CALIFORNIA
AIR RESOURCES BOARD

ZEV Technology Incremental Cost

February 10, 2022

Approach to ZEV Cost Analysis

- Modeling 2026 to 2035 Model Years

Add: ZEV Component Costs

Subtract: Internal Combustion Engine (ICE) Vehicle Component Costs

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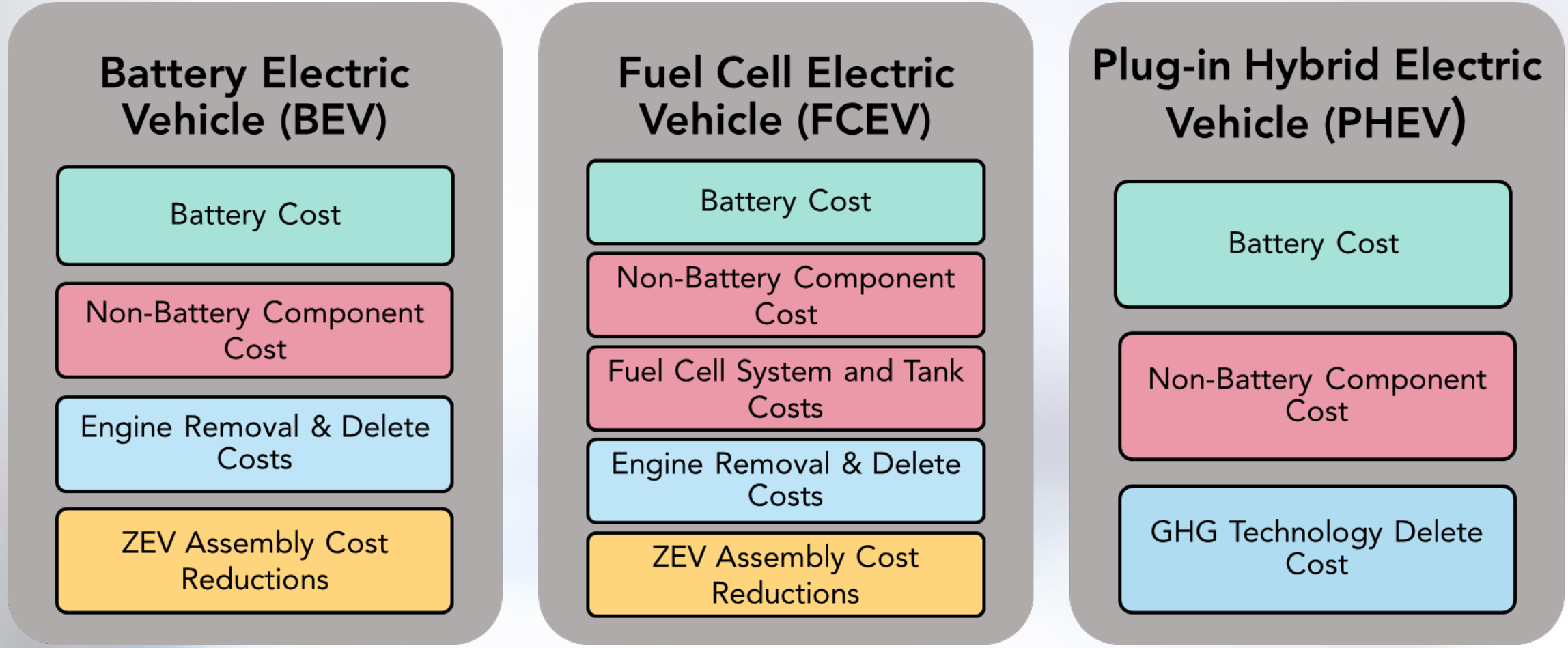
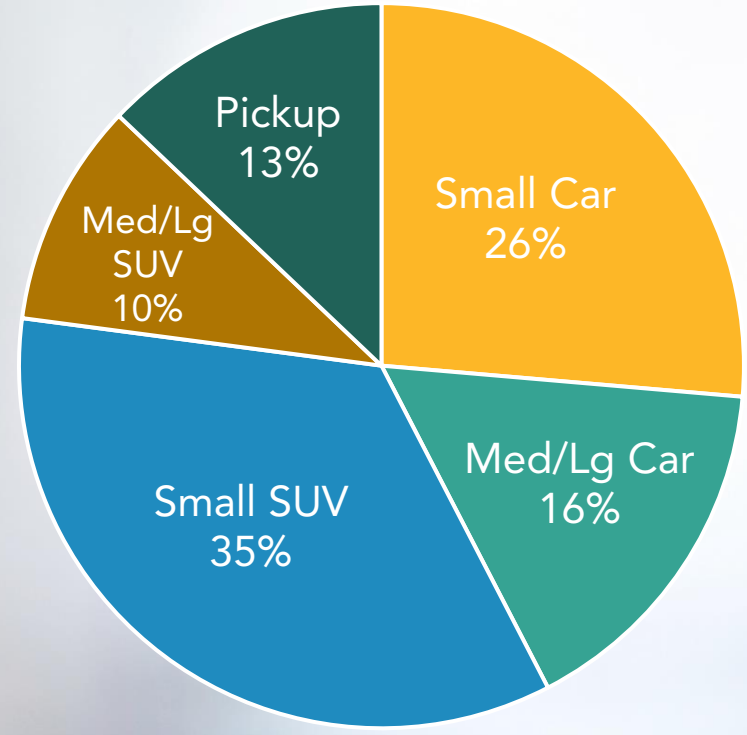
Incremental Direct Manufacturing Cost

