Energy+Environmental Economics

Transportation Electrification Cost-benefit Analysis

Washington Utilities and Transportation Commission

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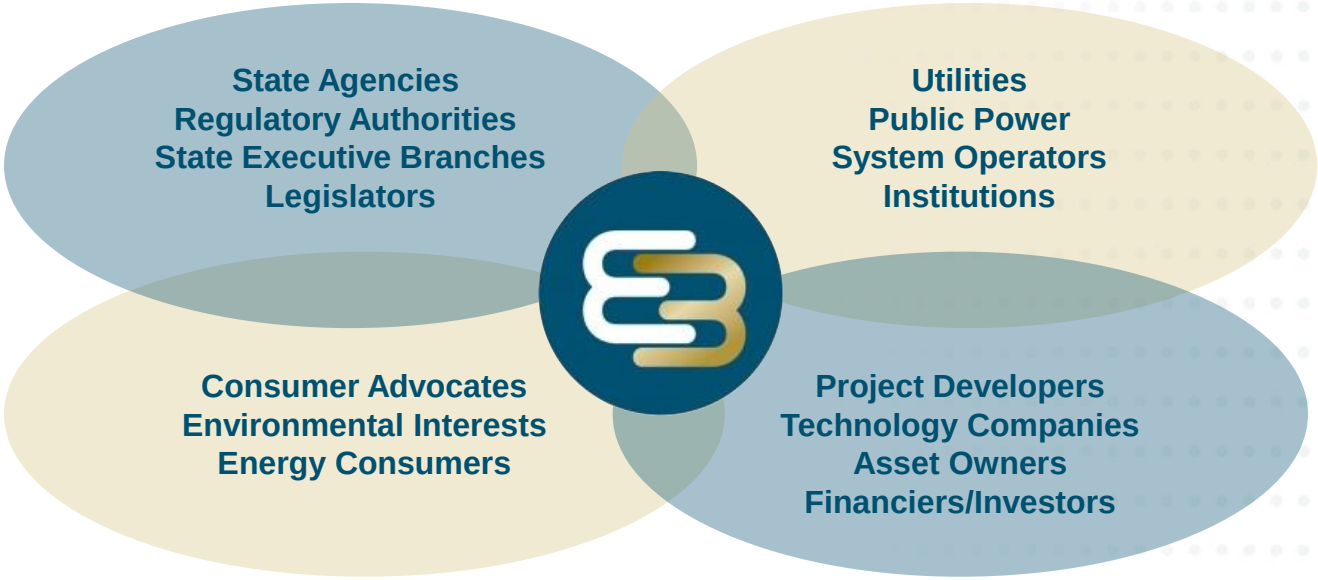
About Energy and Environmental Economics, Inc. (E3)

- Founded in 1989, E3 is an industry leading consultancy in North America with a growing international presence
- E3 operates at the nexus of energy, environment and economics
- Our team employs a unique combination of economic analysis, modeling acumen and deep institutional insight to solve complex problems for a diverse client base including critical thought leadership

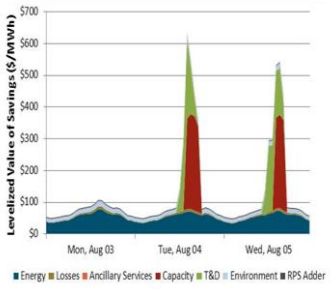


Disclaimer

- Several utilities in PNW have retained E3 to study benefits of transportation electrification (TE)
- Here to share pertinent information helpful for policy makers and stakeholders in WA
- Expressing considered opinions of Eric Cutter, not necessarily those of utilities or E3

Starting with distributed energy resources (DER) cost-benefit tests

- Established methods for calculating 'avoided costs'
- Established cost-benefit framework
- Emphasis on transparency and stakeholder process
- Utility role in bridging market gaps and barriers



	Gross Annual Energy Savings (kWh)
EE PORTFOLIO	5,215,741
Res Lighting	223,977
Res Pool Pump	341,066
Res Refrigeration	267,939

