Managed Electric Vehicle Charging: New Opportunities for Demand Response
SEPA’s Mission & Research

To facilitate the electric power sector’s smart transition to a clean energy future through education, research, standards, and collaboration.
Outline

• The evolution of demand response and the growth of EVs
• What is managed EV charging?
• Utility interest in managed charging
• Opportunities and challenges
• Utility role in managed charging
The evolution of demand response and growth of EVs
2016 DR enrolled capacity by type

**FIGURE 5: TOTAL 2016 ENROLLED DEMAND RESPONSE (MW)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Switch</td>
<td>3.0</td>
</tr>
<tr>
<td>Water Heater</td>
<td>0.22</td>
</tr>
<tr>
<td>Thermostat</td>
<td>2.38</td>
</tr>
<tr>
<td>Fully Automated</td>
<td>1.05</td>
</tr>
<tr>
<td>Customer Initiated</td>
<td>5.53</td>
</tr>
<tr>
<td>Behavioral</td>
<td>0.54</td>
</tr>
<tr>
<td>Other</td>
<td>0.9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>13.6</strong></td>
</tr>
</tbody>
</table>

Source: Smart Electric Power Alliance, 2017. Data reported in SEPA’s DR Survey—results are a sampling of 104 utilities.
**FIGURE 3: THE EVOLUTION OF DEMAND RESPONSE**

**DR 1.0**
- Represents the original demand response initiatives in which utilities notify customers through a pager or telephone message to manually change energy consumption.
- Alternatively, utilities may leverage one-way communication load-control devices to modify usage of residential air conditioning units and water heaters. Older forms of DR allow some customers to use certain types of diesel generators to temporarily shift some load away from the grid. DR 1.0 is predominantly used for emergency events or when wholesale prices are high. A significant amount of DR 1.0 remains in use today and will continue to be used into the future.

**DR 2.0**
- Reflects the increase in bilateral communications, and greater locational capabilities to call DR without curtailing every customer. This may also include the integration of automated demand response that allows increased participation in wholesale electricity markets and grid operations by providing ancillary grid services. 2.0 extends to include shifting of load to low-cost off-peak times when renewable resources are abundant.

**DR 3.0**
- Represents the evolution of demand response as a component in the larger field of DERs. Along with electric vehicles, energy storage, and solar photovoltaics, for example, DR can provide services to the grid in renewable energy integration and distribution congestion management. DR 3.0 can be applied to highly refined and localized problem solving.

Source: Smart Electric Power Alliance, Navigant, and Peak Load Management Alliance®, 2017.
BNEF – 60% of new car sales by 2040

Figure 6: Long-term EV sales penetration by country

Source: Bloomberg New Energy Finance
Navigant - 5.25M by 2026
Base Case (EEI/IEI)
DNV-GL: 100% EV LDV sales by mid 2040s globally

DNV-GL, Energy Transition Outlook, 2017
EEI/IEI - 4.4M to 5.5M EV Chargers by 2025
Navigant - 4.8M EV Chargers by 2025
What is managed EV charging?
Opportunities for EV Managed Charging to Meet Grid Needs (Illustrative)

Source: BMW of North America, 2016 with edits by Smart Electric Power Alliance, 2017

Note: The light blue area illustrates the impacts of a hypothetical TOU residential charging rate with the lowest rate period beginning at 11 pm. The dark blue area shows how managed charging could distribute charging loads with peaks in renewable energy generation.
EVs as a DR Resource

**Figure 4: Demand Response Capabilities**

<table>
<thead>
<tr>
<th>SERVICE TYPE</th>
<th>ANCILLARY SERVICES MARKET</th>
<th>ENERGY MARKET</th>
<th>CAPACITY AND RESOURCE ADEQUACY PAYMENTS</th>
<th>FLEXIBLE (RAMPING) CAPACITY PAYMENTS</th>
<th>REVERSE DR (FUTURE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHED</td>
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<tr>
<td>SHIFT</td>
<td>*</td>
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<tr>
<td>SHIMMY</td>
<td>*</td>
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</tbody>
</table>

* Denotes a market where participation may be possible in the future, but due to uncertainty in the expected prices and markets not calculated in this study.

Utility Interest EV
Managed Charging DR Programs

- Currently Implemented: 3%
- Planning/Researching/Considering: 69%
- No Interest: 20%
- No Response: 8%
- No Response: 3%

Source: Smart Electric Power Alliance, 2017

**Utility EV Activities/Programs by Type**

- EV Info on Website: 113
- Workplace Charging: 94
- EV in Utility Fleet: 116
- Residential EV: 9
- Residential EVSE: 19
- Commercial EV: 3
- Commercial EVSE: 17
- Special EV Rates: 35
- Public Use Charging: 81
- Workplace Charging: 19
- Utility EV Education: 60
- Managed Charging: 10
- V2G Pilot: 3

**Source:** Smart Electric Power Alliance, 2017. N=487
Utility managed charging goals

Which of the following goals does your smart charging program currently support or will it support in the future? (Select all that apply)

- Manage load from EV charging: 10
- Defer or avoid new investment in transmission or generation infrastructure: 9
- Enable renewables integration: 9
- Facilitate grid services: 9
- Help customers manage energy use: 9

Utilities uncertain how to monitor EVs

WHAT TYPE OF PROJECTS HAVE YOU INVESTED IN OR ARE YOU INTERESTED IN INVESTING IN TO IMPROVE YOUR ABILITY TO ADDRESS POTENTIAL EV REQUIREMENTS?

