

Total Cost of Ownership as a Policy Tool

**Cost of Electrification of the Light-duty Vehicle
Fleet of California**

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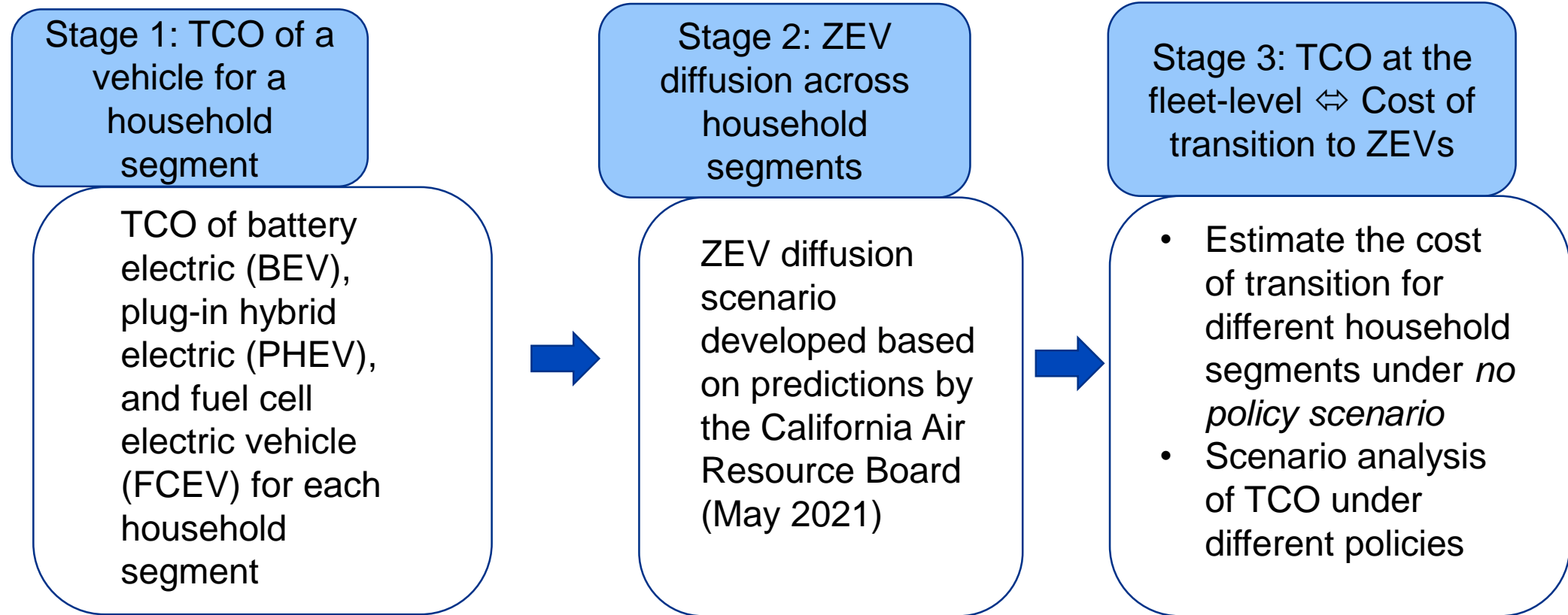
Plug-in Hybrid & Electric Vehicle Researcher Center

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Purpose of the total cost of ownership estimate

- *Total cost of ownership (TCO)* estimates primarily used to compare the cost of adoption of a new technology (Zero emission vehicles (ZEVs)) to the cost of an incumbent technology (Internal combustion engine vehicles (ICEVs))
 - Estimate the break-even point in the cost of adoption of new technology subject to market- and technology-related uncertainties
- TCO can be useful as a policy tool- analyze if the cost of adoption of a new technology differs across the population, why the heterogeneity, and how different policies can ease the cost of transition across the population.

Using total cost of ownership as a policy tool



- Household segments defined based on household income, dwelling type, and size of household fleet
- Period of analysis : 2020-2035

Stage 1: Total cost of ownership at the vehicle-level

Capital Cost

- Vehicle purchase
- Charger installation (only for BEVs, and PHEVs) based on dwelling type

Fuel/ Energy Costs

- Depends on miles traveled by each household segment & their access to home vs non-home charging.