	BIP
Benefit/Cost Ratio	
TRC	3.15
PAC	2.40
RIM	2.39
PCT	1.33
Load Impacts (MW)	233
Energy Savings (MWh)	1,357

Avoided Cost → Program Impacts → Cost-effectiveness Results

DER Cost-benefit tests

Cost Test		Key Question	Applied to TE
Total Resource Cost	TRC	Will the total costs of energy in the region decrease?	Comparison of total monetized marginal costs and benefits from EV adoption
Societal Cost Test	SCT	Is society (state) better off as a whole?	Comparison of society's costs and benefits from EV adoption, including non-monetized costs and benefits
Ratepayer Impact Measure	RIM	Will utility rates increase?	Comparison of marginal revenues from EV load to marginal utility costs from serving EVs and EV programs
Participant Cost Test	PCT	Will EV owners benefit over the life of the vehicle?	Total equipment and operating cost of an EV vs. equivalent internal combustion engine (ICE) vehicle

EVs are the opposite of PV and EE

GHG & Emissions	↓	↓	↓
Total Energy Consumption	↓	↓	↓
Utility Infrastructure	↓ ↑	↓	↑
Retail Rates	↑	↑	↓

+ **PV and EE shift costs to other ratepayers**

+ **EVs can increase asset utilization → lower rates**

Total Resource Cost Test is primary test for DER

Benefits

- + Energy
- + Capacity
- + T&D
- + GHG
- + Losses
- + RPS Purchases

- + O&M Savings
- + Other Resource Benefits

Costs

- + Admin & Overhead Costs
- + EM&V

- + Equipment Costs
- + O&M Costs

Is EE, DR, DG in the Public Interest

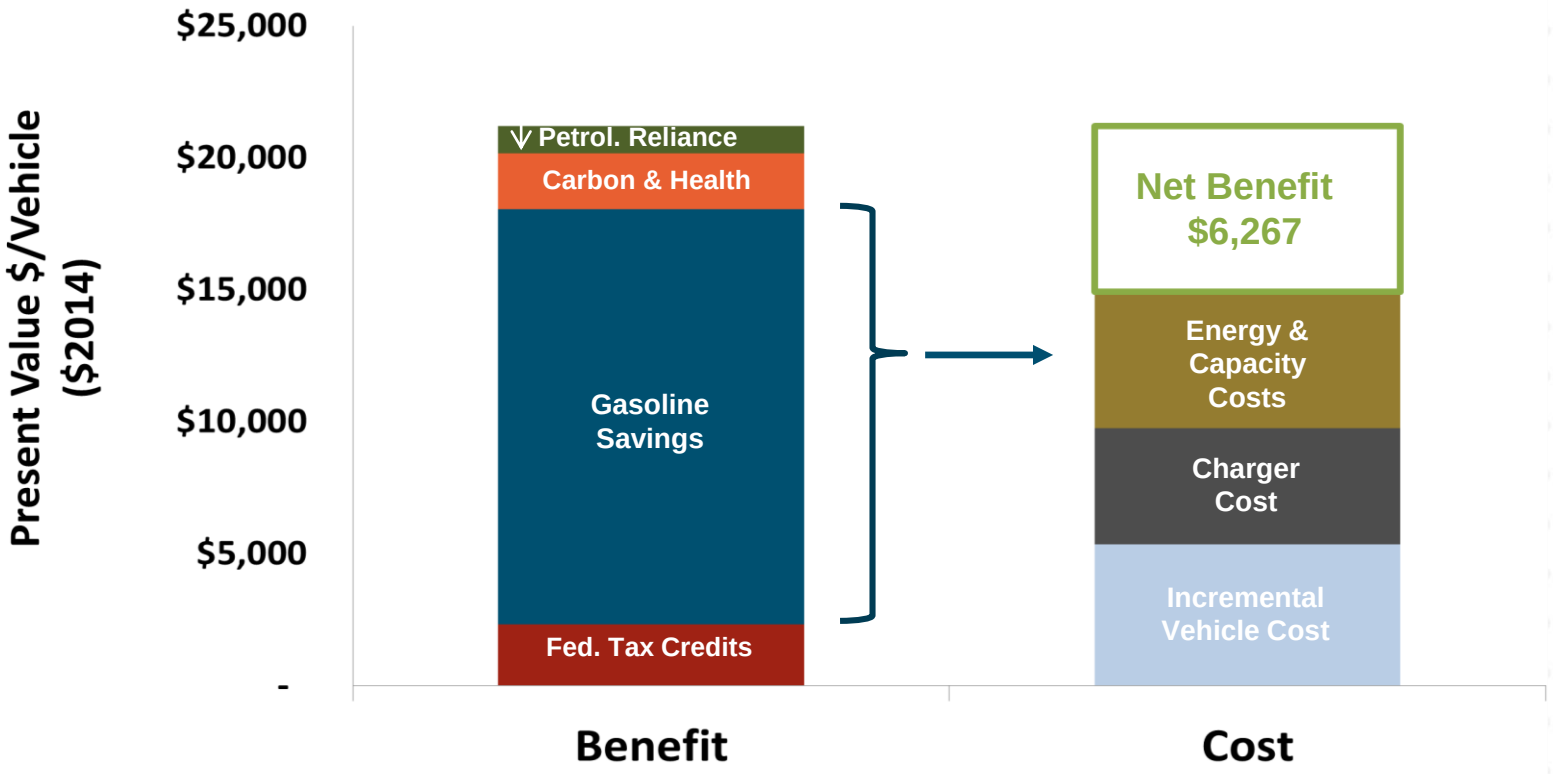
Are there benefits to region as a whole?

