Mapping Costs and Benefits of Intelligent Charging Systems

Vehicle-Grid Integration Communications Protocol Working Group

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California Energy Commission

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Objectives and topics

• Overview macroeconomic net benefits of PEVs and smart charging

• Understand microeconomic decisions that build the supply of smart vehicles and charging infrastructure.
  • Lifecycle management approach and incremental costs
  • Stakeholder-categorized costs and benefits
  • Deliverable 2 skeleton and proposal for organizing

• Preface the OEM and EVSP experts’ presentations
  • Please hold questions until discussion
National Economic Value Assessment of PEVs

1. Market Growth → scale
2. Technology Progress → cost of PEVs & EVSE
3. Price of Gas

Aggressive
Medium Technology
Reference Oil

Low/High sensitivities range from -10% to +20% of Medium EVSE costs
per EERE 2015, CalETC 2014b, and NRC 2015 (NREL at p. 40)
PEVs yield net social benefits, even with costly tech and cheap gas.

<table>
<thead>
<tr>
<th>PEV</th>
<th>Baseline</th>
<th>Null</th>
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</thead>
<tbody>
<tr>
<td>Niche</td>
<td>$384</td>
<td></td>
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<tr>
<td>Breakthrough</td>
<td>$379</td>
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<tr>
<td>Aggressive</td>
<td>$362</td>
<td></td>
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<tr>
<td>High Cost</td>
<td>$262</td>
<td></td>
</tr>
<tr>
<td>Low Cost</td>
<td>$431</td>
<td></td>
</tr>
<tr>
<td>High Oil</td>
<td>$910</td>
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<tr>
<td>Low Oil</td>
<td>$107</td>
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</tbody>
</table>

*Figure ES-8. Breakdown of total costs and benefits in each scenario for 2035*
High-level electricity system highlights

• Demand from 73 million PEVs
  • Increases installed capacity <5% and generation <4%, primarily with RE
  • Electricity price increases 1.2 – 2.2%
  • Increased renewable penetration.

• Smart charging reduces system capacity and costs
  • 2.9% incremental system cost (Aggressive)
  • 2.7% incremental system cost (Aggressive w/ Smart charging)
  • More detailed simulations needed to understand smart charging + EV rates

• Cost of public charging is half the societal benefits in 2035
  • $6.2 B/y for supporting workplace and public charging – economic benefits
  • 14.1 B/y societal benefits per GHG and petroleum reductions

Collaborating for a distributed and smart charging infrastructure market.

CREATING NEW INFRASTRUCTURE

If successful, electric vehicles could make established energy delivery infrastructure and value chains obsolete. Vehicles will move away from centralized fueling points, such as gas stations, to a new, distributed and ideally smart electric-grid-based delivery system. This shift will inevitably open a service industry to handle customer recharging needs – with a new set of players and rules.

WHAT TO DO: COLLABORATE TO COMPETE

To accelerate the overall electrification trend once it gains critical mass, markets need legislative decisions that align across all forms of transportation, and ideally across borders in ways that reinforce each other. Strong lead markets could form the tipping point of a true electric vehicles disruption. At the same time, the willingness of carmakers and suppliers to work with competitors will limit their risk exposure while driving technology forward and costs down for the benefit of all participants.

-The Oliver Wyman Automotive Manager, 2017
Decisions of individuals and firms

DSO/LSE/CCA/ISO

VGI Aggregator

Non-Participants/Society

User

PEV OEM

Host

EVSE OEM & EVSP Operator
Key agents developing vehicles and or smart charging services
Application and Product Lifecycle Management (ALM/PLM)

Stage 1: Ideation
- Hardware requirements
- Software requirements

Stage 2: Design
- Hardware design
- Software development

Stage 3: Validation
- Hardware simulation
- Software unit test
- Hardware test plan
- Software test plan
- Integration build 1
- Integration build x
- Defects
- Defects
- Hardware changes
- Software changes

Stage 4: Production
- Release to manufacturing

Key: 
- ALM tools master
- PLM tools master

Source: Accenture analysis.
Note: This chart appears in "Maximizing the return on your billion-dollar R&D investment: Unified ALM-PLM," an Outlook Point of View from November 2013, an Accenture publication. Copyright 2013 Accenture. All rights reserved.
What is the **incremental cost** to develop a standards-based smart charging system?

