EV Workplace Charging
Power Demand ... the hidden secret

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Workplace Charging Considerations

• Charging rate required for employees

• First cost of equipment

• Fee or non-fee based

• Impact on building energy/demand
EV Chargers

Electrical Ratings

• AC Level 1: 120 VAC, 1.9 kW
  Typically 1.3 kW

• AC Level 2: 240 VAC, 19.2 kW
  Typically 6 kW
EV Chargers

Electrical Ratings

• DC Level 1: 500 VDC, 40 kW
• DC Level 2: 500 VDC, 100 kW

CHAdeMO
Kia, Nissan, Mitsubishi, Subaru, Toyota

SAE Combo
Audi, BMW, Chrysler, Daimler, Ford, GM, Porsche, Volkswagen
# Equipment Costs

<table>
<thead>
<tr>
<th>Charger</th>
<th>Average Capitol Cost¹</th>
<th>Recurring Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Payment</td>
<td>Equipment</td>
</tr>
<tr>
<td>AC Level 1</td>
<td>No-fee</td>
<td>$150</td>
</tr>
<tr>
<td>AC Level 2</td>
<td>No-fee</td>
<td>$725</td>
</tr>
<tr>
<td></td>
<td>Fee-based</td>
<td>$2,125</td>
</tr>
<tr>
<td>DC Level 2</td>
<td>Fee-based</td>
<td>$23,500</td>
</tr>
</tbody>
</table>

¹ Agenbroad, J., Holland, B., “Pulling Back the Veil on EV Charging Station Cost”, Rocky Mountain Institute, April 2014.

² Includes permitting
# Operating Costs

<table>
<thead>
<tr>
<th>Charger</th>
<th>Recurring Costs</th>
<th>Energy (sessions)</th>
<th>Demand¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Level 1</td>
<td></td>
<td>$300² (250)</td>
<td>$0</td>
</tr>
<tr>
<td>(1 EV)</td>
<td></td>
<td></td>
<td>$300 /EV/yr</td>
</tr>
<tr>
<td>AC Level 2</td>
<td></td>
<td>$810³ (1,350)</td>
<td>$792</td>
</tr>
<tr>
<td>(5.4 EV’s)</td>
<td></td>
<td></td>
<td>$297 /EV/yr</td>
</tr>
<tr>
<td>DC Level 2</td>
<td></td>
<td>$4,320⁴ (7,200)</td>
<td>$5,016</td>
</tr>
<tr>
<td>(28.8 EV’s)</td>
<td></td>
<td></td>
<td>$324 /EV/yr</td>
</tr>
</tbody>
</table>

¹ AC Level 2: 6 kW, DC Level 2: 32 kW avg., $11/kW, 12 months/year (MI: $22/kW)
² 35 mi, 3.5 mi/kWh, $0.12/kWh, $0/kW (residential or non-demand electric rate)
³ 1.67 hours @ 6 kW, 5.4 times per day 5 days/week, 50 weeks, $0.06/kWh (commercial electric rate)
⁴ 0.3125 hours @ 38 kW avg., 28.8 times per day, 5 days/week, 50 weeks, $0.06/kWh (commercial)
### Operating Costs

<table>
<thead>
<tr>
<th>Charger</th>
<th>AC Level 1 (1 EV)</th>
<th>AC Level 2 (1 EV)</th>
<th>DC Level 2 (1 EV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(10 kWh’s/day)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Recurring Costs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy (sessions)</strong></td>
<td>$300² (250)</td>
<td>$150³ (250)</td>
<td>$150⁴ (250)</td>
</tr>
<tr>
<td><strong>Demand¹</strong></td>
<td>$0</td>
<td>$792</td>
<td>$2,904</td>
</tr>
<tr>
<td><strong>Demand</strong></td>
<td>$300 /EV/yr</td>
<td>$942 /EV/yr</td>
<td>$3,054 /EV/yr</td>
</tr>
</tbody>
</table>

1. AC Level 2: 6 kW, DC Level 2: 32 kW avg., $11/kW, 12 months/year (MI: $22/kW)
2. 35 mi, 3.5 mi/kWh, $0.12/kWh, $0/kW (residential or non-demand electric rate)
3. 1.67 hours @ 6 kW, 1 times per day 5 days/week, 50 weeks, $0.06/kWh (commercial electric rate)
4. 0.3125 hours @ 22 kW avg., 1 time per day, 5 days/week, 50 weeks, $0.06/kWh (commercial)
Charger Selection

What type of charger is appropriate for workplace charging?

- **Fast**: DC Level 2, 400 VDC
- **Moderate**: AC Level 2, 208 VAC
- **Slow**: AC Level 1

AC Level 1 - slow: 9 hours ≈ 30 miles
EV Workplace Charging
Power Demand … the hidden secret

• Impact on Building Electrical Demand

• Demand Limiting Strategies

Illustrated by case study
FSEC Building Information

- 70,000 ft²
- 200 tons chiller capacity
- 90 employees
- 2 workplace chargers (12 kW)
- 2 public Level 2 (12 kW)
- 1 public DC Fast charger (45 kW)
- 5 ½ PEV’s (5 Leaf, 1 Volt)
Building Demand Impact Example

Monthly Peak Demand: February 24, 2015

- 30.2 kW
- 23.4 kW

16.1 kWh's $2.42 revenue

Monthly Peak Demand: March 5, 2015
Charger Impact on Utility Cost

<table>
<thead>
<tr>
<th>Charger Type</th>
<th>Energy</th>
<th>Demand</th>
<th>Total</th>
<th>Revenue (session)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>kWh</td>
<td>kW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC Fast</td>
<td>3,129</td>
<td>30</td>
<td>$475</td>
<td>$407</td>
</tr>
<tr>
<td>Public Lev 2</td>
<td>2,368</td>
<td>8</td>
<td>$205</td>
<td>$424</td>
</tr>
<tr>
<td>Employee Lev 2</td>
<td>7,235</td>
<td>36</td>
<td>$746</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>12,732</td>
<td>74</td>
<td>$1,426</td>
<td>$831</td>
</tr>
</tbody>
</table>

Normal Building Operation:
- 370 kW summer peak
- 1,500 MWh/yr
- $10,000/mo. electric
Controllable Workplace Chargers

Pulses

June 16, 2016

DC Fast Charger

Control Signal

Running Monthly Demand

Electrical Use

30-min Average

Workplace Chargers

Turn off workplace chargers when building nears peak
Demand Limiting Strategies

- Scheduling (passive)
- Turn off at peak (active)
- Chiller plant capacity reduction
- Auxilliary power interrupt
- EV as storage medium (V2G)
EVs in the Future – World Sales
Plug-in Light Vehicles

Annual Sales

- China
- Canada
- Western Europe
- Japan
- United States

Current Research Activities
FSEC Facilities Resource Study

- Monitor Utility Electric Meter
- Workplace Charging Stations
- Battery Storage
- Server Software
- Public DC Fast Charging Station

★ = Facility Resource
Current Research Activities

FSEC Charging Station

- Charging Technologies
- Electric Grid Integration
- Environmental Effects
- Transportation Planning
Current Research Activities
FSEC EV Laboratory

• Charge vs Discharge
• V2G Applications
• Charging Optimization
• Electrical Demand
Current Research Activities

FSEC EV Laboratory - Wireless Charging
Current Research Activities

Florida Turnpike Charging Station Optimization Study

• Infrastructure requirements
• Queueing models
• Siting
Thank You

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