Electric vehicle infrastructure – A new mindset

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Electric vehicle infrastructure – A new mindset?
Electric vehicle (EV) adoption is driven by vehicle economics and the availability of charging infrastructure

**Vehicle Economics**
- **Cost of Ownership**
  - Most consumers evaluate three-year EV total cost of ownership (TCO) parity with conventional internal combustion engines (ICE)
  - TCO parity without incentives will likely be the tipping point for large BEV/PHEV\(^1\) adoption
- **Regulation**
  - Regulations impact economics to an extent (e.g., fuel economy standards, EV incentives, ICE bans)
  - Historically, headline-grabbing regulations (e.g., ICE bans) get watered down as deadlines approach
  - Given TCO parity and sufficient infrastructure availability, regulations can be implemented quickly to accelerate EV adoption
- **Consumer Behavior**
  - Changes in demand patterns and consumer preferences will likely continue to shape TCO economics
  - EV range/range anxiety, familiarity with charging providers and their networks, and access to more ‘away-from-home’ charging use cases will likely each impact EV adoption
- **Charging Infrastructure**
  - Availability of EV charging infrastructure decreases consumer range anxiety
  - Charger speed, utilization, and capital investment requirements dictate which charging use cases (e.g., public highway, work charging) are economical

\(^1\) BEV = Battery electric vehicle, PHEV = Plug-in Hybrid Electric Vehicles
Once TCO parity is reached, EVs could become up to 65% of new vehicle market share

Global EV penetration

Powertrain Electrification Summary

- Driven by tightening regulations and incentives
- Limited to niche vehicles and early adopters
- Driven by TCO and investment needs
- Broader pace of electrification driven by customer adoption rate

When 3-year TCO reaches incentive-free parity, we anticipate accelerated BEV adoption

Discussion

- The US ICE/BEV tipping point (i.e., TCO parity) could occur by 2024 - 2026
- US will have 12%-15% EV penetration of new vehicles by 2030...
- ...while there will be significantly higher penetration in EU and China in that timeframe
- In the US, auto OEMs are introducing over 70 EV nameplates by 2027

Notes: Global penetration calculated using China EU and U.S. EV penetration; 3-year total cost of ownership; Incentives phase out in 2020+
Source: Battery expert Interviews, Strategy& analysis
External estimates suggest significant EV infrastructure investment is needed just to meet 2025 projections.
Charging infrastructure technology trades off charge time, power/Range, and cost

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<table>
<thead>
<tr>
<th>Use Cases</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3(^1)</th>
<th>Level 4(^1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overnight charging</td>
<td>120 Volts-AC</td>
<td>200-240 Volts-AC</td>
<td>200-500 Volts-DC</td>
<td>480+ Volts-DC</td>
</tr>
<tr>
<td>At work, overnight</td>
<td>~20 hours</td>
<td>~5-6 hours</td>
<td>~30 minutes</td>
<td>~20 mins</td>
</tr>
<tr>
<td>~20 hours</td>
<td>~5-6 hours</td>
<td>~30 minutes</td>
<td>~20 mins</td>
<td></td>
</tr>
<tr>
<td>~5 miles</td>
<td>~25 miles</td>
<td>~100+ miles</td>
<td>100+ miles</td>
<td></td>
</tr>
<tr>
<td>NEMA 5-15 (Standard electrical outlet)</td>
<td>SAE J1772 (i.e., 'J-Plug')</td>
<td>SAE J1772 Combo (CCS – Combo Charging System), CHAdeMO(^4)</td>
<td>Dual SAE J1772 Combo CCS1, single CHAdeMO, single SAE J1772 Combo CCS1</td>
<td></td>
</tr>
<tr>
<td>No investment needed</td>
<td>$2,000 - $7,500</td>
<td>~$75,000</td>
<td>~$125,000</td>
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</tr>
<tr>
<td>~$4000</td>
<td>~$13,000</td>
<td>~$28,000</td>
<td></td>
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</tbody>
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1) Not all vehicles are compatible with Level 3 or 4 charging; 2) Estimated charging time for an example BEV from empty to full; 3) Excludes some suppliers that makes adapters to fit either SAE or CHAdeMO plugs; 4) CHAdeMO stands for ‘Charge de Move’, or move using charge; 5) Includes est. cost of EVSE hardware, site preparation, interconnection, etc.

Sources: Utility Dive, NREL, Idaho National Laboratory, Semaconnect, ClipperCreek, Charge Hub, Strategy\& analysis

-80% of the charging
EV charging stations may reach minimum efficient scale at 4-6 charger points across all level types.

Capital expenditures per charger by level and station format ($ per charger)

**Level 2 - Capex per Charger**

![Graph showing capital expenditures per charger for Level 2]

Capex / Charger @ 6 Chargers per Station = ~$6,000  
Capex / KW = ~$1,200

**Level 3 - Capex per Charger**

![Graph showing capital expenditures per charger for Level 3]

Capex / Charger @ 6 Chargers per Station = ~$49,000  
Capex / KW = ~$600

**Level 4 - Capex per Charger**

![Graph showing capital expenditures per charger for Level 4]

Capex / Charger @ 6 Chargers per Station = ~$96,000  
Capex / KW = ~$800

Sources: International Council of Clean Transportation, EV expert interviews, Strategy& analysis
Expected utilization will likely be the critical factor in breakeven pricing for positive charging economics.

Charging Economics: Breakeven Price by Charger Type

4 Charger Configuration for Various Utilization Levels

- **Level 2**: Expected utilization range of L3 and L4 chargers
- **Level 3**: Expected utilization range of L2 chargers

**Typical breakeven price (cents/kWh)**
- L2 - $0.44
- L3 - $0.49
- L4 - $0.59
- Home - $0.16

Sources: International Council of Clean Transportation, EV expert interviews, Strategy& analysis

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1) All-in breakeven price is selling price requested to earn a 10% return on capital invested with a wholesale power cost of $0.16 per Kwh.
A broad range of players are investing in EV infrastructure using a variety of approaches
EV infrastructure business models are taking shape from a variety of public or private partnerships

### Example EVSE Business Models

<table>
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<tr>
<th>Model Type</th>
<th>Description</th>
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| **Standalone (Own and Operate)**    | • EVSE company provides charging infrastructure and services  
                                | • Costs are passed to consumers in charging rates                                                                                           |
| **Retail Host – Owned Channels**    | • Retail host utilizing EV charging to promote increased foot traffic  
                                | • Subsidize EVSE investment and monetize investment via other means                                                                              |
| **Auto OEM Subsidization**          | • Auto OEMs help finance EVSE investment CAPEX  
                                | • Price of EV infrastructure recovered in EV car sales price                                                                                 |
| **Utility Partnership**             | • Incentivize EV adoption and EVSE charging infrastructure deployment  
                                | • Potential to pass investment costs to customers via regulated rates                                                                       |
| **Government Run**                  | • Subsidize EVSE investment with tax dollars or government debt  
                                | • Useful for segments that would not otherwise attract investment                                                                             |

**Electric vehicle infrastructure – A new mindset**

**Strategy**
Panel discussion
Thank you