ZEV Technology Incremental Cost Categories



Modeling the California Fleet



Model Year 2019 – California Sales

Technology	Range (mi)*
BEV	300
Longer Range BEV	400
PHEV	50
FCEV	320

*Modeled ranges are EPA label all-electric-range equivalent

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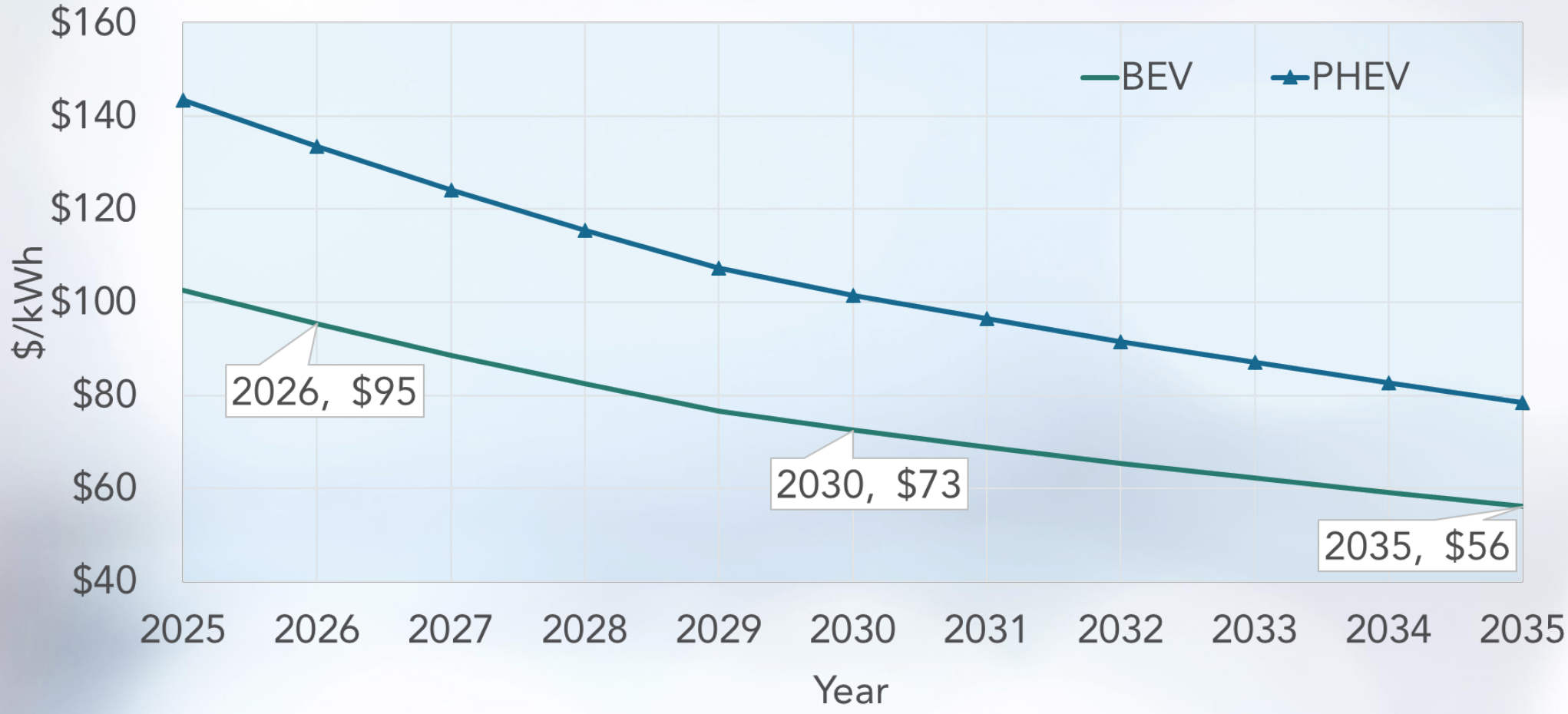
Battery Pack Costs