Doesn't consider who gains/loses

Transportation electrification is fundamentally energy efficiency

Net Societal Benefits from PEV Charging Load

Illustrative results for California Utilities



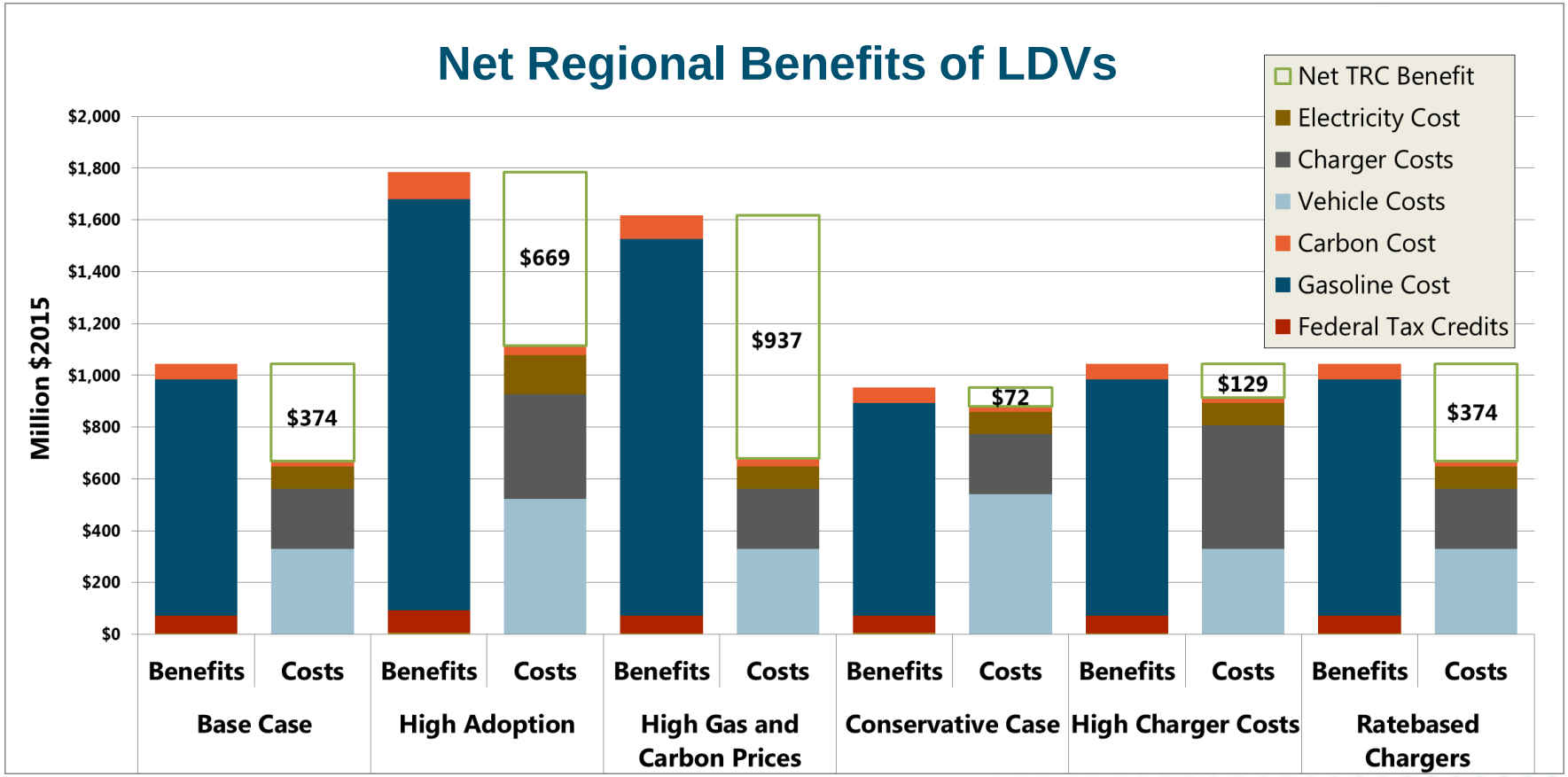
More efficient primary energy use with EVs

