Infrastructure Working Council (IWC) Meeting Presentations

Day One

June 8, 2016

Bus and Truck Charging Interface

Presenter: Mark Kosowski, EPRI

IWC Meeting

June 7, 2016

Bus and Truck Charging Interface Group

- There is a need to standardize bus charging prior to building an infrastructure including depot, wireless, and overhead charging
- Discussion points are standardizing and understanding the utility and bus interfaces
- Meetings occur about 3 times per year adjacent to the IWC meetings
- Lots of Interest from
  - Utilities,
  - Bus Manufacturers,
  - Transit Authorities,
  - Charger Manufacturers, and
  - Laboratories

Bus and Truck Charging Interface Group

- At least four charging interfacing standards have emerged
  - Manual DC connection at high power- SAE J-1772
    - An existing document that will make provisions for the higher power needs of the busses
  - Wireless connection at high power- SAE J-2954-2
    - A developing document that will make provisions for the higher power needs of the busses
  - Overhead connection at high power- SAE J-3105
    - New document which started late last year
  - Manual 3 phase AC at high power- SAE J-3068
    - New document that is getting good acceptance

Bus Charging Interface Group
Next Meeting

When

Tuesday, November 15, 2016

Where

San Francisco, California

Hosted by

Pacific Gas and Electric

SAE J-3105 Status
Overhead Charging

Presenter: Mark Kosowski, EPRI

June 7, 2016

Meeting Schedule and Membership

A link to the SAE membership form is shown below. If desired, please fill in form and send back to Mark Kosowski for membership. It is not required to be an SAE member to be on committee. Also there are different levels of participation.

http://www.sae.org/standardsdev/participationReq/

Also the meeting minutes, documents and meetings will be at the link below, but you need to be a member of the committee.

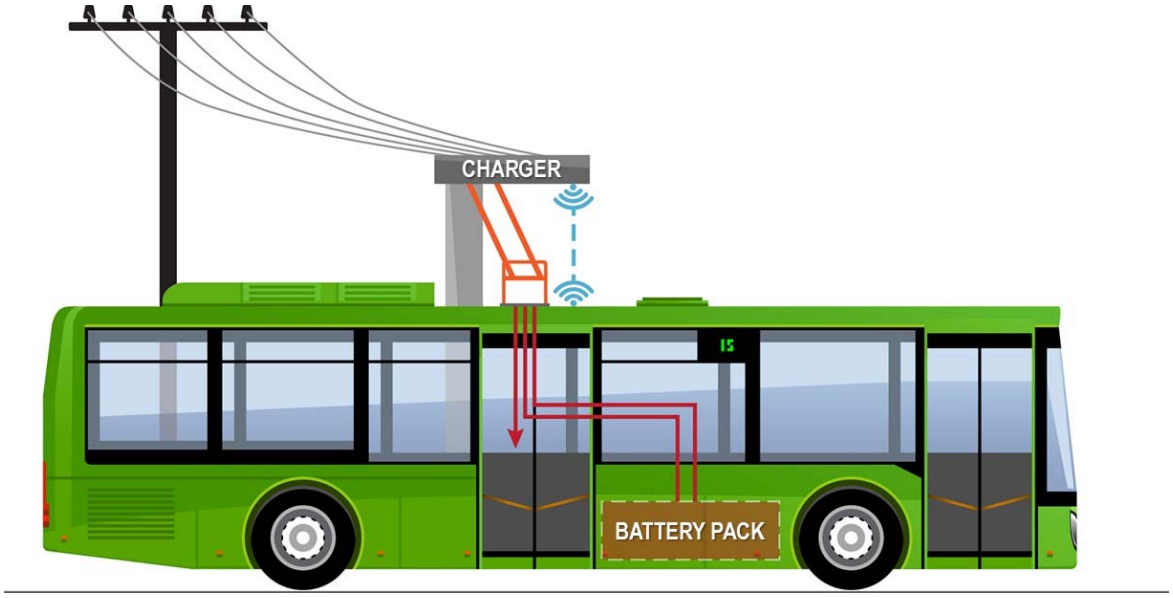
http://www.sae.org/servlets/works/committeeHome.do?comtID=TEVHYB13

Meeting Schedule

2nd and 4th Thursdays of the month at 11 am ET (late in Europe and early for California) Next Meeting is June 16

Overhead Charging Document

- Overhead connection at high power- SAE J-3105
  - Document wants to standardize the interface between the Overhead infrastructure and the bus
  - Strategy- combine present requirements/systems with future needs and produce a standard looking forward



Power Levels

Power Configurations

Connection Points

Communications

Safety

Alignment Protocol

Survey Timeline and Distribution Plan

- Final review meeting scheduled for Friday, June 10.
- Distribute survey to APTA transit agencies, related APTA committees (like Clean Propulsion group), and personal invite from group.
- Request feedback by June 30 (tbd).
- Organize and distribute results to J-3105 by July 8.

Summary

Requirements are being identified from

1) The existing systems
2) New survey going out to determine the future requirements
3) Certain document sections will be shared from other documents

The plan is to compare the existing systems to the new requirements and determine the new standard for overhead charging.

Plan to have a Face to Face meeting in the fall- location TBD

The plan is to complete the document by the end of this year.

Wireless Charging-high power- SAE J-2954-2

The task force will have two Co-leaders- one from charger manufacturers and one as a Bus OEM. And the kick-off of this document will occur soon.

Updates

- Manual DC connection at high power- SAE J-1772
  - An existing document that will make provisions for the higher power needs of the busses
  - By John Halliwell
- Manual 3 phase AC at high power- SAE J-3068
  - New document that is getting good acceptance
  - By Rodney McGee
- IEC Update
  - By Greg Nieminiski
- Excellent Discussion on all topics including manual (depot) charging

Contact Information

Mark Kosowski

EPRI

mkosowski@epri.com

248-421-7124

Together…Shaping the Future of Electricity

EMPower the People for Electric Mobility

HOW TO ADVOCATE FOR ELECTRIC VEHICLE CHARGING AT YOUR MULTI-UNIT COMMUNITY

Joel R. Pointon
Principal – JRP Charge - Multi-unit Charging Consulting

JRP Charge

Basics -

Real Estate

Control

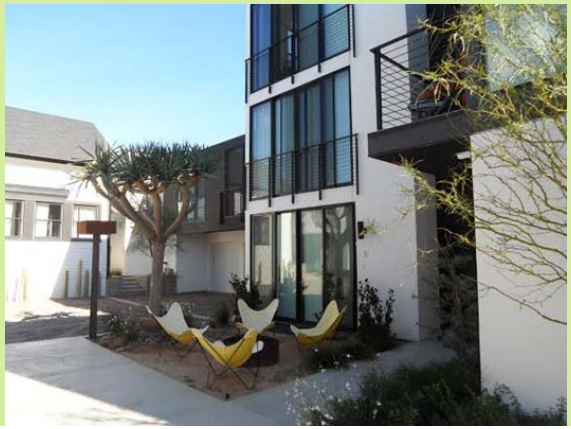
Location

Multi-unit Dwelling (MuD) Vehicle Charging Challenges

- Metered Electricity Access Relative to Parking
- Which Type of Metered Electricity (Common Area vs. Individual)
- How to Measure Individual Use for Charging
- How to Pay
- Existing Codes, Covenants and Regulations (CC&Rs)
- Community Support for Charging
- Development of Policies for Users (that Non-Users Agree With)
- Which Business Model Fits Best for Your Community
- Alignment with Community Traditions

Multi-unit Dwelling (MuD) Vehicle Charging Selling Points

- Amenity Attracts New Segment of Population
- Projects Sustainable/Green Image
- Demographics are Available for PEV Owners
- Keeps Your Community Competitive as PEV Demand Grows
- Sustainability Points for LEED Certification
  (Platinum, Gold, Silver, etc.)



