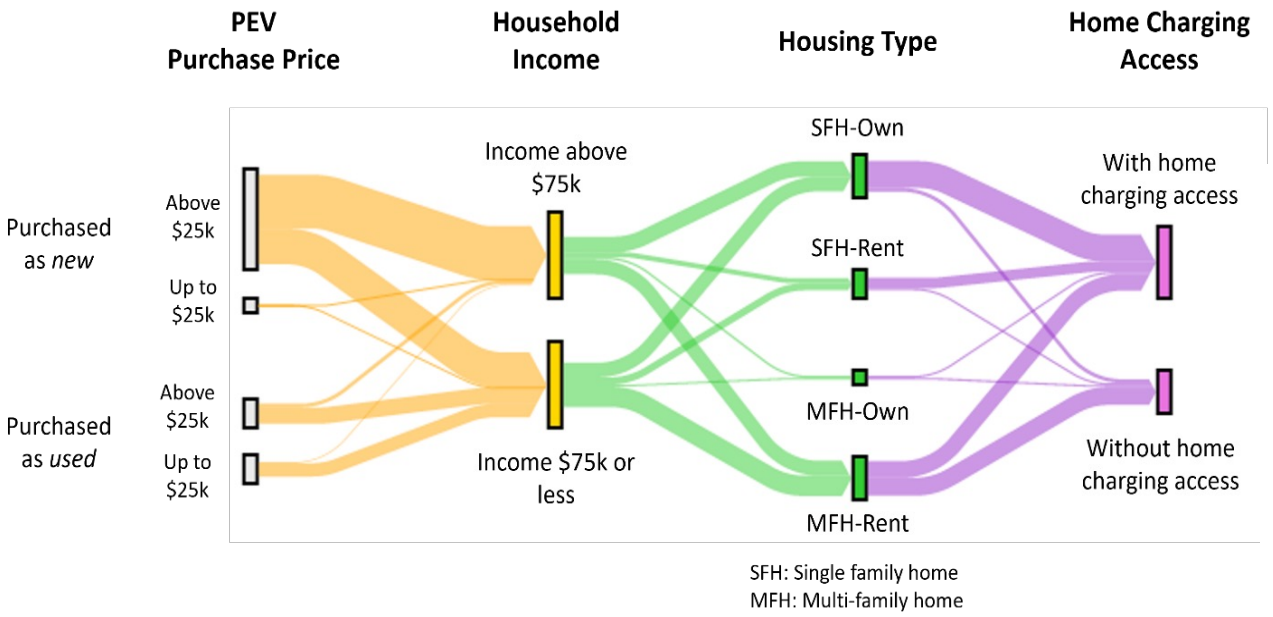






(Source: EVI-Equity)