- **Integrated circuit**: chipsets, modem, radios, powerline communication, memory, processor
- **Vehicle and/or equipment-based charge controller**
- **Requirements to implement a protocol(s)**
- **Use of open source or programming original code**
- **Conformance and interoperation testing and certification**
- **Ordering, supplier tooling, manufacturing, per-unit pricing**

*What are the reasonable counterfactual (“base cost”) assumptions for the market?*
Stakeholder costs can yield private and social benefits

Public investment in R&D, customer rate-base

DSO/ LSE/ CCA/ ISO

DSO/ LSE/ CCA/ ISO

Billin and settlement system upgrades, EVSE investments

Software development, customer acquisition

Ratepayer or Society

Software development, customer acquisition

VGI Aggregator

Delightful customer experiences, decreased costs, simplicity, increased sustainability

Lower air pollution and GHG, economic growth, market efficiency

Advanced rate enrollments, avoided upgrades, increased load factor & renewables use, flexibility services

Eased enrollments, measurement & verification, faster settlements, increased revenue

Lower energy costs, higher asset utilization, increased charging carrying capacity, attracted tenants & retained employees, value added services

Higher sales, interoperability, scale economies, efficient investments

Delightful customer experiences, decreased costs, simplicity, increased sustainability

Public investment in R&D, customer rate-base

Billing and settlement system upgrades, EVSE investments

Software development, customer acquisition

Smart charging systems ($/EV, $/EVSE or $/year,...)

Ratepayer or Society

VGI Aggregator

Host

User

PEV OEM

EVSE OEM

EVSP or Operator
Achieving benefits for California relies on PEV charging data

Data should be

• Accountable
• Specific
• Verifiable
• Fungible
• Secure

Other non-policy uses for this data will exist!

<table>
<thead>
<tr>
<th>Select Agency ZEV Activities</th>
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<tbody>
<tr>
<td>Reliable operation of the grid by <strong>scheduling PEV demand</strong></td>
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<td>Locating electric vehicle <strong>charging stations</strong></td>
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<td>Open, <strong>authenticated access</strong> to public charging sessions</td>
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<td><strong>Charge control</strong> per Time-Of-Use or Dynamic rates</td>
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<td>Provision and settlement of <strong>grid ancillary services</strong> as DERs</td>
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<tr>
<td>Accurate <strong>receipt of commercial sale</strong> of electric fuel</td>
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<td><strong>Monitoring traffic</strong> flows/congestion, road capacity, and tolling</td>
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<tr>
<td>Validating <strong>Credit Generation</strong> for Low Carbon Fuel Standard</td>
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<td><strong>Analyzing utilization and maintenance</strong> of deployed networks</td>
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<td>Improving load and generation <strong>forecasting and grid planning</strong></td>
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<td><strong>Allocating construction</strong> costs to drivers proportionate to use</td>
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<tr>
<td>Target future <strong>strategic investments</strong> in charging networks</td>
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<tr>
<td>Track <strong>deployment, petroleum &amp; emissions reduction goals</strong></td>
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<tr>
<td>Meet energy efficiency and <strong>fleet procurement</strong> targets</td>
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Revised per CEC/CPUC December 7, 2016 Vehicle-Grid Integration Communications Standards Workshop
Identify opportunity costs and risks

- What benefits are accrued with certain information and what is foregone without it?
  - How is adoption enabled or hindered?
  - What will encourage private investment?
  - What future use cases are stifled without intelligence?

- What are the implementation costs if levelized over “widespread” scale?
  - Sensitivity to thousands of units? Millions?

- How can the efficiencies of an international automotive market be leveraged?

- What advanced technologies are concerning? How do risk tolerances differ among stakeholders?
# Deliverable 2 example and proposal


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<thead>
<tr>
<th>Stakeholder</th>
<th>Costs</th>
<th>Inc/Dec Factors</th>
<th>Benefits</th>
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<tbody>
<tr>
<td>User</td>
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2. Repeat for [Comm. Protocol 1-X], or alternative, for Use Cases [1 – X]

3. Juxtapose use case implementations, delineate opportunity costs

- **Subgroups?**
- **Divide and Conquer:**
  - Type of implementation: Comm. Protocol, alternative, or null *(Suggested)*
  - **Use Cases**
  - **Costs**
  - **Benefits**
Bridging a gap to transformative investments

- Supplier decision-making to develop smart charging systems
  - Automotive Original Equipment Manufacturer
  - EV Service Provider/ EVSE Operator
  - EVSE Manufacturer
  - VGI Resource Aggregator
- Automotive and charging service competitors can cooperate during the nascent phases of the market to minimize their exposure to risk, advance technology, and reduce costs needed for electrification’s success.
  - Legislative decisions, aligned and reinforced, across borders
  - Economies of scale
  - Increase supply chain efficiencies
  - Commoditize communications technologies and charge controllers
  - Compete on delivery of differentiated services and benefits
Feedback sought after presenters…

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