4 Elements of emPower Toolkit PEVC Website

http://www.pevcollaborative.org/MuD

emPower the People Tools - How to Advocate for Electric Vehicle Charging at Your Property

- emPower the People - Step-by-Step Guide on How to Advocate for EV Charging at Your Property (PDF)
- emPower Resident Survey (Word)
- My Property Profile Template (Word)
- emPower Sample Letter (Word)

Go with the flow (chart)

Page 1

More Details

Page 2

EDUCATE

Yourself - Your Community – Your Property Management

- Get the vocabulary and understand the different charging station technologies and options
- Learn about your community's networks, traditions, "groups" and committees, and get to know your neighbors (avoid mentioning this project the first time you introduce yourself)
- Attend an HOA/ resident meeting without an agenda, and watch and learn who is who and "how it works"

Resources:

- PEVC Multi-unit Dwelling (MuD) resources (guidelines, case studies, etc.)
- Plug-In Electric Vehicle Resource Center (vehicles, rebates, etc.)
- Plug In America (General information and support)

INVESTIGATE

Property Rules

- **What are the rules?** Find the CC&Rs/rules/ regulations/guidelines that are documented for your community – make a master list and get a copy of each to place in a 3-ring binder (HOA, property management, residents association are excellent sources for these documents). Pay particular attention and highlight any references to parking/garages/common community resources, etc.

- **Property Profile** – Use the My Property Profile template to create a profile of your community: number of living units; number of parking spaces, whether parking is assigned (note if deeded), unassigned, parking for visitors; individual electric metering for living units, separate metering for common areas, which common areas are served, etc.? (See "My Community Profile" for details). Take a walking tour of your community to verify what is current and take some pictures of the different areas (these may come in handy later).

- **Survey your Neighbors** – Customize and distribute the Resident's Survey for Plug-In Vehicle Interest to get the current and future interest level for plug-in electric vehicles and how many fall into BEV/ PHEV categories. This will be valuable information to provide to your property management when you submit your letter of request. This is also a great way to establish an email list of those that may be interested in helping.

CONGREGATE

- **Make Connections** – Create a base support group of like minded tenants for getting vehicle charging into your community. Form an "Organizing Committee" that can help you brainstorm and network with your community. Hold a "Getting the Juice" get together with these folks and with the juice and cookies, share the information and resources you have to date and ask for helpers for the steps going forward. There is power in numbers and it helps to be inclusive.

- **Meet with Management** – Have a friendly sit-down with management to discuss your interests and to explain the groundwork you are doing to help with the process. Let them know that you look forward to sitting down with them in the future to share information and to get their feedback. Try not to jump into detailed discussions here – it's a meet and greet. Make it friendly and inclusive (a plate of cookies here can't hurt either) and reassure them they will be in the loop and that you will communicate with the site management representatives first (no letters to corporate at this stage). Let them know that you look forward to helping them add this amenity to your community to make it more appealing to like-minded residents in the future.

MOTIVATE

- **Send a Letter!** Write a letter on behalf of the community to the local property management representatives citing the information and survey data that you have collected. Here is a sample letter with suggestions of some references you may wish to include.

Yet More Details

Page 3

COLLABORATE

- **Walk the Walk:** Walk the parking areas with property management representatives and the facilities support staff. Look at layouts, metering rooms, existing wiring runs, etc., so everyone has a basic orientation and understands the whole picture. Perhaps management will invite their electrical contractor to attend and explain electric details. A licensed electrical contractor will handle coordination with the utility, inspectors, licenses and support for any future construction/installation project. Make sure the property managers know how to contact the point person for the core "Organizing Committee" going forward.
- **Other Facts You'll Need:** If looking at using electricity from common area metering, it will be necessary for property management to review a few pieces of information with their local utility such as:
  - *Existing electric rates*
  - *Impacts on these rates from an increased electrical load*
  - *Information about any special rates or special projects for multi-unit dwelling charging for which you may qualify, and whether there are any grants/discounts/rebates/private special projects that may apply to multi-unit vehicle charging in your region.*
  - *New service drops may be the next level of conversation with the utility for vehicle charging and whether this approach might provide access to incentive rates for vehicle charging.*

NEGOTIATE

Let's Talk: At this point your property manager may wish to look at the different companies that offer charging station technology/support that span from simple "non-communicating" charging units that may only require a flat monthly fee for residents to use, to advanced networked charging units that offer monthly subscription rates for support and custom reports related to usage. The property owner/manager can coordinate visits and bids for services from these companies that offer hardware and support. The PEV Collaborative case studies offer insights into the growing range of solutions for multi-unit charging projects.

CELEBRATE

Hopefully your efforts will have paid off and resulted in a path to vehicle charging for your community. **CONGRATULATIONS!** Here are some ideas you might consider for your community to acknowledge this advancement:

- **Schedule a "Mini Ride-and-Drive"** – Invite any residents, relatives, friends, local Plug In America members, or even local dealerships to offer ride and/or drives of plug-in electric vehicles on a weekend at your community for a few hours and let others who are curious experience the electric ride experience.
- **Send a Thank You Letter!** – Acknowledge your property manager (and be sure to copy thier corporate leaders) for their cooperation and forward-looking action.
- **Get it in Writing!** – Encourage your property manager to contact the PEV Collaborative and get your project committed to a case study available to others. Share the wealth of your experience and help encourage more projects for similar communities.
- **Make NOISE!** – Schedule a little celebration on the first day you can charge the cars in your community. You all deserve a plate of cookies as well! **Great work!** Enjoy your electric miles!