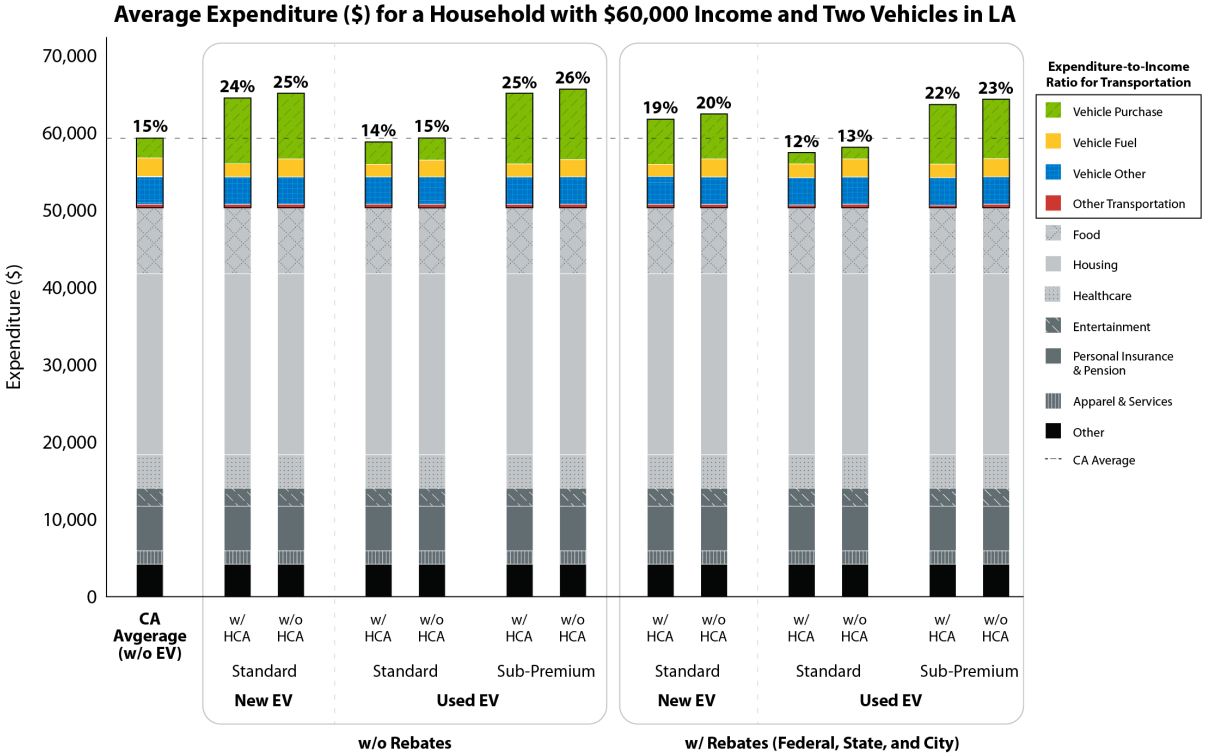
LA100 case study: EV and EVSE Affordability



Breakdown of EV owners in Los Angeles in 2035 by household income, housing type, and access to home charging (based on BAU scenario), where plug-in EVs (PEVs) include both BEVs and PHEVs.

In 2035, more than half of EV buyers are estimated to come from the low-to-middle income population; most people in that population do not have access to home charging

Transportation costs are 15% of income without an EV; Adopting an EV makes it 12%–26%, varying with new/used, rebates, vehicle type, and home charging