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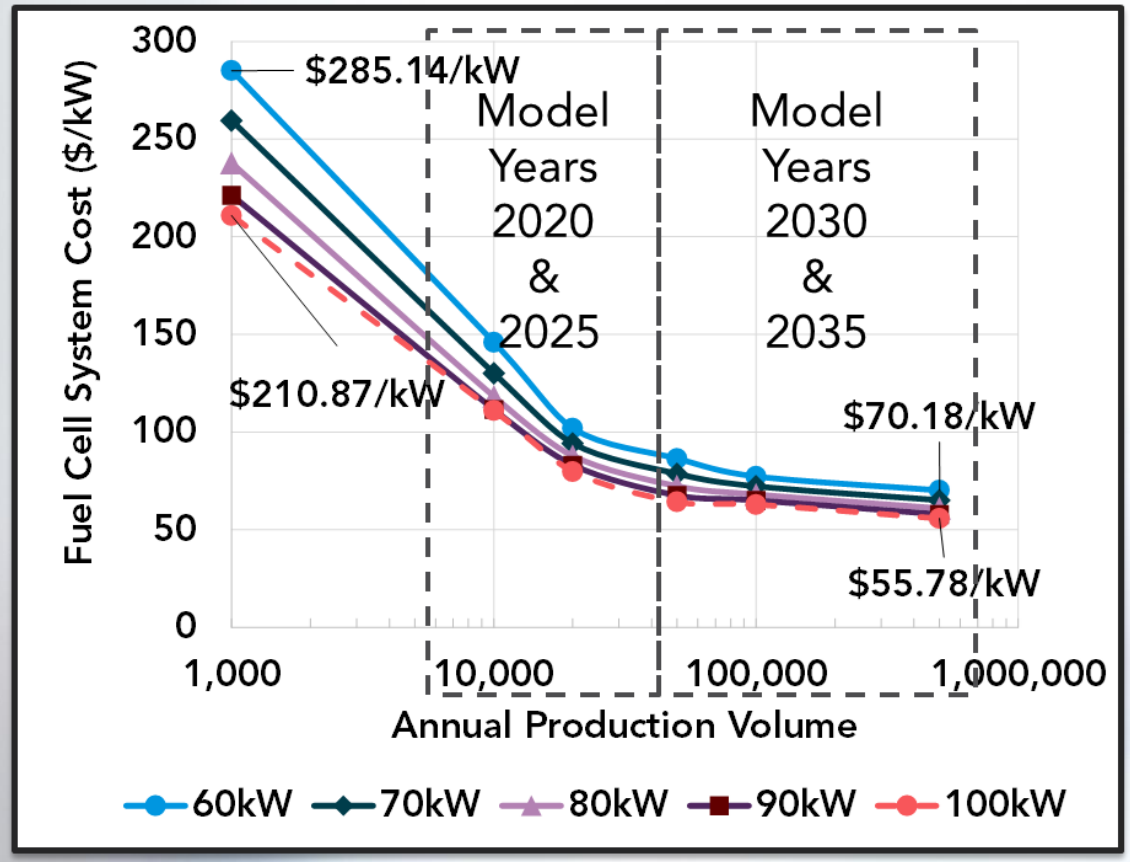
Non-Battery Component Cost Projections