Please send your suggestions, comments and questions on this document to: JRPCharge@gmail.com

To see all of the resources described in this document, visit www.PEVCollaborative.org/MuD

CALIFORNIA PLUG-IN ELECTRIC VEHICLE COLLABORATIVE

www.PEVCollaborative.org

Educate

EDUCATE

Yourself - Your Community – Your Property Management

Get the vocabulary and understand the different charging station technologies and options

Learn about your community's networks, traditions, "groups" and committees, and get to know your neighbors (avoid mentioning this project the first time you introduce yourself)

Attend an HOA/ resident meeting without an agenda, and watch and learn who is who and "how it works"

PEVC Multi-unit Dwelling (MuD) resources (guidelines, case studies, etc.)**:** http://www.pevcollaborative.org/MuD
Plug-in Electric Vehicle Resource Center (vehicles, rebates, etc.): http://www.driveclean.ca.gov/pev
Plug In America (General information and support): http://www.pluginamerica.org

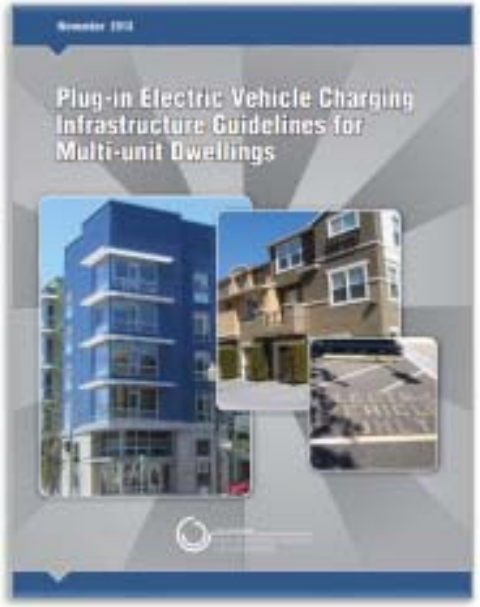
http://www.pevcollaborative.org/MuD

Levels of Charging

Relative Costs

Business Models

Resources – Multi-unit Guideline

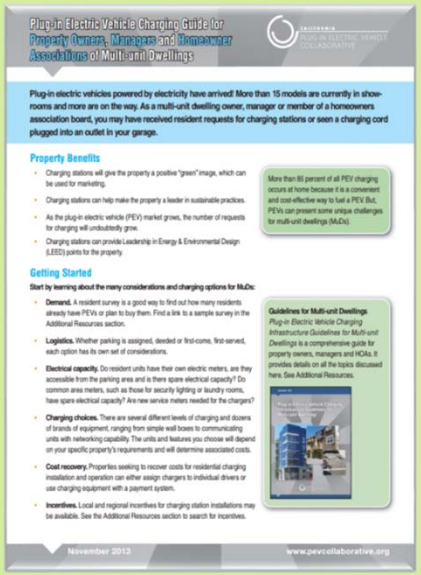


Includes information on:

- Charging a PEV
- Charging equipment installation flow
- Community considerations for charging station installation
- Operating/Maint. costs
- Financial recovery models and technology solutions
- Case Studies

Decision Guides

Guide 1: Great primer on electric vehicle charging for multi-unit dwellings



Guide 2: Information for property owners, managers, and homeowner associations

Guide 3: Information for residents of MuDs

www.PEVCollaborative/MuD

www.DriveClean.ca.gov/pev

Vehicles
Chargers
Rebates
Incentives

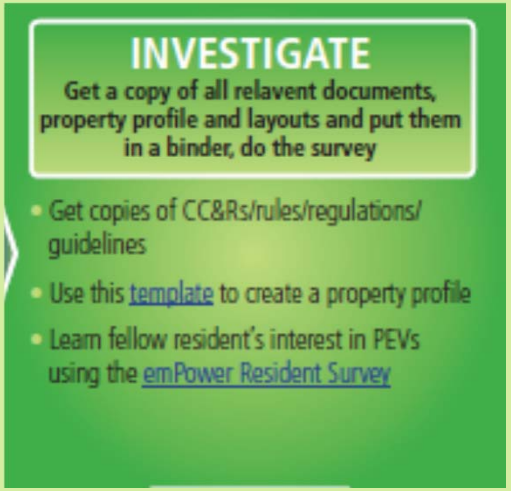
Plug-in America (PIA)

http://www.pluginamerica.org/

- Why Plug-in Vehicles?
- Take Action
- Vehicles
- Charging
- Blogs
- Join

This webinar – http://www.pluginamerica/webinars

Investigate



Property Rules

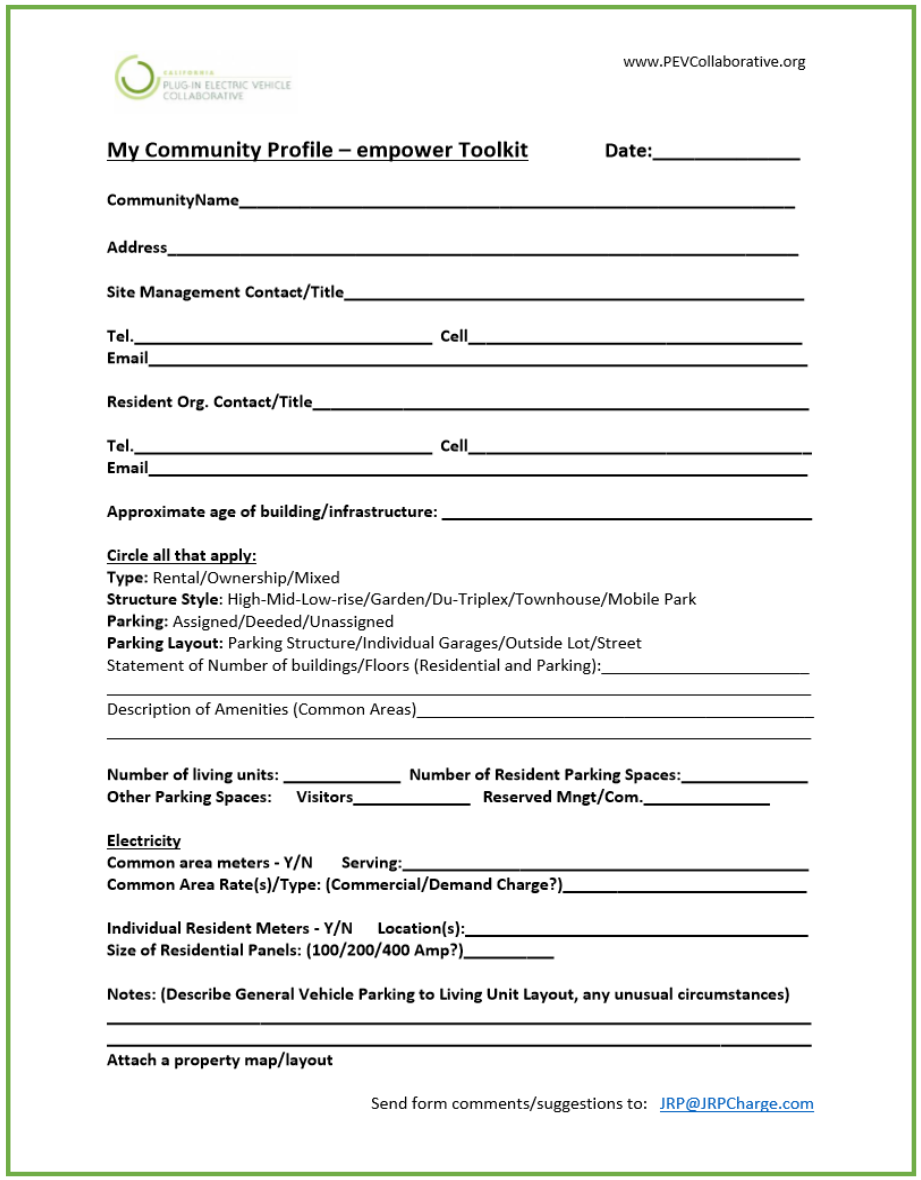
What are the rules? Find the CC&Rs/rules/regulations/guidelines that are documented for your community – make a master list and get a copy of each to place in a 3-ring binder (HOA, property management, residents association are excellent sources for these documents). Pay particular attention and highlight any references to parking/garages/common community resources, etc.