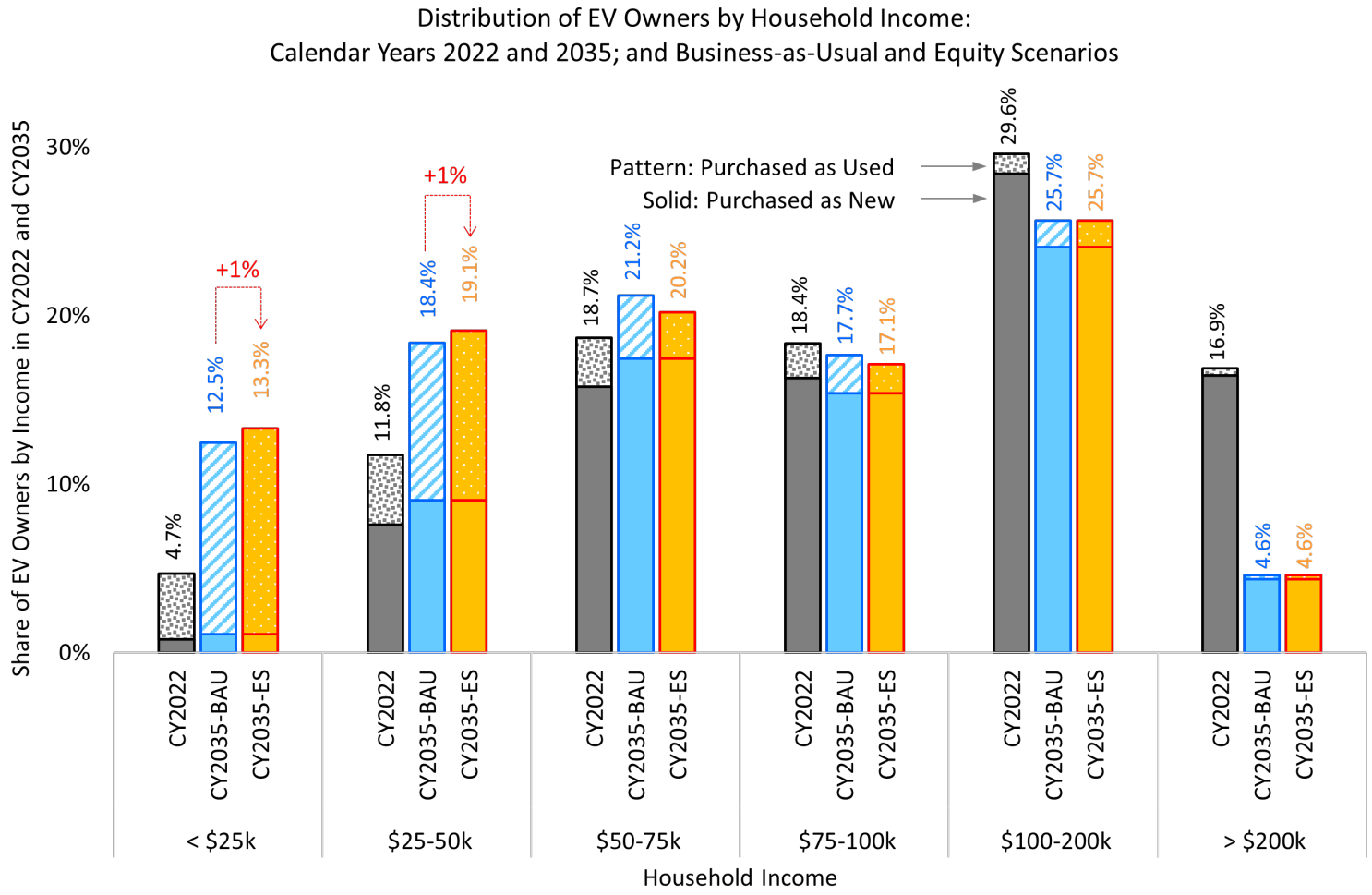


2022 household expenditures related to EV and home charging access (based on today's market conditions), HCA = home charging access

LA100 case study: Equity Strategies

Increasing low-income rebates for used EVs from $2,500 to $4,000, aligning with federal levels, could potentially stimulate a 2% increase in used EV adoption among low-income households, (roughly 50,000 vehicles by 2035)

