A Discussion on Electric Vehicle Charging

Rob Stewart
Mgr Advanced Technology and New Business, Pepco Holdings, Inc
Pepco Holdings, Inc.
3 states and Washington DC in mid-Atlantic US
Transmission & Distribution – 90% of Revenue

Regulated transmission and distribution is PHI’s core business.
Investing in the Smart Grid

Smart Grid benefits to the customer…

Puts decision making in the hands of customers
- Improved information, programs and pricing options will allow customers to make informed energy choices
- Gives customers better information about their service and use

Automatically accommodates changing conditions
- Fault isolation, quick automatic restoration, advanced grid sensors
- Reroute power flows, change load patterns, improve voltage profiles
- Automatic notification for corrective actions and maintenance activities, which minimizes workforce intervention

Enables us to operate the system with greater efficiency
- Better asset management by optimizing grid design and investments
- Optimized grid operations, reduce losses
- Greater reliability and security

Promotes green energy initiatives
- Enables participation of distributed, renewable energy resources and plug-in electric vehicles
- Providing enhanced monitoring and control capabilities
PHI History with Electrical Vehicles

• Member of DOE Site Operator Program
  ▪ Maintained a fleet of 6 all-electric conversion vehicles
• Founding Member of EV America
  ▪ Developed first utility standards for electric vehicles
  ▪ Later turned over to DOE
• GM PrEView Drive Program
  ▪ 60 customer drivers for two weeks at a time
  ▪ Installed over 75 Level 2 chargers
• Toyota RAV4 EV Program
• Ford Ranger EV Program
Plug-In Vehicles are coming....

- Penetration projections are inconsistent
- Initial Impacts to infrastructure will be due to clustering
- Significant penetration is still years away
- Washington, DC region is expected to be any early target market for several manufacturers

**OEM Deployment in the Pepco Region**

- Ford Transit Connect 2010
- Chevy Volt 2011
- Nissan Leaf 2011
- Ford Focus 2011
- Ford PHEV 2012
- Fisker Nina PHEV 2012
- Tesla 2012
- BMW Megacity 2013
# Regulatory Landscape

<table>
<thead>
<tr>
<th>State</th>
<th>Electric Vehicle Initiatives</th>
<th>Energy Reduction Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Jersey</td>
<td>State Introduced legislations related to public charging at State toll roads rest areas and New Shopping Center Development. There is also tax credits for purchases of vehicles</td>
<td>NJ State goal of reducing energy consumption and GHG emissions by 20% by 2020</td>
</tr>
<tr>
<td>Maryland</td>
<td>Recently Introduced legislation related to: 1) Utilities Demand response for charging EV’s, 2) Tax Credits for EVSE’ and 3) creating MD EV’s Infrastructure Council</td>
<td>EmPOWER Maryland initiative aims to reduce electricity consumption in the state by 15% by 2015</td>
</tr>
<tr>
<td>Delaware</td>
<td>No Significant Activities</td>
<td>Similarly, DE has a program to reduce electricity consumption by 15% by 2015</td>
</tr>
<tr>
<td>District of Columbia</td>
<td>No Significant Activities</td>
<td>DC has a number of energy reduction goals, including a proposed reduction of GHG emissions by 30% by 2020</td>
</tr>
</tbody>
</table>
Projecting PEV Growth

PHI has built a set of projections covering PEV take-up in each of its jurisdictions, using both top-down and bottom-up techniques. In this example, the forecast covers the Maryland service territory.

Triangulating both forecasts reveals very similar projections. Taking the mid-point between the two yields 5,231 plug-in vehicles in 2015 and 19,252 in 2020.
EVs Need High-Powered Chargers

- Most vehicles will come with a Level 1 charger (120V home outlet)
- Level 2 charging required for overnight charging of larger batteries
- Faster charging also allows higher efficiency, smaller battery
- Customers surveyed preferred Level 2 chargers
- Cost of installation is a potential issue
  - 75% of existing hybrid owners would pay at least $200
  - PrEView Program showed $1200 average installation cost
  - *May require installation incentive.*

### Voltage / Current

<table>
<thead>
<tr>
<th>Level 1</th>
<th>120V @ 12A</th>
<th>1.4 kW</th>
<th>6 hours</th>
<th>17 hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 2</td>
<td>240V @ 32A</td>
<td>7.7 kW</td>
<td>3.5 hours</td>
<td>3 hours</td>
</tr>
<tr>
<td></td>
<td>240V @ 70A</td>
<td>16.8 kW</td>
<td>½ hour</td>
<td>1.5 hours</td>
</tr>
</tbody>
</table>
The following analysis was based on a number of assumptions, including:

Plug-in electric vehicles (PEVs) / consumption:
• An individual PEV will use 7 kWhr per day per charge
• Each PEV will charge 320 days per year

Chargers/Demand:
• The demand of a Level 2 charger is 7.68 kW
• The demand of a Level 1 charger is 1.4 kW

Other assumptions:
• 80% of chargers are Level 2 chargers, 20% are Level 1
• 90% of charging is done off-peak, 10% on-peak
Plug-In Vehicles’ Impact on Load: Yearly MWhr

**Base Case**

Maryland Yearly kWhr Sales from PEVs: Base Case

- 2015: 13,754 MWhr
- 2030: 40,195 MWhr

**Aggressive Case**

Maryland Yearly kWhr Sales from PEVs: Aggressive Case

- 2015: 27,509 MWhr
- 2030: 80,392 MWhr

**Conservative Case**

Maryland Yearly kWhr Sales from PEVs: Conservative Case

- 2015: 6,877 MWhr
- 2030: 43,125 MWhr

**Blended Forecast**

Maryland Yearly kWhr Sales from PEVs: Blended Forecast

- 2015: 11,719 MWhr
- 2030: 43,125 MWhr
Plug-In Vehicles’ Impact on Demand: MW

**Base Case**

Maryland kW Demand Impact: Base Case

- **2015:** 36 MW Off-Peak
  - 4 MW On-Peak
- **2030:** 104 MW Off-Peak
  - 12 MW On-Peak