(SELECT ALL THAT APPLY)

EV Impact on SMUD Transformers through 2030

- Under current assumptions, distribution impacts could cost $50M to $100M+ to address
- Potential mitigation solutions include EV managed charging

Source: Smart Electric Power Alliance, Black & Veatch, and SMUD, 2017
www.segapower.org
Opportunities and challenges
Communications Interface Options

FIGURE 4: MANAGED CHARGING NETWORK COMMUNICATION INTERFACE OPTIONS

Transport Layer Protocols
(Network Communication Interfaces)

- Wi-Fi
- EVSE
- CP Smart Adapter
- Control-Pilot Signal
- Integrated Telematics
- OBD2 Interface

GRID OPERATOR OR UTILITY
- Control signals to modify charge rate

AGGREGATOR
- Wi-Fi signal to EV or through EVSE
- AMI backhaul link to smart meter to EV or through EVSE
- Cellular broadband signal to EV or through EVSE
- FM radio broadcast to EV or through EVSE (one-way)
- Ethernet connection to EVSE

MESSAGING/APPLICATION PROTOCOLS

ROUTE
- Wi-Fi

AMI METER
- Wi-Fi or PLC
- EVSE

CELL TOWER
- GPRS or CDMA
- EVSE

RADIO TOWER
- RDS
- EVSE

ETHERNET CABLE
- E.G., CATS
- EVSE

ELECTRIC VEHICLE

Source: Dr. David P. Tuttle, 2016 with edits by Smart Electric Power Alliance, 2017
Charging protocols in development

FIGURE 5: OPEN VEHICLE-GRID INTEGRATION PLATFORM SCOPE

OPEN VGI PLATFORM

UTILITY/INFRASTRUCTURE INTERFACE
- IEEE 2030.5/
  IEC/ISO 15118/
  IEEE 2030.1-1/
  OpenADR 2.0b
- Data Analytics:
  Energy Use,
  Behavior, Customer
  Preferences
- EVSE Network
  Interface
- Open API

GRID SERVICES
- Aggregation
- Demand Response
- Renewable Balancing
- Measurement and
  Verification
- Demand Charge
  Mitigation
- Dynamic Pricing

PHASE 3 EXTENSIONS
- Frequency Regulation
- Energy/ISO Market
  Interface

SYSTEMS COORDINATION

PRIVACY & SECURITY

Source: Electric Power Research Institute, 2016
Managed Charging Ecosystem

utilities/balancing authorities

aggregators

VGI/connected car platform providers

OEMS/EVSE manufacturers

customers

Source: Smart Electric Power Alliance, 2017
Utility as Managed Charging Hub

Source: Smart Electric Power Alliance, 2017
SEPA EV Working Group
and Upcoming Activities

• EV Working Group kicked off May 2017
• Member-only benefit
• Meets first Thursday of every month from 2-3pm Eastern for one hour
• Three subcommittees:
  • Managed charging/V2G
  • Distribution planning for EVs
  • Utility rates, tariffs, and incentives
• Upcoming research on utility growth of EV programs
• Utility EV workshop in April 2018
• More information at www.sepapower.org
NV Energy
Electric Vehicle Program

Marie Steele
Manager, Electric Vehicles & Renewable Energy
NV Energy Overview

- Headquartered in Las Vegas, Nevada, with territory throughout Nevada
- 2,436 employees
- 1.26 million electric and 164,000 gas customers
- Service to 90% of Nevada population, along with tourist population in excess of 45 million
- 6,011 megawatts of owned power generation (91% natural gas, 9% coal/renewable/other)

Provides electric services to Las Vegas and surrounding areas
- 917,000 electric customers
- 4,639 megawatts of owned power generation capacity

Provides electric and gas services to Reno and northern Nevada
- 342,000 electric customers and 164,000 gas customers
- 1,372 megawatts of owned power generation capacity

(1) Net summer peak megawatts owned in operation as of May 31, 2017
NV Energy Electric Vehicle Program

- Electric Vehicle Time of Use Rates since 2009
  - Residential, Commercial, Multi-Family
- NV Energy Workplace & Public Charging
- Electrification of the NV Energy Fleet
- Charging Station Shared Investment Program
- Nevada Electric Highway Partnership

“This Electric Highway will allow electric vehicle drivers to power their cars by tapping into Nevada’s own renewable energy resources. This will strengthen our state’s energy independence while reducing Nevada’s petroleum imports.”