- Method:
  - Near-term costs estimated from numerous teardowns and vehicle comparison reports
  - Additional 1% per year cost reduction projected for future years
- Example Cost:
  - 300-mile BEV Medium/Large SUV non-battery component costs start at ~$3,700 in 2026 and decrease to ~$3,300 in 2035

Non-Battery Components:

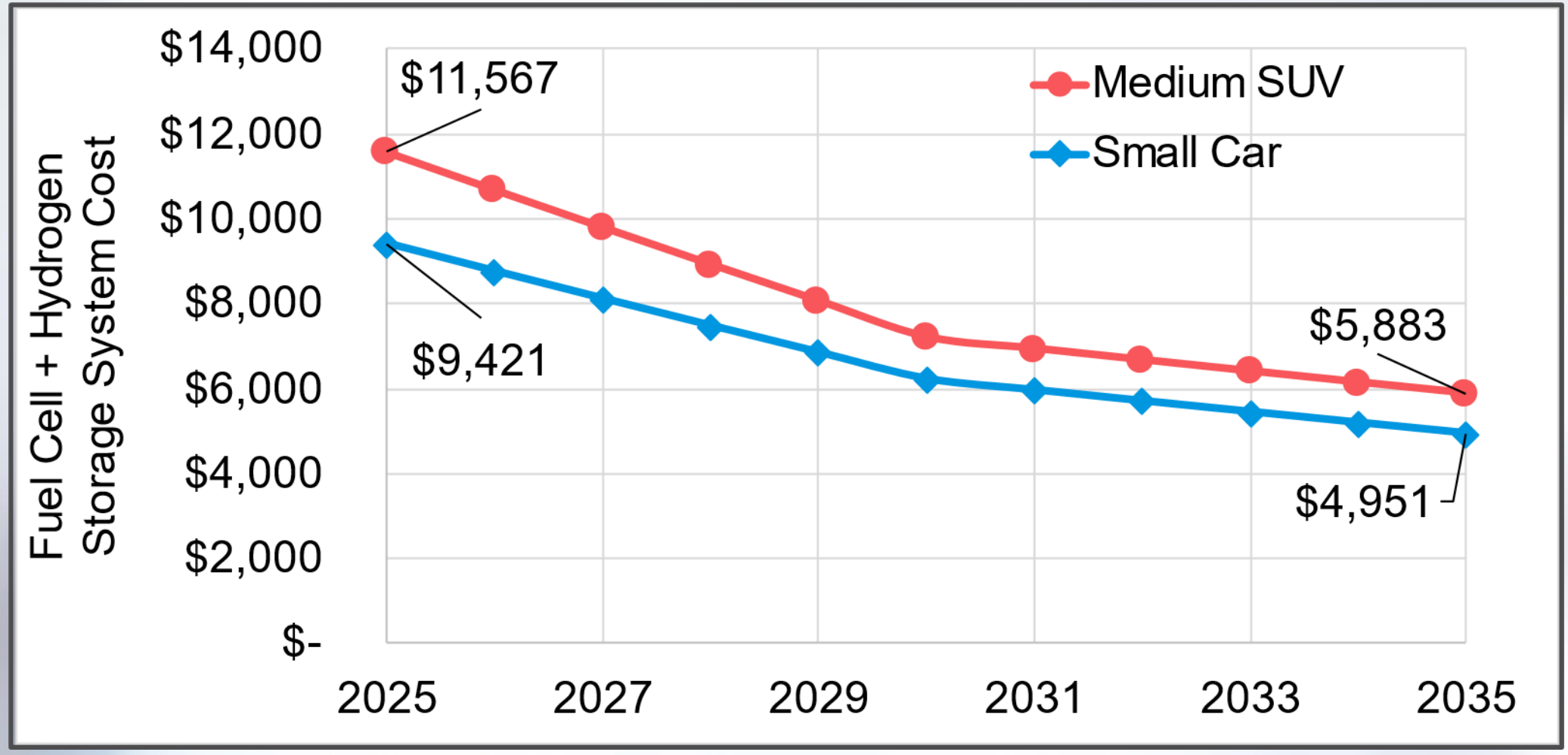
- Motor and gearbox
- Inverter
- DC-DC converter
- HV cabling
- HV control unit
- On-board charger
- Convenience cord