Property Profile - Use the template provided to create a profile for your community: number of living units; number of parking spaces, whether parking is assigned (note if deeded), unassigned, parking for visitors; individual electric metering for living units, separate metering for common areas, which common areas are served, etc.? (See "My Community Profile" link for details). Take a walking tour of your community to verify what is current and take some pictures of the different areas (these may come in handy later).

Survey your Neighbors – Customize and distribute the Resident Survey for Plug-in Vehicle Interest to get the current and future interest level for plug-in electric vehicles and how many fall into BEV/PHEV categories. This will be valuable information to provide to your property management when you submit your letter of request. This is also a great way to establish an email list of those that may be interested in helping.

Link: Property Profile and Survey: http//www.pevcollaborative.org/MuD

My Community Profile



www.PEVCollaborative.org

My Community Profile – empower Toolkit **Date:_____**

CommunityName_____

Address_____

Site Management Contact/Title_____

Tel._____ **Cell**_____
Email_____

Resident Org. Contact/Title_____

Tel._____ **Cell**_____
Email_____

Approximate age of building/infrastructure: _____

Circle all that apply:
Type: Rental/Ownership/Mixed
Structure Style: High-Mid-Low-rise/Garden/Du-Triplex/Townhouse/Mobile Park
Parking: Assigned/Deeded/Unassigned
Parking Layout: Parking Structure/Individual Garages/Outside Lot/Street
Statement of Number of buildings/Floors (Residential and Parking):_____
_____
Description of Amenities (Common Areas)_____
_____

Number of living units: _____ **Number of Resident Parking Spaces:**_____
Other Parking Spaces: Visitors_____ **Reserved Mngt/Com.**_____

Electricity
Common area meters - Y/N Serving:_____
Common Area Rate(s)/Type: (Commercial/Demand Charge?)_____

Individual Resident Meters - Y/N Location(s):_____
Size of Residential Panels: (100/200/400 Amp?)_____

Notes: (Describe General Vehicle Parking to Living Unit Layout, any unusual circumstances)
_____
_____
Attach a property map/layout

Send form comments/suggestions to: JRP@JRPCharge.com

My Community Profile

My Community Profile - emPower Toolkit **Date:**_____

CommunityName_____

Address_____

Site Management Contact/Title_____

Tel._____ **Cell**_____

Email_____

Resident Org. Contact/Title_____

Tel._____ **Cell**_____

Email_____

Approximate age of building/infrastructure: _____

Circle all that apply:

Type: Rental/Ownership/Mixed

Structure Style: High-Mid-Low-rise/Garden/Du-Triplex/Townhouse/Mobile Park

Parking: Assigned/Deeded/Unassigned

Parking Layout: Parking Structure/Individual Garages/Outside Lot/Street

Statement of Number of buildings/Floors (Residential and Parking):_____

_____

Continued

Description of Amenities (Common Areas)_____

_____

Number of living units: _____ Number of Resident Parking Spaces:_____

Other Parking Spaces: Visitors_____ Reserved Mngt/Com._____

Electricity

Common area meters - Y/N Serving:_____

Common Area Rate(s)/Type: (Commercial/Demand Charge?)_____

Individual Resident Meters - Y/N Location(s):_____

Size of Residential Panels: (100/200/400 Amp?)_____

Notes: (Describe General Vehicle Parking to Living Unit Layout, any unusual circumstances)

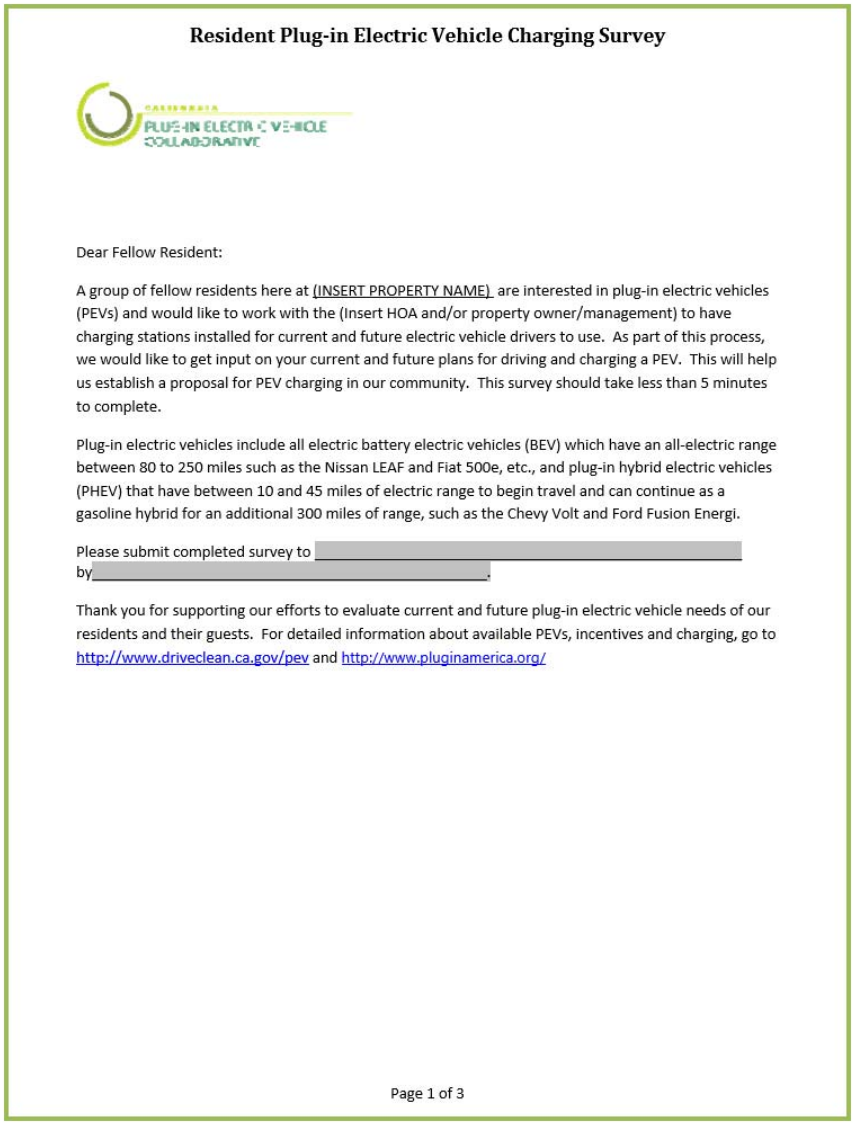
_____

_____**Attach a property map/layout**

Send form comments/suggestions to: JRP@JRPCharge

Multi-unit Resident Survey

Page 1



Resident Plug-in Electric Vehicle Charging Survey

Dear Fellow Resident:

A group of fellow residents here at (INSERT PROPERTY NAME) are interested in plug-in electric vehicles (PEVs) and would like to work with the (Insert HOA and/or property owner/management) to have charging stations installed for current and future electric vehicle drivers to use. As part of this process, we would like to get input on your current and future plans for driving and charging a PEV. This will help us establish a proposal for PEV charging in our community. This survey should take less than 5 minutes to complete.