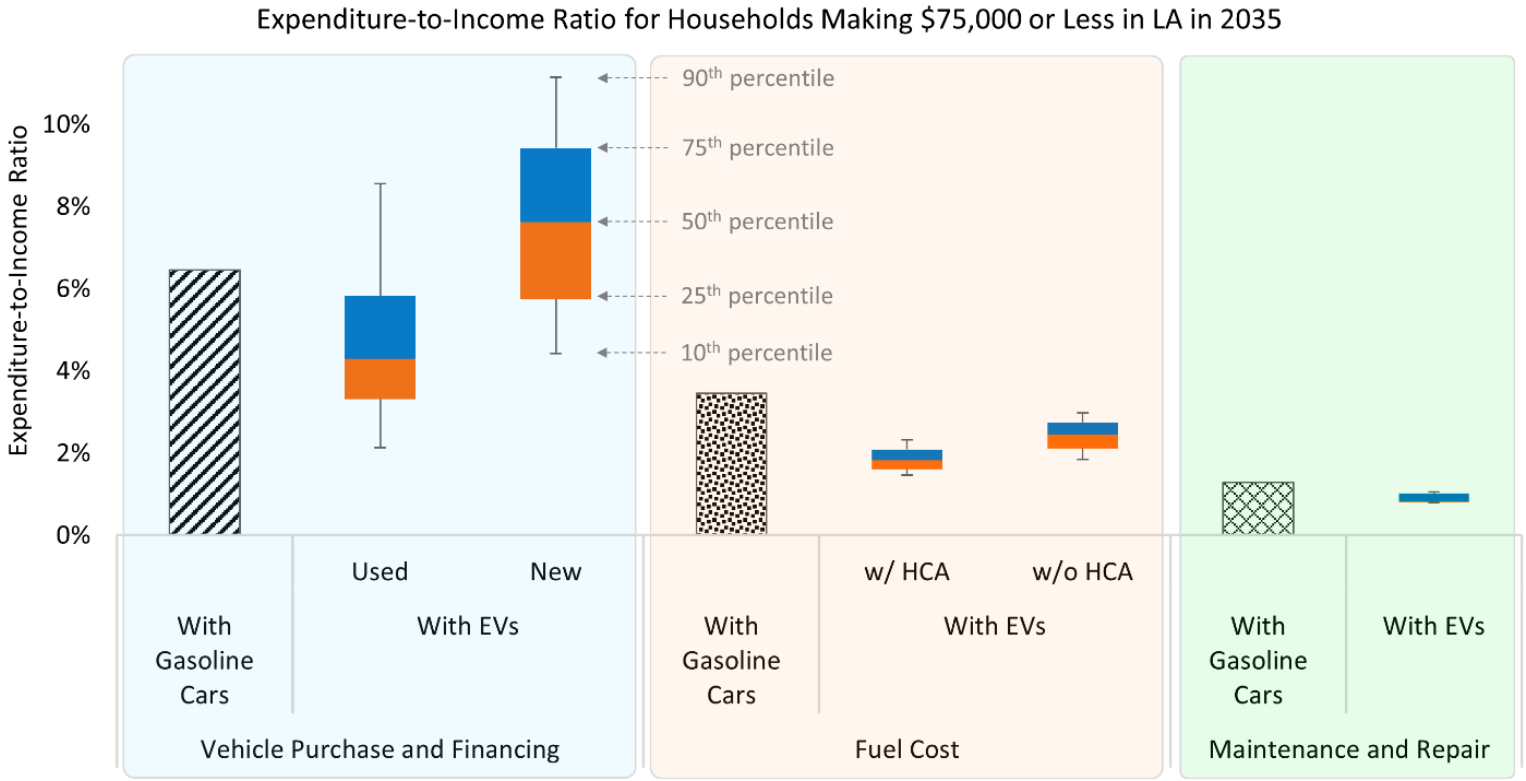
- **Business-as-Usual (BAU) scenario:** A $7,500 federal and $2,000–$7,500 state rebate for new BEVs ($1,000–6,500 for PHEVs) and a $4,000 federal and $1,500–$2,500 city rebate for used EVs were modelled based on income thresholds in the BAU scenario
- **Equity scenario:** an Equity scenario was evaluated in which the city rebate increases from $2,500 to $4,000 for households with annual incomes up to $40,000



CY = calendar year, BAU = Business-as-Usual, ES = Equity scenario

LA100 case study: Equity Strategies

- For vehicle purchase and financing – on average, opting for used EVs could enable households with annual incomes ≤$75K to save approximately 3% of their total expenditures
- For operating costs – EVs offer a reduction in fuel expenses across all scenarios, irrespective of home charging availability
- For maintenance cost – EVs decrease maintenance and repair costs by 35%
- Additional incentives would be needed to reduce the cost burden for EV households w/ no home charging access



Expenditure-to-income ratio for households with an income of $75,000 or less that adopted EVs in Los Angeles by 2035

HCA = home charging access

Additional Capabilities of EVI-Equity

- **Multi-modal analysis/solutions**
  - Shared e-micromobility
  - Shared EV access
  - Improved transit service
- **EVSE network evaluation**
  - Network sufficiency
  - Marginal effect of EVSE network expansion
  - Exploring neighborhood amenities for opportunity charging

Thanks! Questions?

www.nrel.gov

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