Other costs

- Insurance
- Maintenance
- Registration

Resale Value

- Depends on depreciation of vehicles

Total cost of ownership of a vehicle :

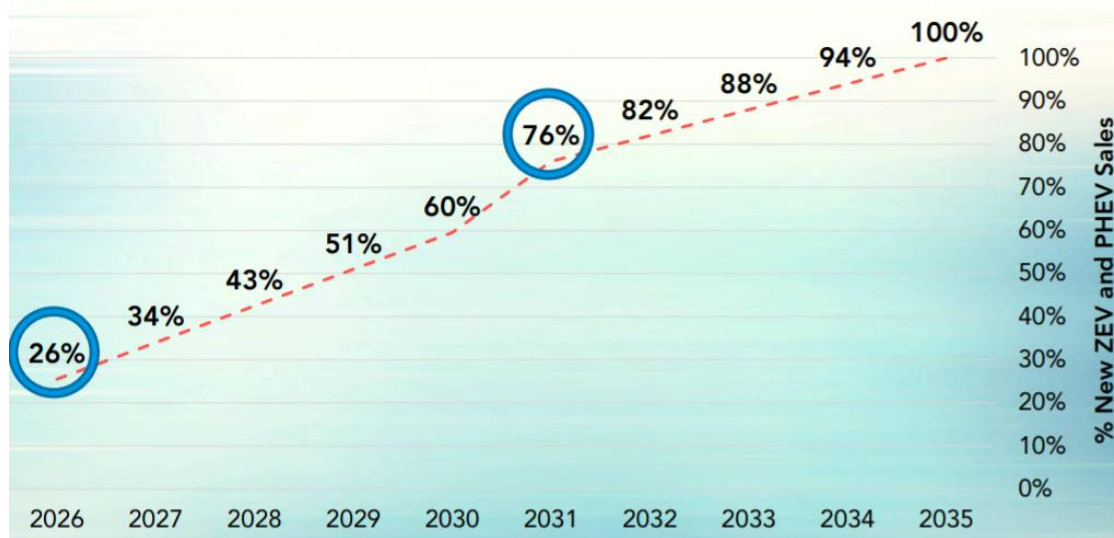
- BEV, PHEV, FCEV, and ICEV in the passenger car and passenger truck segment for each household-type.

Household segments considered in the TCO analysis

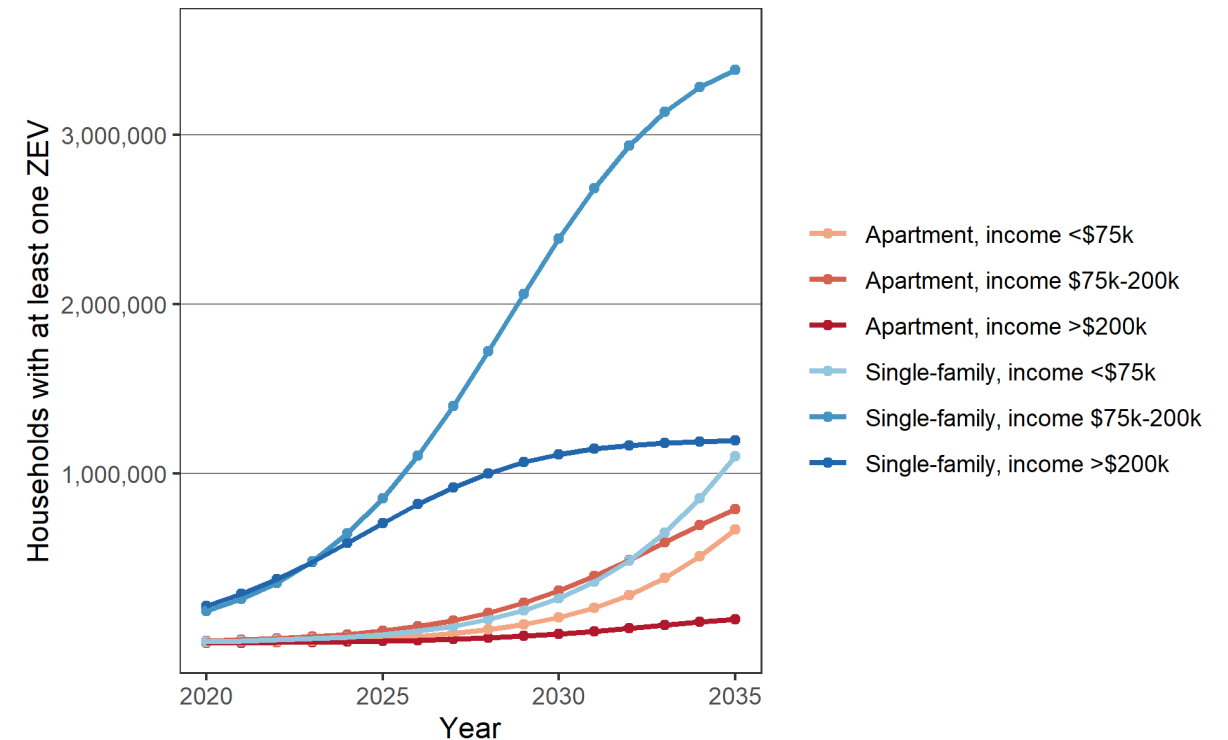
Housing Type	Household Income
Single-family	Under \$75,000
Single-family	\$75,000 - \$200,000
Single-family	Above \$200,000
Apartment	Under \$75,000
Apartment	\$75,000 - \$200,000
Apartment	Above \$200,000