Plug-in electric vehicles include all electric battery electric vehicles (BEV) which have an all-electric range between 80 to 250 miles such as the Nissan LEAF and Fiat 500e, etc., and plug-in hybrid electric vehicles (PHEV) that have between 10 and 45 miles of electric range to begin travel and can continue as a gasoline hybrid for an additional 300 miles of range, such as the Chevy Volt and Ford Fusion Energi.

Please submit completed survey to _____
by _____.

Thank you for supporting our efforts to evaluate current and future plug-in electric vehicle needs of our residents and their guests. For detailed information about available PEVs, incentives and charging, go to http://www.driveclean.ca.gov/pev and http://www.pluginamerica.org/

Page 1 of 3

Survey Page 2

Resident Plug-in Electric Vehicle Charging Survey

Definitions: (more information at http://www.driveclean.ca.gov/pev)
PEV: A Plug-in Electric Vehicle (PEV) is a general term for any car that runs at least partially on battery power and is recharged by plugging in to the electricity grid. There are two different types of PEVs to choose from: pure battery electric and plug-in hybrid electric vehicles.

BEV: Battery Electric Vehicles (BEVs) operate exclusively on electricity stored in batteries and only has an electric motor. (e.g., Nissan LEAF, Ford Focus EV, Tesla Model S, Chevy Bolt, etc.).

PHEV: Plug-in Hybrid Electric Vehicles (PHEVs) combines two propulsion systems in one vehicle; an electric motor that is battery-powered and can be plugged in and recharged, and an engine refueled with gasoline. (e.g., Chevy Volt, Toyota Prius Plug-in, Ford C Max and Fusion Energi, etc.)

1. Do you currently own or lease a plug-in electric vehicle (PEV)? (Select One Only)

- ❒ YES, I own or lease at least one PEV. [Skip to Question 5.]
  If "YES", please specify vehicle year, make, and model: _____
- ❒ NO, I do not own any PEVs.

2. On a scale of 1 to 5 with 1 being "No," and 5 being "Very Likely," how likely are you to purchase or lease a PEV by the end of 2018? (Select One Only)

No	Not Likely	Maybe	Likey	Very Likely	Don't Know
1	2	3	4	5	
❒	❒	❒	❒	❒	❒

[If you selected 1, 2 or Don't Know, skip to Question 9.]

3. In which year do you think you would buy or lease a PEV? (Select One Only)

- ❒ in 2016
- ❒ in 2017
- ❒ in 2018 or beyond

4. What type of PEV would you most likely lease or purchase? (Select One Only)

- ❒ **Battery Electric Vehicle** (BEV: All electric with ~100-200 miles electric range; e.g., Nissan LEAF, Ford Focus EV, Tesla Model 3, Chevy Bolt, etc.)
- ❒ **Plug-in Hybrid Electric Vehicle** (PHEV: ~10-40 miles all electric range and up to 300 miles additional gas/hybrid range; e.g., Chevy Volt, Ford C Max Energi)
- ❒ **Don't Know**

Survey Page 3

Resident Plug-in Electric Vehicle Charging Survey

5. **Approximately how many miles do you drive round trip between home and work?**
(At home? Check here____ and enter average daily miles for routine daily events - then skip to Question 8)
Enter number of miles only : _____ miles

6. **Do you typically park for a full-work day where you work (i.e., 8 hours)? (Select One Only)**

- ❒ YES, I typically park a full work-day at work
- ❒ NO, I do not typically park a full work-day at work (in and out during day)
- ❒ N/A (vanpool, etc.)

7. **Do you have access to electric vehicle charging at work (e.g., wall outlet/120V or 240V charging equipment)? (Select One Only)**

- ❒ Yes
- ❒ No
- ❒ Sometimes
- ❒ Don't Know

8. **Based on your daily commute and your ability or inability to recharge at work and other places, which of the following charging options would you prefer installed in your community: (Select One Only)**

- ❒ **Level 1 (120 V) charging only** (Most charge at 4-6 miles of range/hr of charge - Lower installation cost, slower electricity use and less load on circuit – can use a regular household plug to connect)
- ❒ **Level 2 (240 V) charging only** (Most charge at 16-24 miles of range/hr of charge – Higher hardware/installation costs, faster electricity use and higher load on a circuit – usually requires electrician for installation of heavy duty dryer plug or hard wire to 208/240V)
- ❒ **Either would work for me** (i.e., long park time, lower daily driving, smaller battery)
- ❒ **No idea/Don't know**

9. **Are you interested in receiving information updates about installing electric vehicle charging equipment in your community?**

- ❒ YES, please add me to the charging update distribution list for my community.
  My email is: _____
- ❒ NO, thanks.

For more information on multi-unit dwelling vehicle charging, check out this guide:
http://www.pevcollaborative.org/multi-unit-dwelling

Thank you! Send form comments/suggestions to: JRP@JRPCharge

Survey

Dear Fellow Resident:

A group of fellow residents here at (INSERT PROPERTY NAME) are interested in plug-in electric vehicles (PEVs) and would like to work with the (Insert HOA and/or property owner/management) to have charging stations installed for current and future electric vehicle drivers to use. As part of this process, we would like to get input on your current and future plans for driving and charging a PEV. This will help us establish a proposal for PEV charging in our community. This survey should take less than 5 minutes to complete.

Plug-in electric vehicles include all electric battery electric vehicles (BEV) which have an all-electric range between 80 to 250 miles such as the Nissan LEAF and Fiat 500e, etc., and plug-in hybrid electric vehicles (PHEV) that have between 10 and 45 miles of electric range to begin travel and can continue as a gasoline hybrid for an additional 300 miles of range, such as the Chevy Volt and Ford Fusion Energi.

Please submit completed survey to _____

by_____.

Thank you for supporting our efforts to evaluate current and future plug-in electric vehicle needs of our residents and their guests. For detailed information about available PEVs, incentives and charging, go to http://www.driveclean.ca.gov/pev and http://www.pluginamerica.org/

Definitions: (more information at http://www.driveclean.ca.gov/pev)

- **PEV:** A Plug-in Electric Vehicle (PEV) is a general term for any car that runs at least partially on battery power and is recharged by plugging in to the electricity grid. There are two different types of PEVs to choose from: pure battery electric and plug-in hybrid electric vehicles.
- **BEV:** Battery Electric Vehicles (BEVs) operate exclusively on electricity stored in batteries and only has an electric motor. (e.g., Nissan LEAF, Ford Focus EV, Tesla Model S, Chevy Bolt, etc.).
- **PHEV:** Plug-in Hybrid Electric Vehicles (PHEVs) combines two propulsion systems in one vehicle; an electric motor that is battery-powered and can be plugged in and recharged, and an engine refueled with gasoline. (e.g., Chevy Volt, Toyota Prius Plug-in, Ford C Max and Fusion Energi, etc.)