Fuel Cell and Hydrogen Storage Costs Projected to Fall with Technology Improvement and Manufacturing Scale



- US DOE funds evaluation of FCEV system costs
  - Strategic Analysis: Cost models of state-of-the-art technology at several production volumes
  - ANL: Cost estimates for future vehicles at high production volume with assumptions of future technology advancement
- CARB staff combined the data sources for ACC II evaluations

FCEV Cost Examples



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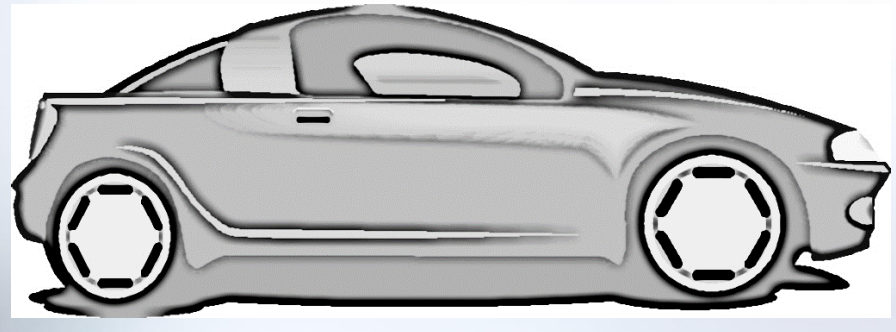
How to Get From Cost to Consumer Price