Expanding TRC to include gasoline and diesel

- **Natural extension of the TRC to include fuel savings in transportation sector**
  - TRC often expanded to include other resources like natural gas for electric only utilities or water in energy-water nexus
  - Combined perspective of Utilities and Transportation Commission and Department of Ecology
- **Who is the first purchaser of fuel that benefits from reduced consumption?**
  - Historically the utility for power generation
  - For transportation, it is the driver

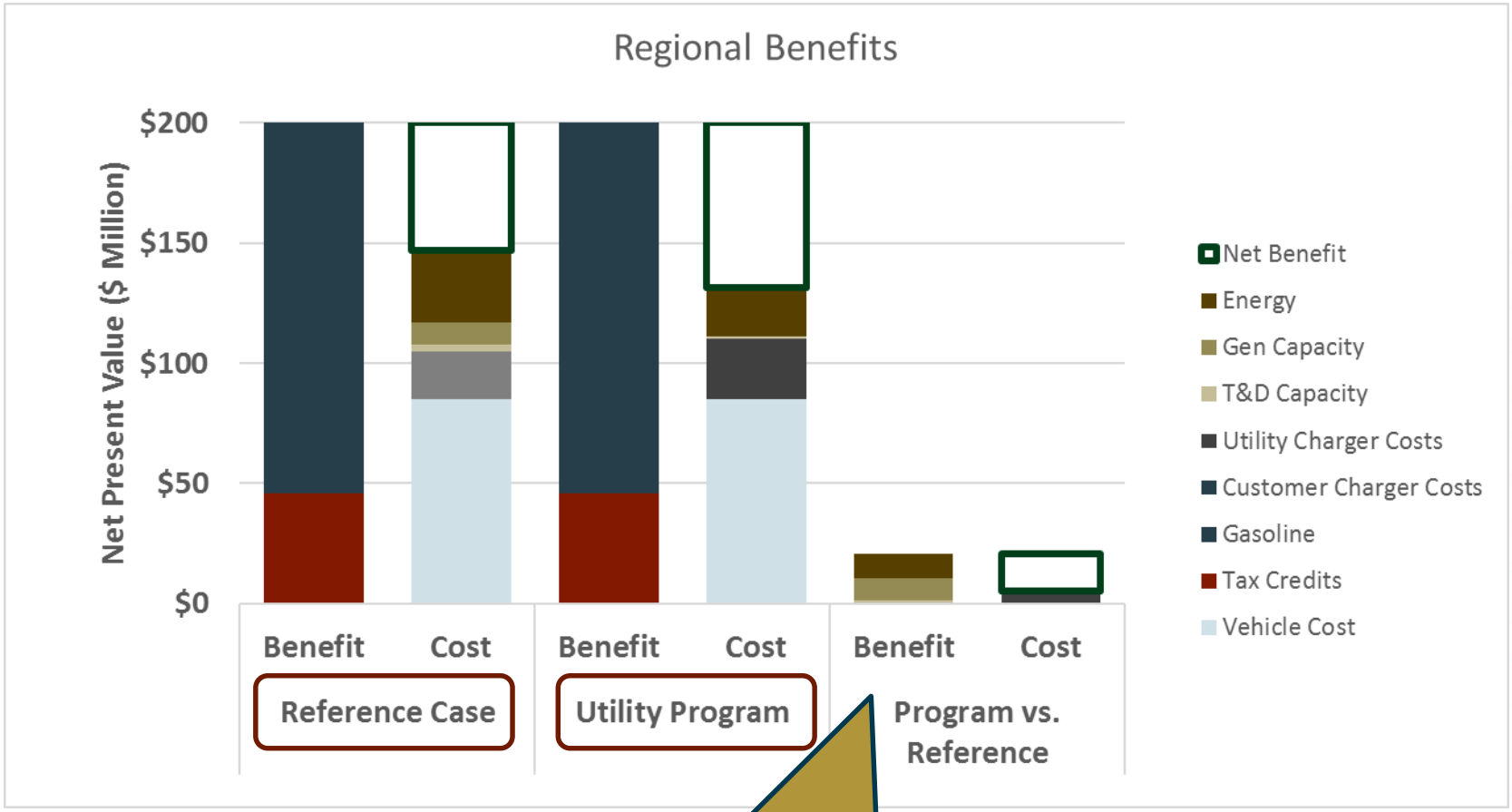
Is energy budget for region reduced?

Seattle City Light - net regional benefits of LDVs



Net regional benefits persistent across a range of scenarios

Benefits of electrification vs. benefits of utility program



Utility managed charging reduces capacity cost

A few thoughts on ratepayer impacts

- **Energy efficiency, distributed generation and demand response tend to increase rates**
- **Upfront investment for TE may increase rates in near-term, but decrease rates in long-term**