1. Do you currently own or lease a plug-in electric vehicle (PEV)? (Select One Only)

YES, I own or lease at least one PEV. [Skip to Question 5.]
If "YES", please specify vehicle year, make, and model:
_____

NO, I do not own any PEVs.

2. On a scale of 1 to 5 with 1 being "No," and 5 being "Very Likely," how likely are you to purchase or lease a PEV by the end of 2018? (Select One Only)

	Not			Very	
No	Likely	Maybe	Likely	Likely	Don't
1	2	3	4	5	Know

[If you selected 1, 2 or Don't Know, skip to Question 9.]

3. In which year do you think you would buy or lease a PEV? (Select One Only)

in 2016

in 2017

in 2018 or beyond

4. What type of PEV would you most likely lease or purchase? (Select One Only)

Battery Electric Vehicle (BEV: All electric with ~100-200 miles electric range; e.g., Nissan LEAF, Ford Focus EV, Tesla Model 3, Chevy Bolt, etc.)

Plug-in Hybrid Electric Vehicle (PHEV: ~10-40 miles all electric range and up to 300 miles additional gas/hybrid range; e.g., Chevy Volt, Ford C Max Energi)

Don't Know

5. Approximately how many miles do you drive round trip between home and work?
(At home? Check here____ and enter average daily miles for routine daily events -then skip to Question 8)
Enter number of miles only :_____ miles

6. Do you typically park for a full-work day where you work (i.e., 8 hours)? (Select One Only)

YES, I typically park a full work-day at work

NO, I do not typically park a full work-day at work (in and out during day)

N/A (vanpool, etc.)

7. Do you have access to electric vehicle charging at work (e.g., wall outlet/120V or 240V charging equipment)? (Select One Only)

Yes

No

Sometimes

Don't Know

8. Based on your daily commute and your ability or inability to recharge at work and other places, which of the following charging options would you prefer installed in your community: (Select One Only)

Level 1 (120 V) charging only (Most charge at 4-6 miles of range/hr of charge - Lower installation cost, slower electricity use and less load on circuit – can use a regular household plug to connect)

Level 2 (240 V) charging only (Most charge at 16-24 miles of range/hr of charge – Higher hardware/installation costs, faster electricity use and higher load on a circuit – usually requires electrician for installation of heavy duty dryer plug or hard wire to 208/240V)

Either would work for me (i.e., long park time, lower daily driving, smaller battery)

No idea/Don't know

9. Are you interested in receiving information updates about installing electric vehicle charging equipment in your community?

YES, please add me to the charging update distribution list for my community.

My email is: _____

NO, thanks.

For more information on multi-unit dwelling vehicle charging, check out this guide: http://www.pevcollaborative.org/MuD

Thank you! Send form comments/suggestions to: JRP@JRPCharge

Congregate

Make Connections - Create a base support group of like-minded tenants for getting vehicle charging into your community. Form an "Organizing Committee" that can help you brainstorm and network with your community. Hold a "Getting the Juice" get together with these folks and with the juice and cookies, share the information and resources you have to date and ask for helpers for the steps going forward. There is power in numbers and it helps to be inclusive.

Meet with Management – Have a friendly sit-down with management to discuss your interests and to explain the groundwork you are doing to help with the process. Let them know that you look forward to sitting down with them in the future to share information and to get their feedback. Try not to jump into detailed discussions here — it's a meet and greet. Make it friendly and inclusive (a plate of cookies here can't hurt either) and reassure them they will be in the loop and that you will communicate with the site management representatives first (no letters to corporate at this stage). Let them know that you look forward to helping them add this amenity to your community to make it more appealing to like-minded residents in the future.

Motivate

Send a Letter! Write a letter on behalf of the community to the local property management representatives citing the information and survey data that you have collected. Here is a sample letter with suggestions of some references you may wish to include.

Link: Sample Letter http://www.pevcollaborative.org/MuD

Sample Letter for Management Request

Sample Letter Template (Edit as you like)

Date:

Inside Address: (Usually Site Management Company Representative you have established relationship with or HOA – or cc HOA or send to both whatever suits your situation)

Dear (add name(s) of point person from above):

Thank you for discussing your property's electric vehicle charging opportunities with us, as we mentioned, with the increasing number of plug-in electric vehicles on California's roads, residents of [insert community name] have been discussing the benefits of adding electric vehicle charging stations as an amenity for this community.

To help support this, we have taken a survey of the residents to get a better sense of the interest in PEVs. The survey results gave us the following feedback: [present your information in any format that works best for you; straight numbers and the responses in percentages/numbers for each question, or a narrative touching on the major information gained from the survey with an offer to share the detailed survey results].

Based on this feedback, we would like to respectfully submit a request to begin an evaluation of how to best add vehicle charging services to our community. There are a variety of technology and business models available. The California PEV Collaborative offers an orientation guide to multi-unit dwelling charging, sample documents and case studies at www.pevcollaborative.org/mud. The PEV Resource Center also offers information on plug-in electric vehicles, rebates and charging technologies at www.DriveClean.ca.gov/pev and Plug In America offers information for the average consumer on different charging technologies at http://www.pluginamerica.org.

Please let us know if we can offer you any support going forward to advance this request and identify resources to answer any questions that may come up. Thank you for your attention, and we look forward to working with you on this in the future.

Sincerely,

(Name of your coordinating Committee and its members)

Please forward suggested edits/comments to: JRP@JRPCharge.com

Sample Letter

Date:

Inside Address: (Usually Site Management Company Representative you have established relationship with or HOA – or cc HOA or send to both whatever suits your situation)

Dear (add name(s) of point person from above):

Thank you for discussing your property's electric vehicle charging opportunities with us, as we mentioned, with the increasing number of plug-in electric vehicles on California's roads, residents of [insert community name] have been discussing the benefits of adding electric vehicle charging stations as an amenity for this community.

To help support this, we have taken a survey of the residents to get a better sense of the interest in PEVs. The survey results gave us the following feedback: [present your information in any format that works best for you; straight numbers and the responses in percentages/numbers for each question, or a narrative touching on the major information gained from the survey with an offer to share the detailed survey results].

Based on this feedback, we would like to respectfully submit a request to begin an evaluation of how to best add vehicle charging services to our community. There are a variety of technology and business models available. The California PEV Collaborative offers an orientation guide to multi-unit dwelling charging, sample documents and case studies at www.pevcollaborative.org/mud. The PEV Resource Center also offers information on plug-in electric vehicles, rebates and charging technologies at www.DriveClean.ca.gov/pev and Plug In America offers information for the average consumer on different charging technologies at http://www.pluginamerica.org.