Add: ZEV Component Costs

Subtract: ICE Vehicle Component Costs



Incremental Direct Manufacturing Cost

X Retail Price Markup (1.5) = Incremental ZEV Price

**Total cost of operation (TCO) analysis not considered – no fuel, maintenance, other operational costs included

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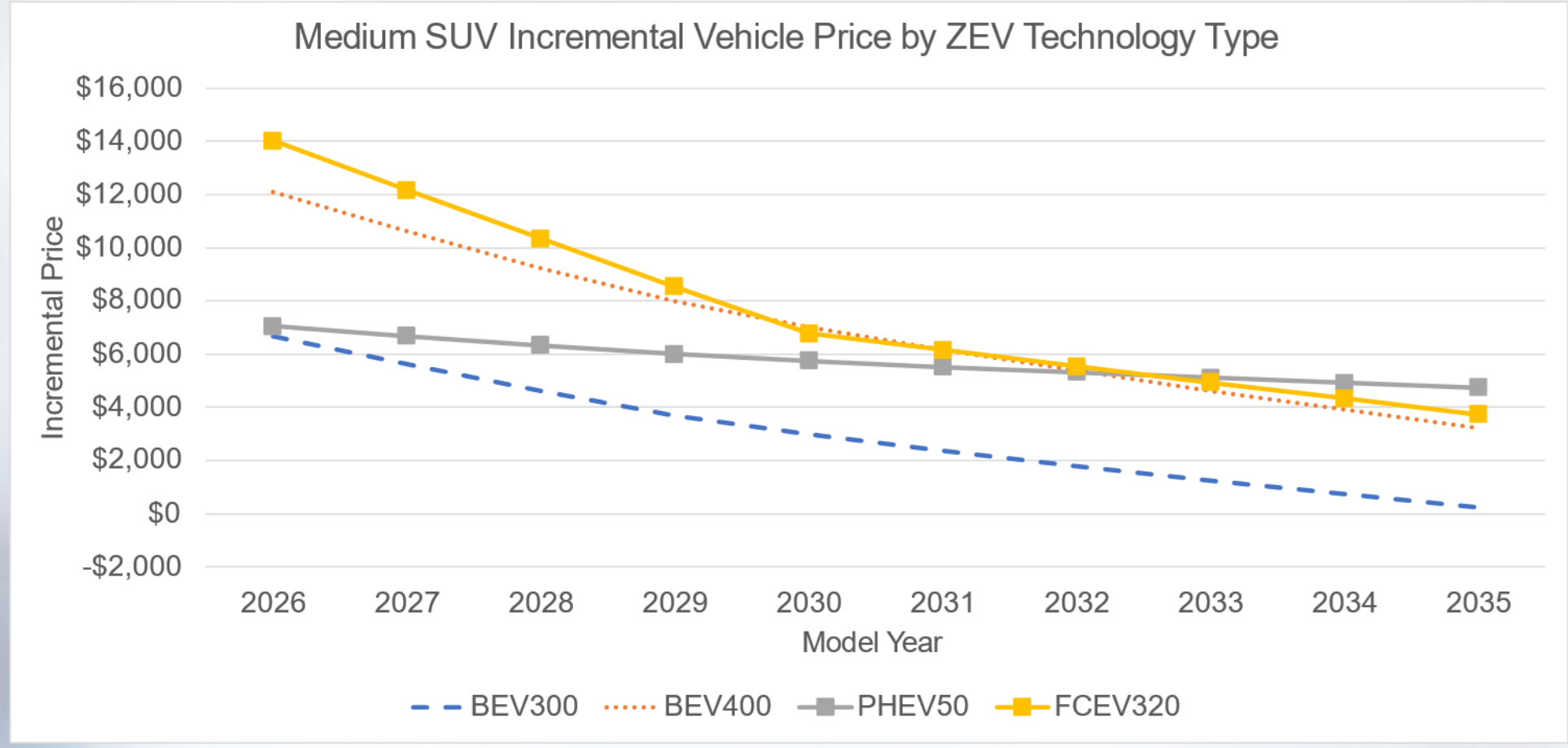
2026 Model Year Incremental Cost and Price for a Medium SUV

Cost Category	BEV 300	BEV 400	PHEV	FCEV
Battery Cost	$8,896	$12,460	$3,015	$1,614
Non-Battery Cost	$4,767	$5,310	$2,656	$2,728
Fuel Cell Stack & Tank Cost	$0	$0	$0	$13,916
Delete Costs	-$7,610	-$8,110	-$965	-$8,110
ZEV Assembly Cost Reductions	-$1,600	-$1,600	$0	-$800
Total Incremental Vehicle Cost	**$4,453**	**$8,060**	**$4,706**	**$9,348**
Retail Price Equivalent / Incremental Price (x1.5)	**$6,680**	**$12,090**	**$7,059**	**$14,022**