- **Inherent trade-off between ratepayer benefits and EV driver (participant) benefits**
- **Fundamentally two ways utility engagement increases ratepayer benefits:**
  - Reduce costs or increase adoption

Ratepayer impacts should be evaluated over long-term and in context of goals for EV adoption

KEY CHALLENGES FOR UTILITY SECTOR

Key policy challenges for utility engagement

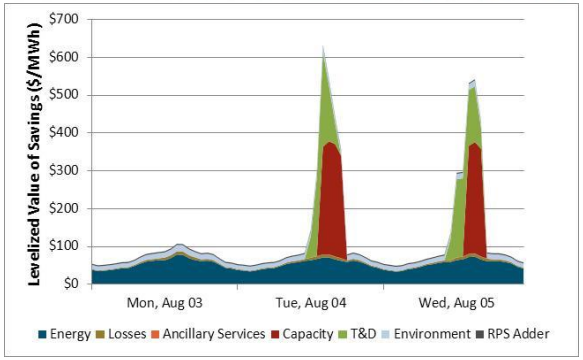
- Requires coordination across utility and transportation sectors
- Nascent market with many unknowns outside energy sector
- Risk of stranded assets if EV adoption is low or technology changes
- Hard to 'attribute' increase in adoption to specific actions

Cost benefit analysis answers some questions and informs others

- Is transportation electrification in the public interest?
- What will be the impact on utility rates?
- What are the key levers to minimize grid and customer costs?
- How much public and/or ratepayer funding needed to achieve EV adoption goals?
- What is best done by utilities vs. left to the competitive market?
- How to balance risk vs. reward?