Please let us know if we can offer you any support going forward to advance this request and identify resources to answer any questions that may come up. Thank you for your attention, and we look forward to working with you on this in the future.

Sincerely,

(Name of your coordinating Committee and its members)

Send form comments/suggestions to: JRP@JRPCharge

Collaborate

Walk the Walk:
Walk the parking areas with property management representatives and the facilities support staff. Look at layouts, metering rooms, existing wiring runs, etc., so everyone has a basic orientation and understands the whole picture. Perhaps management will invite their electrical contractor to attend and explain electrical details A licensed electrical contractor will handle coordination with the utility, inspectors, licenses and support for any future construction/installation project. Make sure the property managers know how to contact the point person for the core "Organizing Committee" going forward.

Other Facts You'll Need: If looking at using electricity from common area metering, it will be necessary for property management to review a few pieces of information with their local utility, such as:

- Existing electric rates
- Impacts on these rates from an increased electrical load
- Information about any special rates or special projects for multi-unit dwelling charging for which you may qualify
- Any grants/discounts/rebates/private special projects that may apply to charging in your region
- New service drops may be the next level of conversation with the utility for vehicle charging and whether this approach might provide access to incentive rates for vehicle charging

Negotiate

Let's Talk: At this point your property manager may wish to look at the different companies that offer charging station technology/support that span from simple "non-communicating" charging units that may only require a flat monthly fee for residents to use, to advanced networked charging units that offer monthly subscription rates for support and custom reports related to usage. The property owner/manager can coordinate visits and bids for services from these companies that offer hardware and support. The PEV Collaborative case studies offer insights into the growing range of solutions for multi-unit charging projects**.**

Link: Case Studies **http://www.pevcollaborative.org/MuD**

Celebrate !!

Hopefully your efforts will have paid off and resulted in a path to vehicle charging for your community. **CONGRATULATIONS!** Here are some ideas you might consider for your community to acknowledge this advancement:

- **Schedule a "Mini Ride-and-Drive"** – Invite any residents, relatives, friends, local Plug In America members, or even local dealerships to offer ride and/or drives of plug-in electric vehicles on a weekend at your community for a few hours and let others who are curious experience the electric ride experience.

- **Send a THANK YOU! Letter** of acknowledgement to your property manager (and be sure to copy their corporate leaders) for their cooperation and the appreciation of the community members for this forward-looking action.

- **Get it in Writing!** Encourage your property manager to contact the PEV Collaborative and get your project committed to a case study available to others. Share the wealth of your experience and help encourage more projects for similar communities.

- **Make NOISE! -** Schedule a little celebration on the first day you can charge the cars in your community. You all deserve a plate of cookies as well! **Great work!** Enjoy your electric miles!

Charging Resources to Check

- Federal Tax Credits for Infrastructure (Commercial – up to 30% - Check Status >2016)
- Grants (e.g. California – CA Energy Commission (CEC) Air Quality Management Dist. (AQMDs)
- Utility Programs – Municipals and Investor Owned Pilots (e.g. SCE, SDG&E – PG&E pending)
- State Settlements – e. g. evGo in California (Multi-unit portion)
- Vendor Incentives – ask relative to hardware quantity or support service schedules
- Local resources in any state – Energy Commissions, Utility, Clean City Coalition, etc.
- http://www.goelectricdrive.org/resources
- These States* have some version of incentive for charging: Alabama, Arizona, California, Colorado, Delaware, District of Columbia, Florida, Georgia, Indiana, Kansas, Louisiana, Maryland Massachusetts, Missouri, North Carolina, New York, Oklahoma, Oregon, Texas, Vermont, Washington

* Some are only specific cities or utilities within a state

Questions?

EMPower the People for Electric Mobility

Joel R. Pointon
Principal – JRP Charge
Multi-unit Charging Consulting

JRP@JRPCharge.com

Thanks to:

Plug-In America - http://www.pluginamerica.org/

Webinar: http://www.pluginamerica/webinars

CA Plug-in Electric Vehicle Collaborative - http://www.pevcollaborative.org/

Toolkit: http://www.pevcollaborative.org/MuD

Charging Infrastructure in Washington State

IWC Meeting – 8 June 2016

PUGET SOUND ENERGY

Major ARRA Public Charging Projects in Washington

	THE EV Project	ChargePoint by Coulomb Technologies	WEST COAST ELECTRIC HIGHWAY
DC Fast Chargers	13		12
Level 2 Public	343	127	2
Level 2 Residential	1127	19	
Level 2 Private Non- residential	34		

PSE PUGET SOUND ENERGY

Where the Networks Stand Today

	blink	chargepoint	AV aerovironment	nrg eVgo	SemaConnect	TESLA
DC Fast Charging Locations	15	11	12	12		5
Level 2 Public Ports	287	496	12	12	118	
Level 2 Private Non-residential						94

PSE PUGET SOUND ENERGY

Data retrieved from DOE June 2, 2016

So What Happened?

CenturyLink North Parking Lot ***Then***

CenturyLink North Parking Lot ***Now***

PSE PUGET SOUND ENERGY

But Some Still Stands

Kirkland Fred Meyer

CenturyLink Parking Garage

PUGET SOUND ENERGY

A Few Lessons Learned in Washington

- Policy Matters!
  - During these projects, Washington waived sales tax on fully electric vehicles, but not plug-in hybrids. As a result, many more EVs than PHEVs.
- A Minimal Network May Not Be Enough
  - Redevelopment has removed many chargers from service, leaving gaps
  - Expect repair and replacement of infrastructure
- Moving Beyond ARRA
  - Automaker funded charging
  - Utilities entering charging

PSE PUGET SOUND ENERGY

What's Happening/Ahead for Washington

WEST COAST ELECTRIC HIGHWAY

- $1M in funding for corridor charging
- RFP expected summer 2016

PSE PUGET SOUND ENERGY

- 1100 residential customers enrolled in charger rebate and data collection program
- Initial data analysis later 2016