Fuel Cell Electric Vehicles Become Cost Competitive With Longer Range BEVs in 2033 – Both Are Cheaper Than PHEVs



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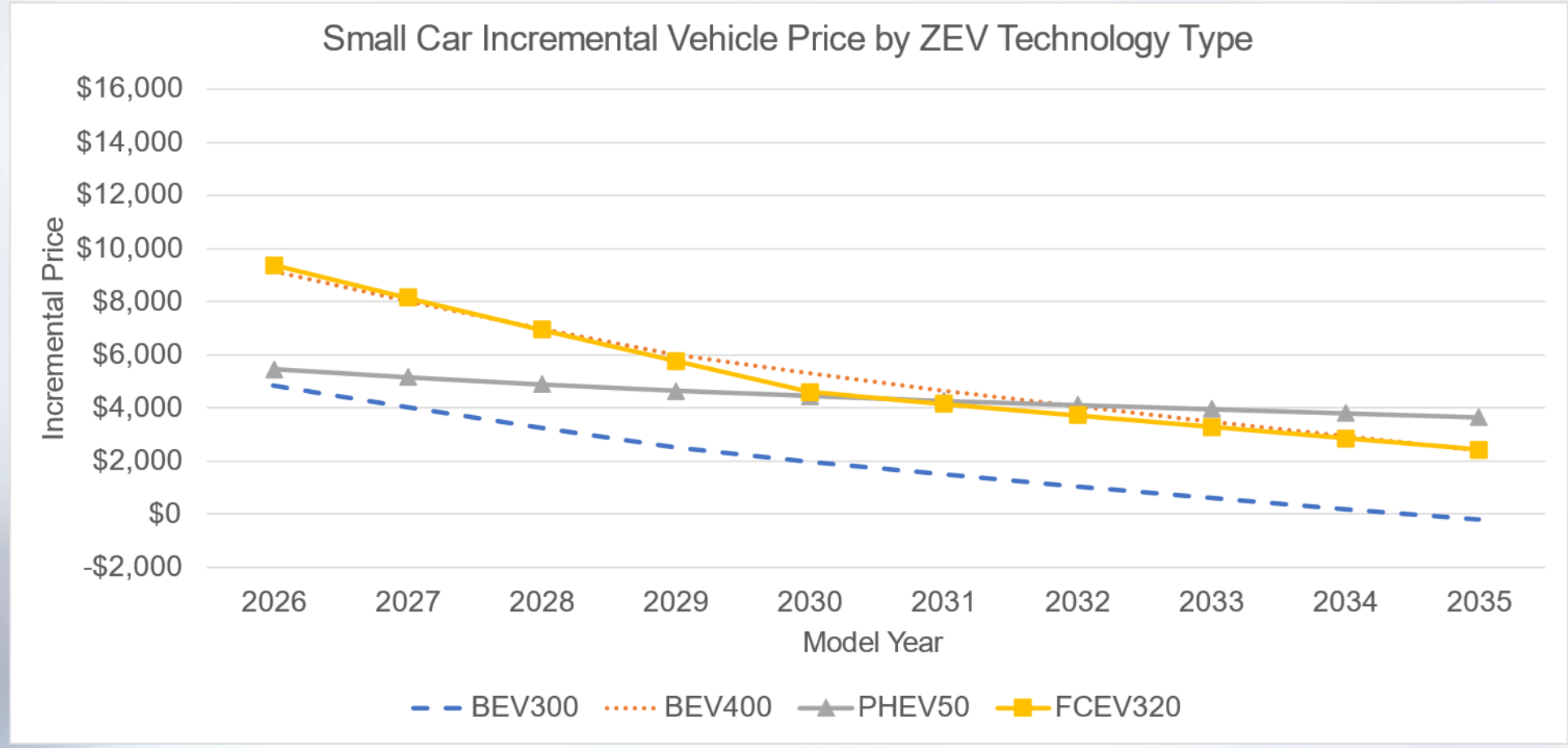
Small Car 300-mile BEVs See Price Parity With Conventional Cars in 2035



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Thank You!