Cost-effectiveness framework

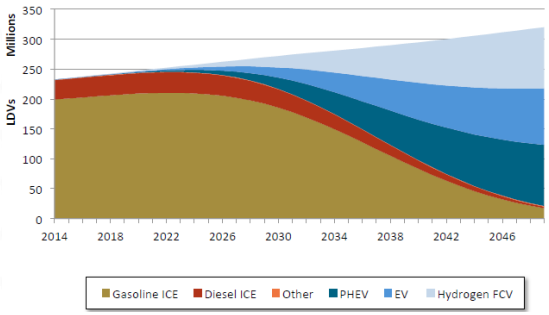
- **Reduce cost and emissions required to meet forecasted electricity demand with distributed energy resources**
- **Compare cost of delivered electricity to conventional resource plan (*$/kWh, $/kW-Yr*.)**
- **Evaluate marginal changes in energy sector**



Compare cost of marginal changes in energy sector against conventional resource plan

GHG Pathways Framework

- **Minimize costs to achieve GHG emission targets across energy, transportation and industrial sectors**
- **Compare cost of carbon reduction in transformational resource plans**
  - (*Hint: not just $/ton*)
- **Evaluate systemic changes across multiple sectors**



Compare cost of transformational changes across multiple sectors to reduce GHG emissions

In conclusion

- **DER Cost-benefit tests are a good starting point to answer some key questions and inform others**
- **Cost-benefit tests are naturally extended to include transportation sector**
- **Key differences for TE:**
  - Uncertainty in vehicle adoption and technology development
  - Difficult to attribute benefits to individual measures
- **TE benefits will (eventually) be best evaluated in utility integrated resource plans**
  - Including linkages to transportation sector and GHG pathways

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Thank You!

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Cost test definition: Electricity system factors

	Ratepayer Impact Measure	Participant Cost Test	Societal Cost Test	Total Resource Cost Test
Electricity Supply Costs				
Electric Energy Generation	–		–	–
Electric Energy Losses	–		–	–
Generation Capacity	–		–	–
T&D Capacity	–		–	–
Ancillary Services	–		–	–
RPS Compliance	–		–	–
Emissions Compliance	–		–	–
Societal Impacts				
Air Pollution Health Impact			–	
Electricity GHG Societal Impact			–	