Stage 2: ZEV diffusion by household segment

California Air Resource Board (CARB) prediction of share of ZEV sales in total LDV sales



ZEV Diffusion (2020-2035): Total households with at least one ZEV grouped by income and housing type

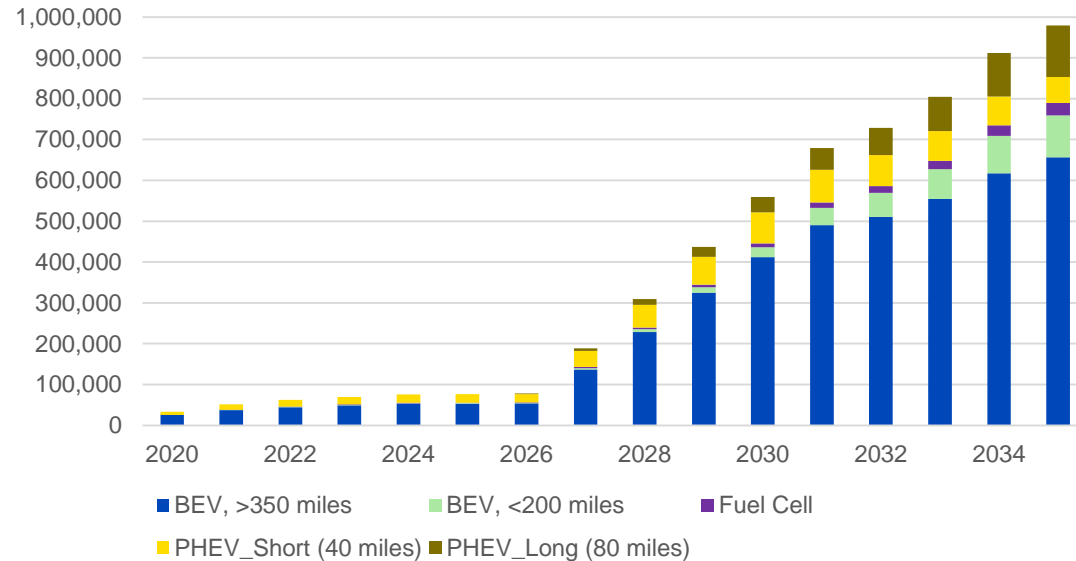


- ZEV diffusion by household segment estimated based on CARB ACC II (May 2021) predictions.
- High-income single-family households are the largest group of ZEV households in the first few years of the study; post 2025 middle-income single-family households are the largest group of adopters

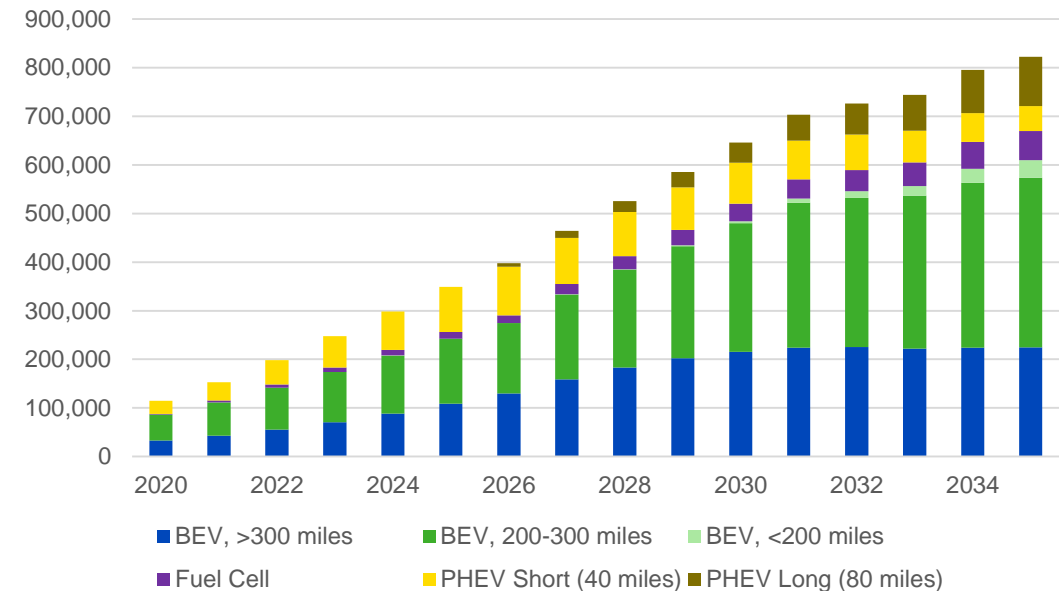
Stage 3: Total cost of adoption at the fleet-level