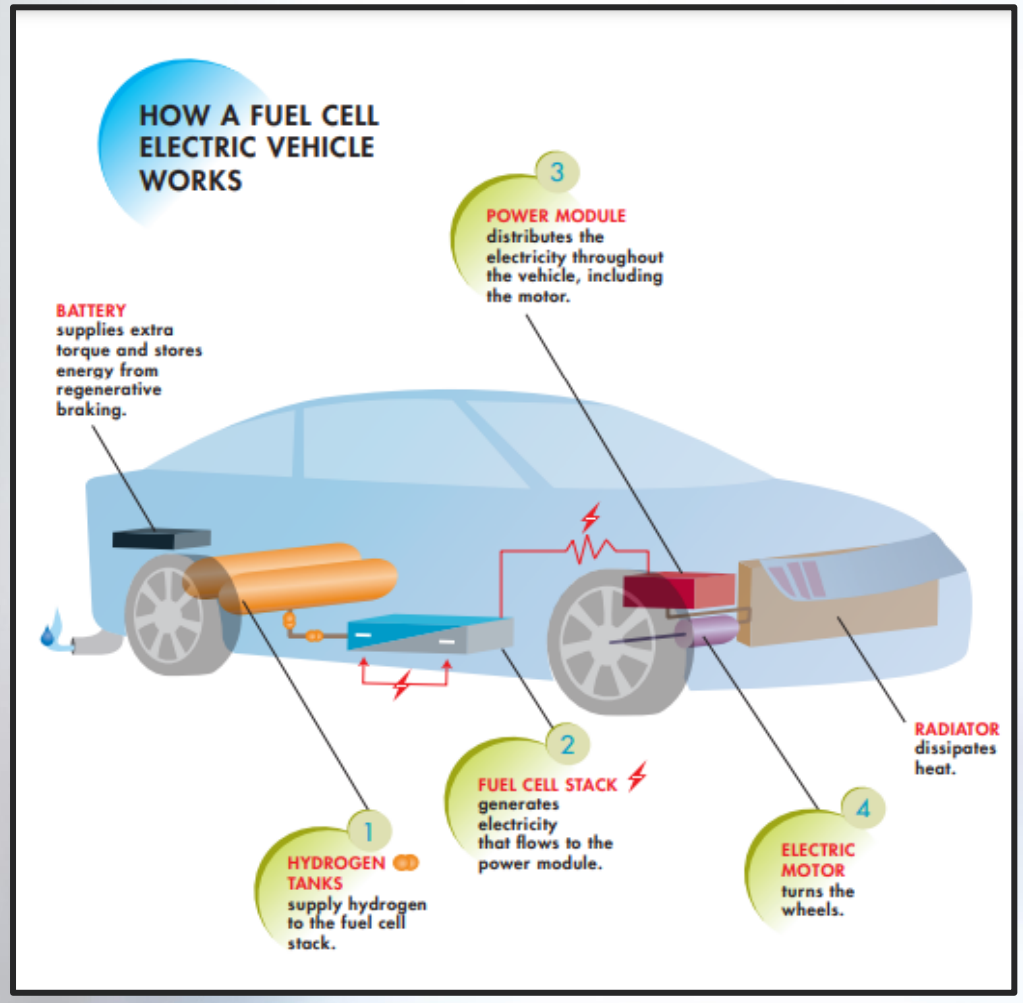
Advanced Clean Cars II

Advanced Clean Cars II SRIA

Advanced Clean Cars II ZEV Cost Workbook

Additional Material

Fuel Cell Electric Vehicle Overview



- FCEV systems have been in development for several decades
- Cost, durability, and performance continue to improve
- Durability and cost remain the largest challenges
- Costs still have substantial room for improvement with economies of scale