— Brian Sandoval, Nevada Governor
Nevada is Primed for Electric Vehicle Growth

With the implementation of the Electric Vehicle Infrastructure Demonstration Program, as part of Senate Bill 145, the Company is poised to support and accelerate the realization of electric vehicle growth in Nevada.

Las Vegas listed #1
In Top 10 Metro Areas for EV Growth

Nevada listed #2
In Top 10 States for EV Growth

Source: ChargePoint
Innovation in Transportation Already in Motion; Autonomous, Connected & Electric (“ACE”) Initiatives

Las Vegas launches the first electric autonomous shuttle on U.S. public roads.

*Source: techcrunch.com

Las Vegas is a top 10 market for autonomous vehicle roll-out

*Source: INRIX Autonomous Vehicle Study

Proterra Starts Industry’s First Autonomous Bus Program in Nevada

Regional Transportation Commission of Washoe County: 4th Street Station, Reno
The Company is working with the State to achieve targeted impacts and the clean energy vision outlined in Nevada Governor Brian Sandoval’s 2016-2020 Strategic Planning Framework, Generations to Come, and complete and “electric highway” system serving the entire state by 2020.
Nevada’s goal for the Nevada Beneficiary Mitigation Plan for the Volkswagen Settlement are to:

- To support long-term investments toward a zero emission transportation sector within the state.
- To efficiently and cost-effectively reduce NOx emissions from areas of the state;
  - that bear a disproportionate share of NOx pollution and potentially, other pollutants;
  - where the vehicles subject to the settlement were, are, or will be operated; and

**2017 Legislative Session; Senate Bill 145**

- The creation of the Electric Vehicle Demonstration Program which is the establishment of programs directed by the utility to promote electric vehicle infrastructure, including, without limitation;
  - Education and awareness programs for customers of the utility
  - Programs to provide technical assistance related to the charging of electric vehicles to governmental entities or the owners or operators of large fleets of motor vehicles
  - Programs to create partnerships with private organizations to promote the development of electric vehicle infrastructure.

**2017 Legislative Session; Senate Bill 146**

- Establishment of distributed resources plan.
  - What is the role of transportation electrification in a distributed resource plan?
If utilities anticipate the load of charging EVs and plan for it proactively, they can not only accommodate the load at low cost, but also reap numerous benefits to the entire system.*

- NV Energy has been proactive in our electric vehicle program to acknowledge that electric vehicle load may occur at peak and have thus designed levers and incentives in our programs to grow electric vehicle load off-peak wherever possible.
  - Electric vehicle time of use rates for residential, commercial and multi-family customers.
  - Demand response clause to shed load if necessary for all electric vehicle charging stations encompassed in the NV Energy Charging Station Shared Investment Program.

*Rocky Mountain Institute Electricity Innovation Lab; Electric Vehicles as Distributed Energy Resources
NV Energy Charging Station Shared Investment Program

Partnerships Driving Sustainability

NV Energy partnered with ~50 Nevada companies in 2013 and doubled the electric vehicle charging infrastructure in Nevada.

- Airports
- Universities
- Shopping Centers
- Casinos
- Government Buildings
- Small Businesses

“NV Energy’s innovative and proactive market approach lets it keep pace with Nevada’s quickly evolving electric transportation landscape, which Clean Energy Project believes will be central to our state’s economic future and the new Nevada.”

— Clean Energy Project
Why we care. Public Charging is Happening At Peak

Southern Nevada In August

Level 2 Public Charging
NV Energy Charging Station Shared Investment Program: Shedding Load
Shifting Electric Vehicle Load via Price Signals

Residential Electric Vehicle Time-of-Use Rates

- 96% of Nevada Power Customers experience lower bills on their EV TOU than other rate classes.
  - Attrition rate is 1%
  - Participation Rate 36%

- Rate applies to entire home, not just the electric vehicle load
  - Pro: successful customers shifted the load of their entire home and save money.
  - Pro: participation in rate self-identifies electric vehicles on the grid by premise.
  - Issue: not all electric-vehicle owners participate. No current solution that incentivizes off-peak behavior of just the electric vehicle load and not the entire home.
• Electric Vehicle Tariffs
• Further Incorporate EVs in the Customer Experience

• **Proposed**: Smart, flexible, connected charging system to better plan for the future of our grid and renewable energy penetration as part of the Electric Vehicle Infrastructure Demonstration Program
  – Development of technical and contractual requirements and communication protocols for vehicle grid integration
  – Integrate electric vehicles into Demand Response and Distributed Resource Planning

• **Proposed** Smart Charge Reward Program
  – Evaluate the willingness and ability for EV owners to charge during off-peak periods through a variety of strategies;
  – Evaluate the impact that the proposed SmartCharge Rewards mechanism has at stimulating grid-friendly EV charging behaviors;
  – Evaluate the customer’s interest in collecting EV charging and driving feedback.
  – Provide customers with education and awareness of vehicle electrification.
Electric Vehicles as a part of Disaggregation

- New disaggregation service that leverages the smart grid
- Enhanced personalization opportunities
Questions?

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