Each household segment sub-divided based on household fleet-size and accordingly allocated a BEV, PHEV, or an FCEV from the passenger car or passenger truck segment.

Passenger Trucks in the Fleet



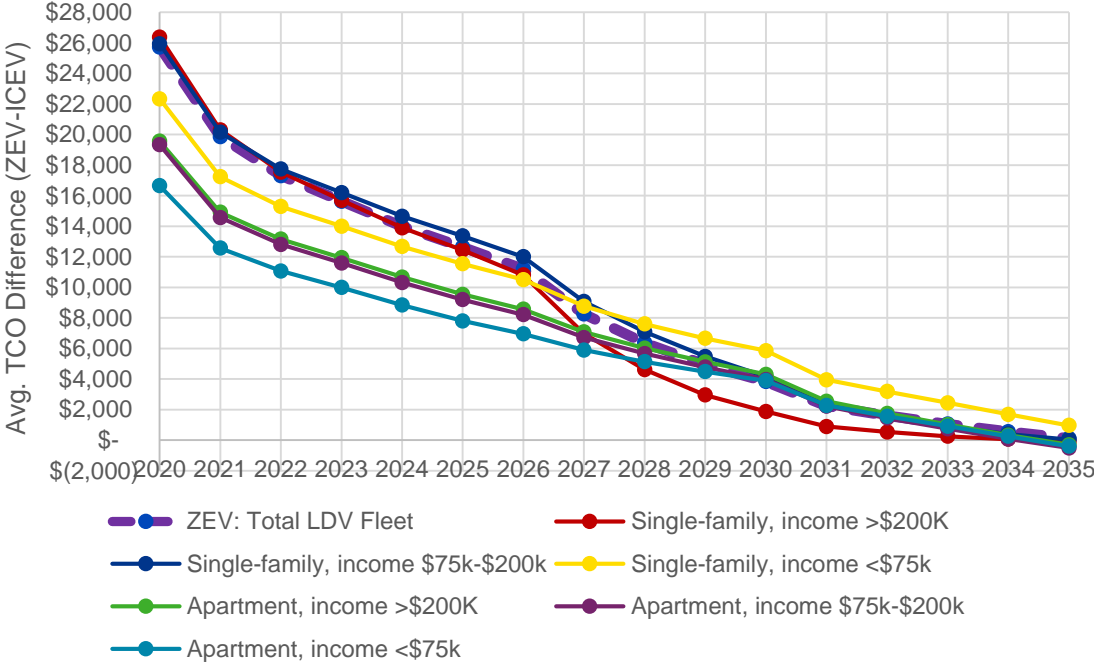
Passenger Cars in the Fleet



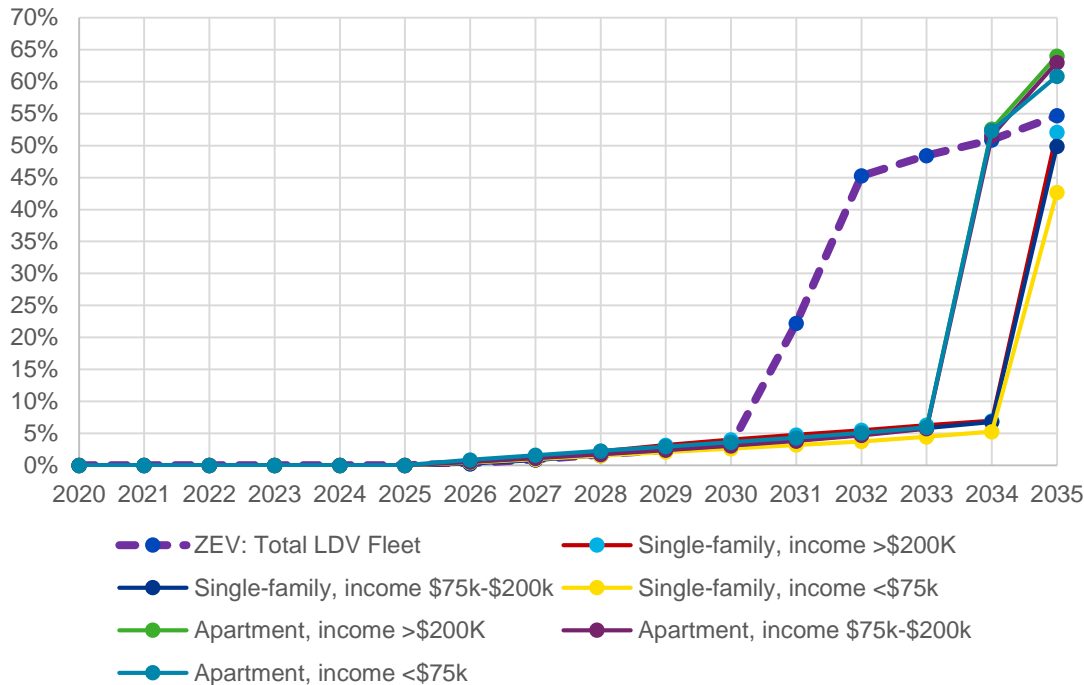
- Cost of ZEV adoption for a household segment (fleet-level)= Number of new ZEV sales allocated to the household segment X TCO (vehicle-level) of the ZEV-type allocated