**Aggressive Case**

Maryland kW Demand Impact: Aggressive Case

- **2015:** 71 MW Off-Peak
  - 8 MW On-Peak
- **2030:** 207 MW Off-Peak
  - 23 MW On-Peak

**Conservative Case**

Maryland kW Demand Impact: Conservative Case

- **2015:** 18 MW Off-Peak
  - 2 MW On-Peak
- **2030:** 52 MW Off-Peak
  - 6 MW On-Peak

**Blended Forecast**

Maryland kW Demand Impact: Blended Forecast

- **2015:** 30 MW Off-Peak
  - 3 MW On-Peak
- **2030:** 111 MW Off-Peak
  - 12 MW On-Peak
Unmanaged EV charging can create problems for utilities.....

**Local Distribution System Impact**

- EV load is equivalent to ½ to full home load, so adding EVs may overload local transformers
- Older, more affluent neighborhoods with higher concentrations of EVs will be particularly at risk (e.g., Washington, DC & Maryland Suburbs)

**Peak Load Increase**

- Most drivers will return home and plug in between 4-8 PM, resulting in an increased afternoon peak
- Uncontrolled will create need for additional Infrastructure and result in longer and higher peak demand
- Impact to EmPower Maryland goals

**Operational Needs**

- Metering EVSE as separate load for billing, GHG credits
- Back-office integration of EVSE for control, billing
- Remote diagnostics for lower maintenance costs
- *Need to avoid the need for installing a second meter by certifying the metrology in the chargers*
EV Control and Monitoring Features:

- EVSE device management (import/search/view/edit)
- View EVSE usage data (plug in/out, charge start/stop)
- Direct control of EVSE (start/stop charging)
- Basic charge scheduling (static schedules)
- Aggregated load impacts by transformer, feeder and substation
Benefits of EVSE as Smart Grid Node

1. Robust, reliable communications
   - Multiple connectivity paths
   - No single point of failure
   - No HAN required for fleet/public
   - Peer2Peer connectivity to SG devices
   - EVSE becomes a repeater in the Mesh Network

2. Lower operating costs
   - SG is utility controlled
   - Charger integrated with existing SG Communications network

3. Maturity of standards
   - Unaffected by ZigBee SEP upgrade issues
   - Future-proofing with OTA upgrades
ClipperCreek EVSE Overview

Power
• Level 2: 240V, 30A

Communications
• Silver Spring Networks comms module
• 900MHz RF mesh radio, 2.4GHz HAN radio

Metrology
• Revenue-grade meter from TransData
• Meets ANSI accuracy standards

User interface
• SAE-J1772™ Coupler
• Button for on-demand charging
• Charge indicator light
• Error indicator light

Charging features
• Charge on/low/off (low is configurable)
• In case of a fault, unit will auto-restart if possible
Possible Rate Options....

**Time of Use**
- Most frequently used EV tariff
- AMI Meter enables significant benefit
  - Communicates with Charger
  - Eliminates need for second meter
- Encourages off-peak charging

**Flat EV Rate**
- Several utilities have introduced a variant of this rate
- Charge all you want for a flat fee
- Does not encourage off-peak charging

**Sliding Scale - EV**
- Derivation on Flat Rate
- Rate ratchets with consumption
- Does not encourage off-peak charging

---

**Example Rates for incentivizing EV Charging**

<table>
<thead>
<tr>
<th>Time of Use (TOU)</th>
<th>7a</th>
<th>2p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-Peak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial-Peak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On-Peak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partial-Peak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Illustrative, utilities' peak and off-peak times vary

1. **Time of Use**
2. **Flat Rate**
3. **Sliding Scale - EV**
Utility interface with car dealerships

Source of EV sales information

- Data on EV penetration
- Location of EV sales
- Information on future availability of EVs

Channel to communicate with customers

- Educational materials / Company brochure on EVs
- Location map of EV chargers
- Direct to Company website

Note: it is important to obtain this data at the premise address level (rather than high level zip code data)

This is a great opportunity to ensure utility is doing all it can with regards to customer outreach.
Further consideration…..

• Further infrastructure reviews and modeling need to be conducted to better understand the distribution system impacts of vehicle charging
• We need to combine this with better information on vehicle penetration into each region
• A rate structure needs to be developed that will properly incentivize EV ownership and charging
• We need to educate customers and key stakeholders on the benefits of off-peak charging of electric vehicles
• How are utilities going to balance EV Deployment with State sponsored Energy Reduction goals?
Moving Forward.....

Public Education
• Continue to reach out to local stakeholders
• Continue to participate in Customer Education programs and outreach to industry and research organizations

OEMs
• Continue vehicle demonstration / evaluation programs
• Continue to work collaboratively to integrate Plug-in Vehicles with the Smart Grid

Technology Readiness
• Integrate EV charger monitoring and control into existing Smart Grid Deployment
• Further evaluate system impacts of EV and charging
• Evaluate vehicle batteries in stationary applications
• Evaluate how EV’s and other distributed resources will change the distribution system
Where is PHI now??

- Participating in EPRI / Ford Escape PHEV Program
- 2 Hybrid Bucket Trucks in fleet
- Will deploy 1 PHEV Bucket Truck in 2011
- Will deploy 10 Chevy Volts in fleet by Q3 2011
- 5 EVSE Charging Stations Installed
  - 2 Edison Place
  - 1 NCRO
  - 1 Bay Region
  - 1 ACE
- Demonstrate EV charger communication and management
Questions?