Cost	Benefit
–	+

Cost test definition: Transportation system factors

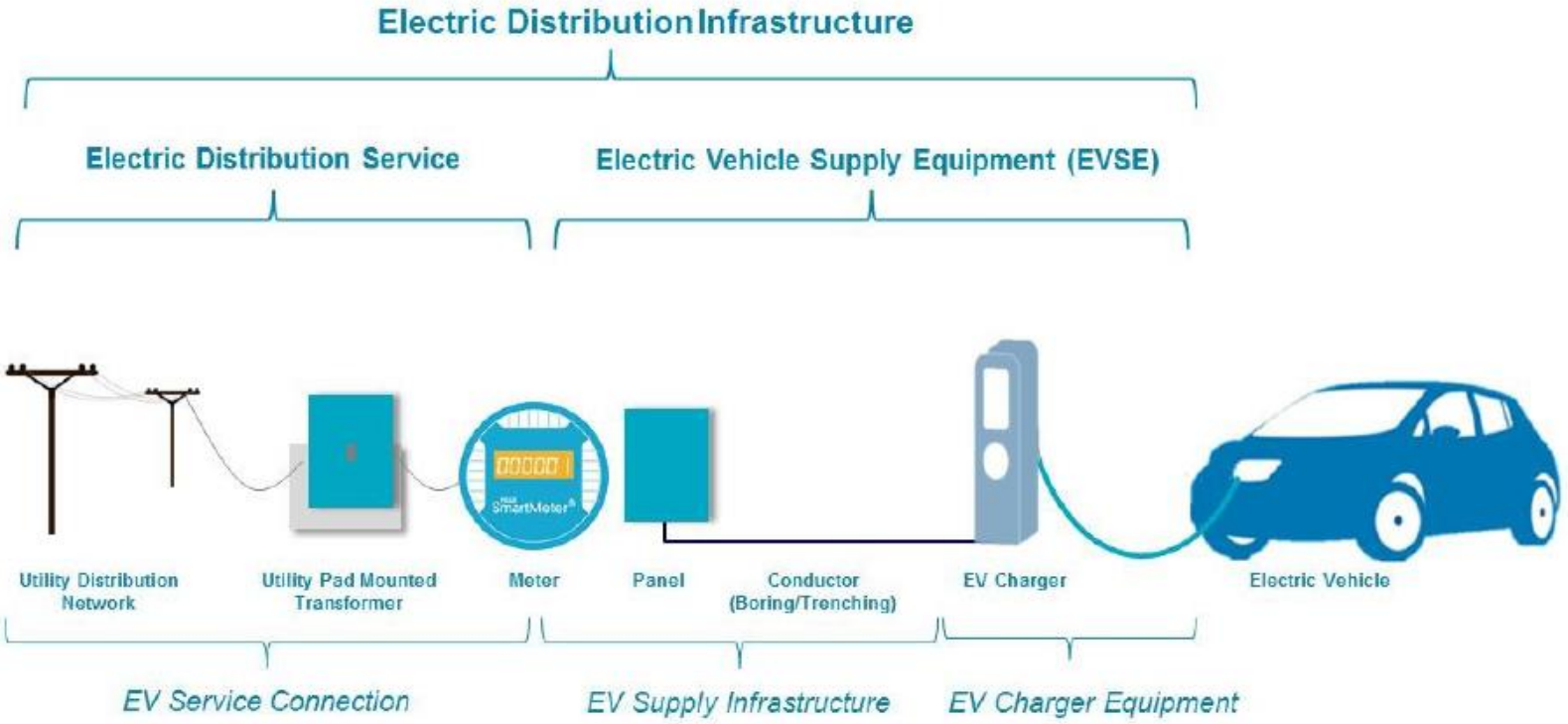
	Ratepayer Impact Measure	Participant Cost Test	Societal Cost Test	Total Resource Cost Test
PEV Ownership Costs and Benefits				
Incremental Vehicle Cost		–	–	–
Federal EV Incentives		+	+	+
State EV Incentives		+		
Transportation Fuel		+	+	+
Vehicle O&M		+	+	+
Charging Costs				
Personal Charging Equipment		–	–	–
Vehicle Charging Utility Bills	+	–		
Public Charging Infrastructure			–	–
Societal Impacts				
Reduced Oil Imports (Energy Independence Value)			+	
Gasoline GHG Societal Impact			+	
Air Pollution Health Impact			+	
Administrative Costs				
EV Program Administration	–		–	–

Cost	Benefit
–	+

How cost-effectiveness helps answer threshold questions

Covered by Cost-effectiveness	Beyond Cost-effectiveness
Net Benefits of transportation electrification across multiple scenarios	**Attribution**: How much will utility investment increase EV adoption
Incremental Benefits: of increasing EV adoption and managed charging	**Business Models**: what is best business model for deploying charging infrastructure
Key Drivers: Illustrate key drivers of EV benefits	**Rate Design:** Rate design or rate level that will maximize EV adoption or customer response for smart charging
Upside/Downside Risk: Cost to ratepayers if EV adoption is lower than expected	
Headroom: How much can utility spend without shifting costs to other ratepayers	
Gap Analysis: How much funding is needed to make EVs economic for customers	

California utilities envision different roles to support electrification



SDG&E	Smartphone app controls charging	Duplicates functions built into the car
PG&E	Utility owns L2 and fast chargers	Competes directly with EVSPs
SCE	Utility does make-readies & provides rebate for chargers	Enables competitive EVSP market

Source of diagram: PG&E application (A15-02-009), p. 4.