Base Scenario : No Policy

Average TCO Difference: Total and by Household Group



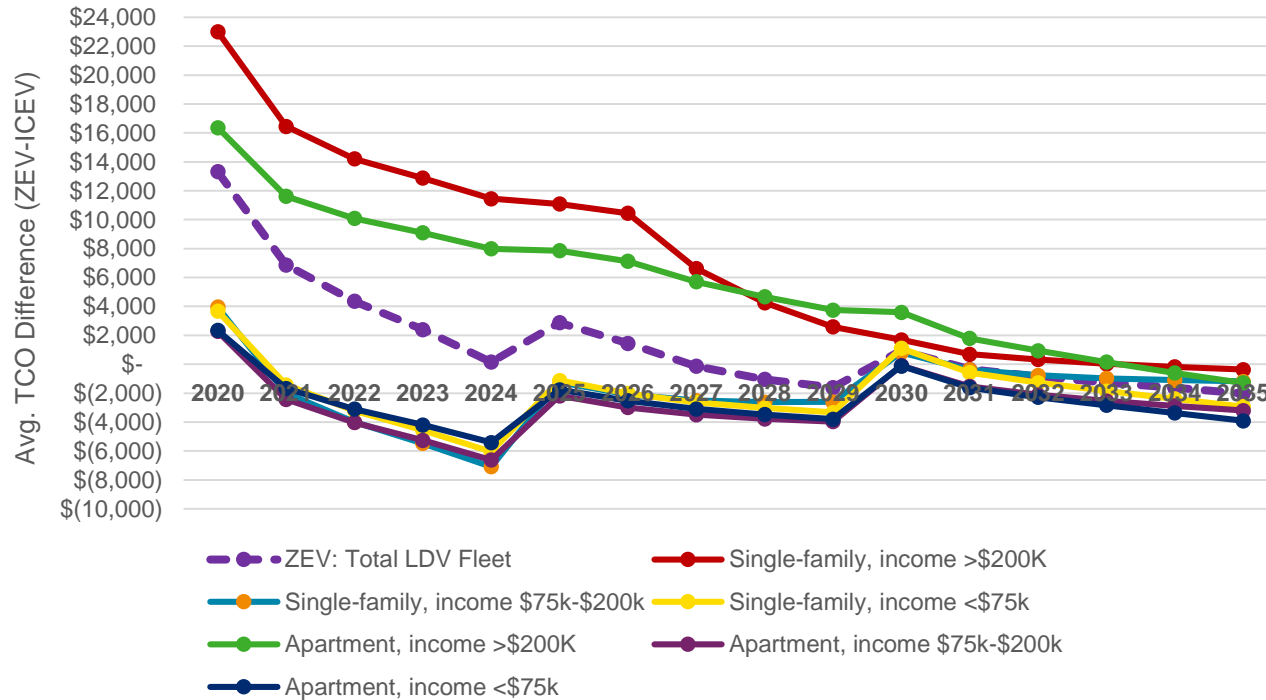
Percentage of Households Benefiting from Transitioning to ZEVs



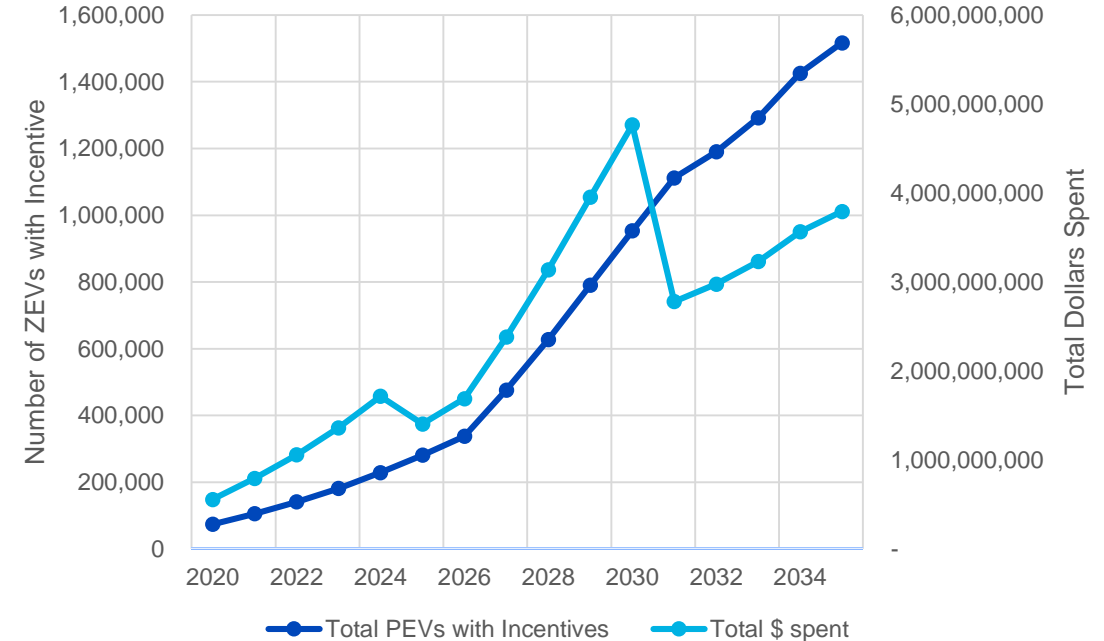
TCO Benefits accrue mainly post 2035. Share of ZEV adopters benefiting from transitioning increases after 2030, as households electrify their second or third vehicle in the household as well as the purchase price of the vehicles drop

Scenario 1: Purchase price subsidy to low- and middle-income households

Average TCO Difference: Total and by Household Group



Total dollars spent on incentive by year (2020-2035)

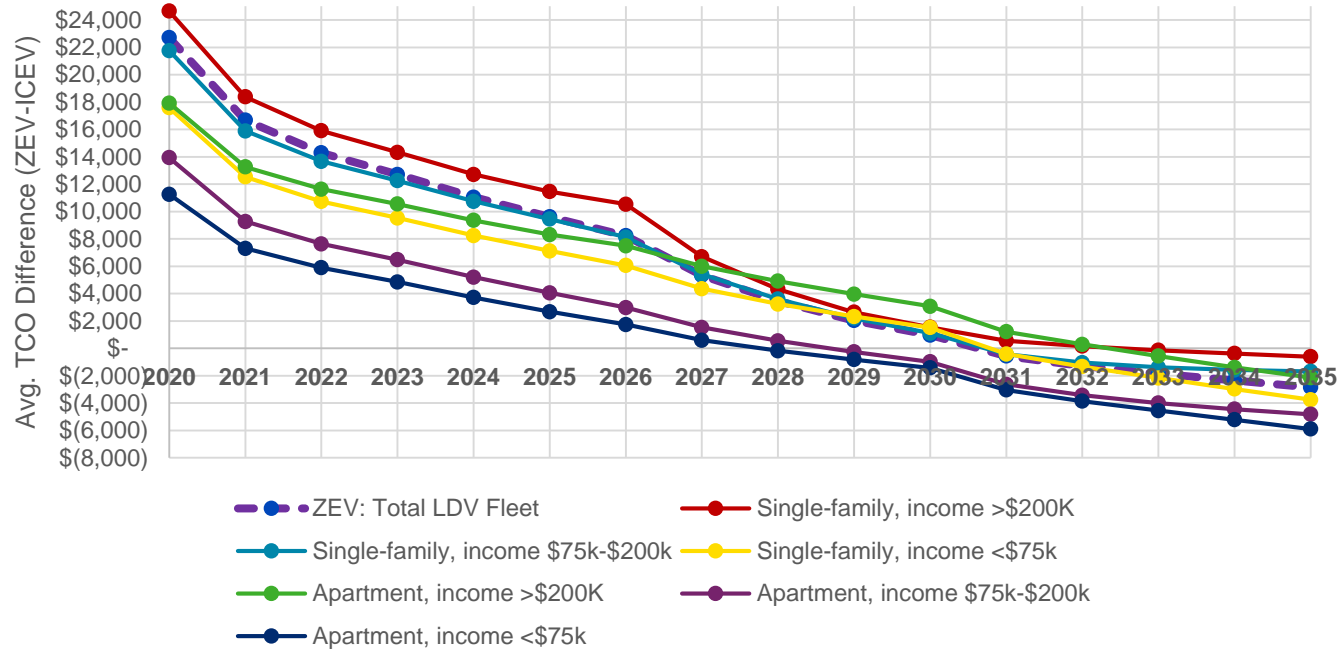


Incentive: 2020-2015: \$7500; 2025-2030: \$5000; 2030-2035: \$2500

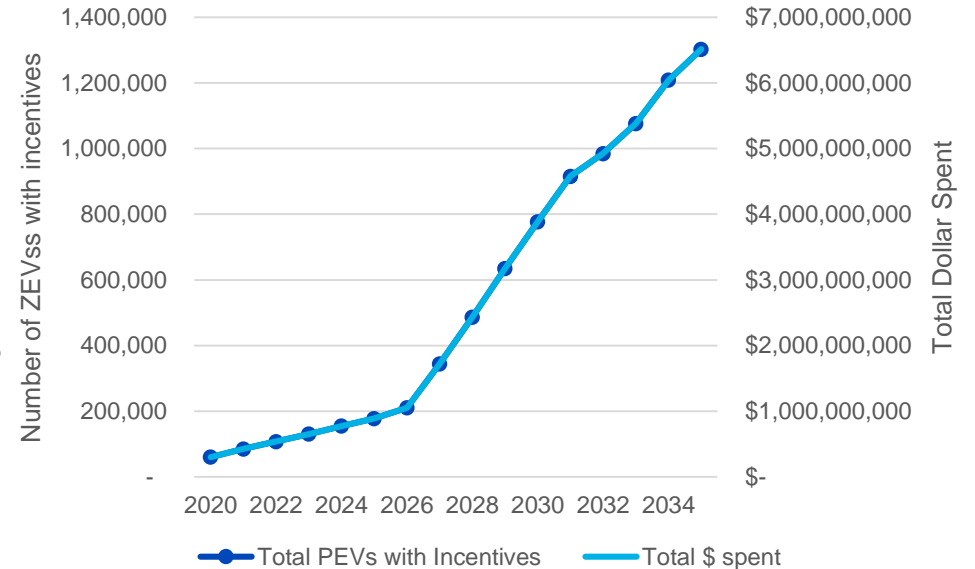
TCO parity reached earlier compared to the base scenario, particularly for the household groups receiving the incentive. As more middle- and low-income households enter the PEV market, the expenditure on subsidies go up until 2030 even though the amount per vehicle decreases.

Scenario 2: Purchase price subsidy to long-range ZEVs

Average TCO Difference: Total and by Household Group



Total dollars spent on incentive by year (2020-2035)

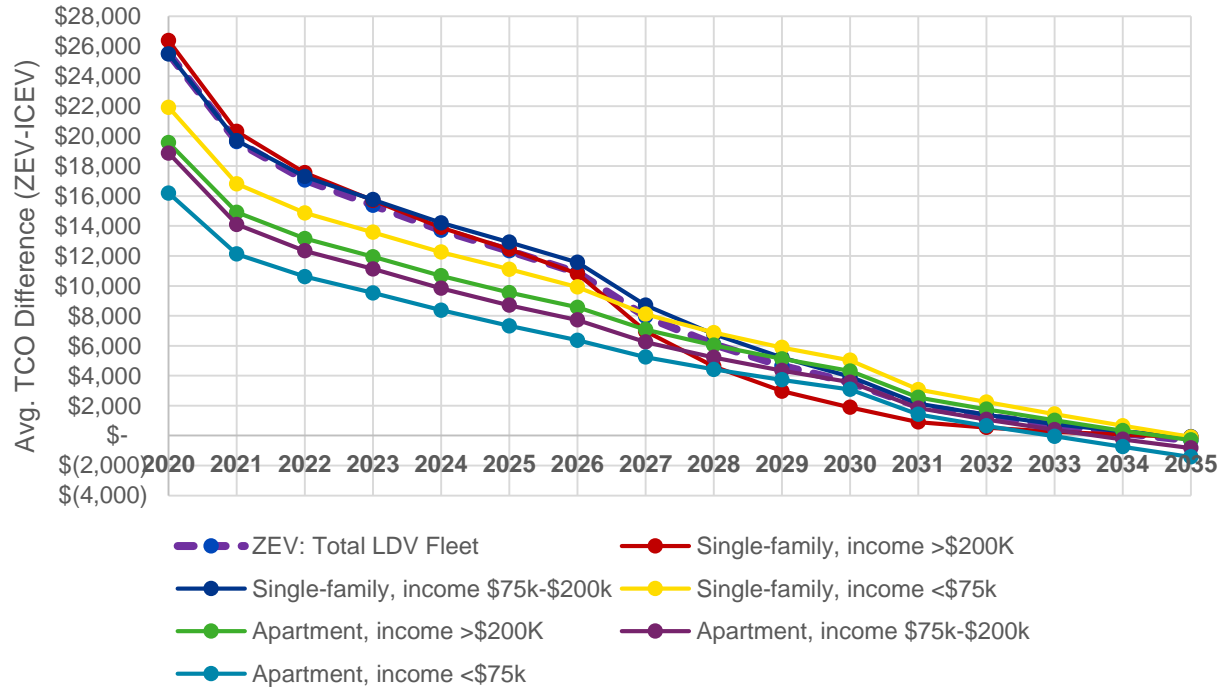


Incentive: \$5000 per vehicle

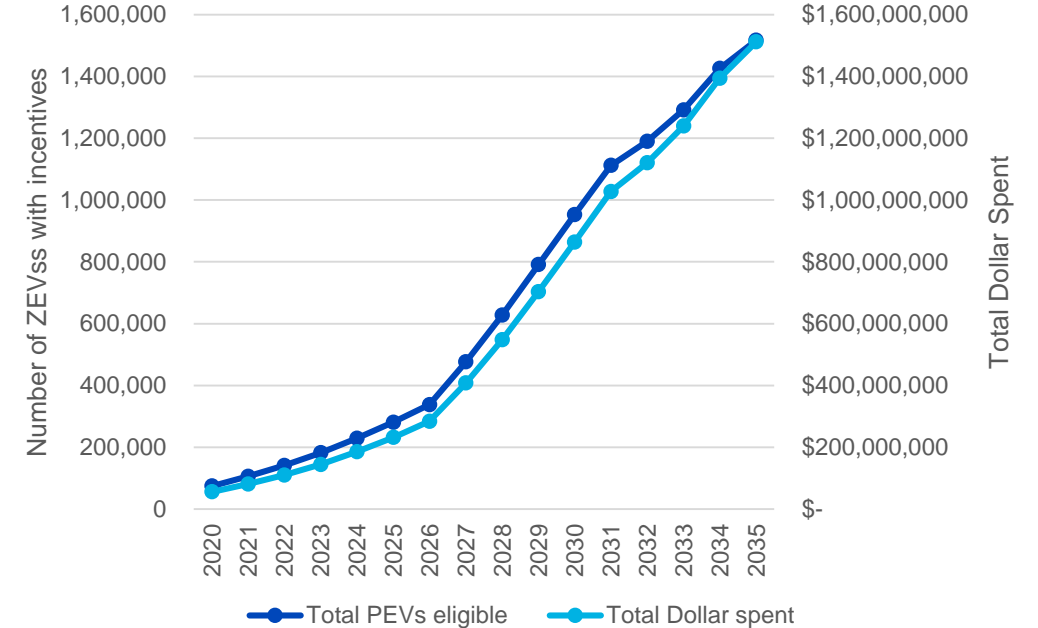
TCO parity reached earlier compared to the base scenario, but later compared to Scenario 1. The total expenditure on incentives is higher than Scenario 1 as households transition to ZEVs; expenditure expected to be higher is the market primarily moves towards long-range BEVs and PHEVs.

Scenario 3: Per-mile cost reduction

Average TCO Difference: Total and by Household Group



Total dollars spent on incentive by year (2020-2035)



Incentive: Per-mile cost reduction for low- and middle-income households. Residential electricity cost (\$/kWh) reduced by 5% and non-home charging cost by 10%.

- Cost parity reached earlier than base scenario but later than the scenarios with purchase subsidy. TCO difference lowered for the low-income groups (both single-family and apartments). The expenditure on incentives is least in this scenario

Concluding Remarks

- Assuming the technology changes and the diffusion process follows the trends predicted so far, total cost of ownership parity between ZEVs and conventional ICEVs can be hard to achieve over the next decade without government support.
- Purchase price- based incentives can help the market to reach TCO parity earlier; the timeline and the household groups benefiting from the program will depend on how the incentive program is designed.
- Per-mile cost reduction may not be as effective as purchase price-based incentives in terms of TCO parity but the expenditure on incentives is least.



Thank you

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