AVISTA

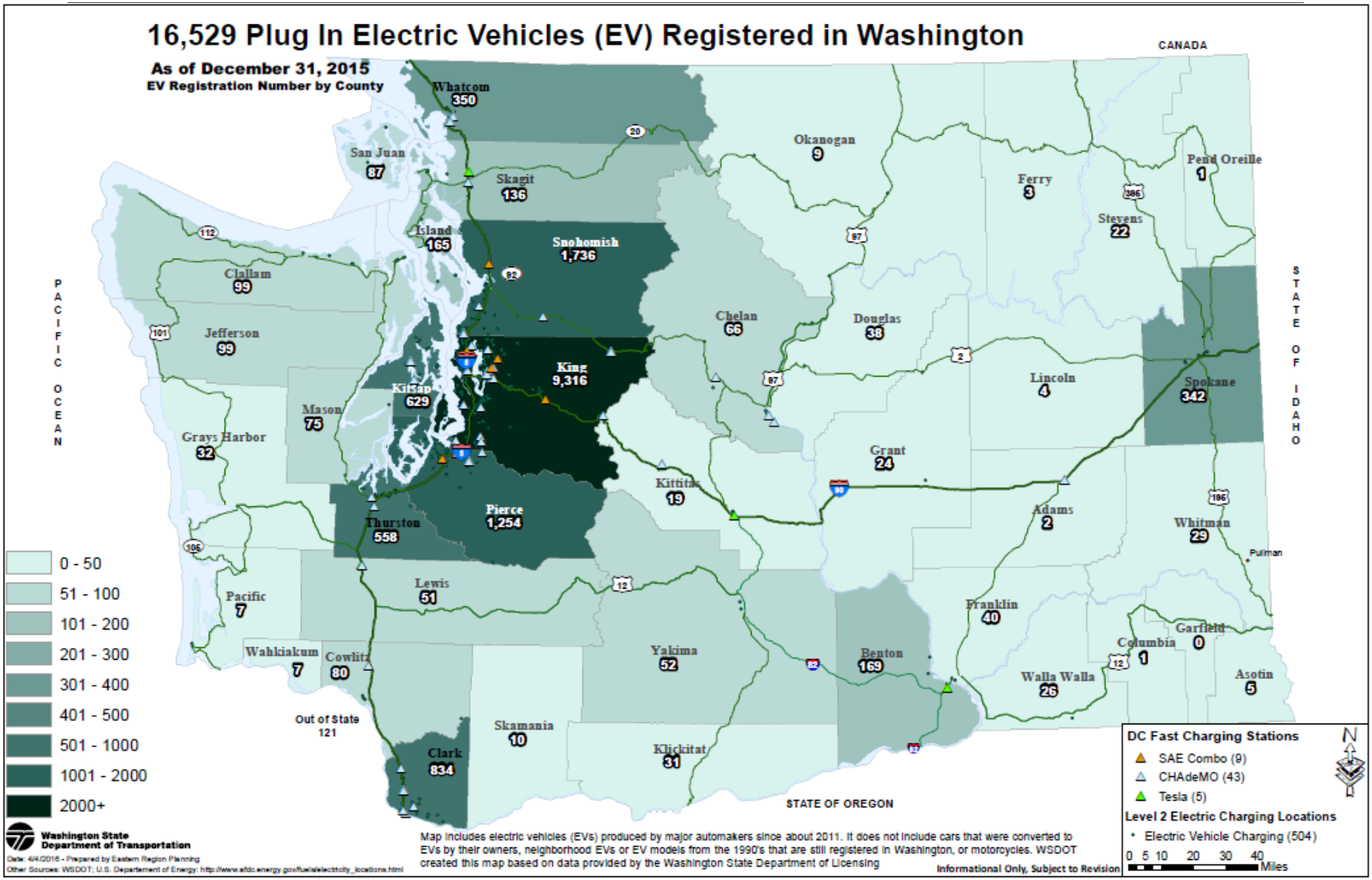
- Recently approved by Utilities and Transportation Commission for DC Fast Charge, Public, Workplace, and Residential Charging Pilot
- Launch expected 2nd Half 2016

Seattle City Light

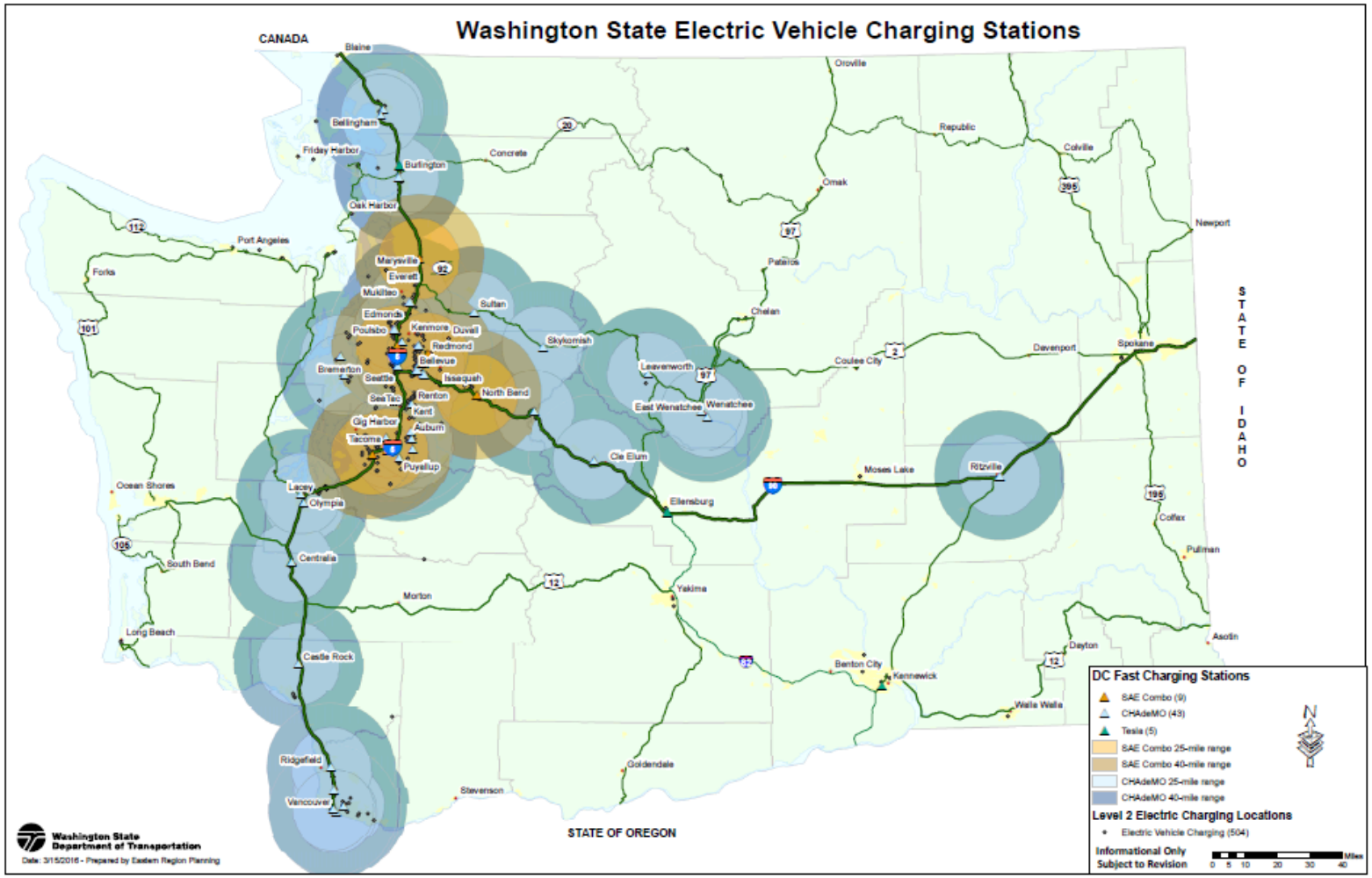
- DC Fast Chargers as part of City of Seattle's Drive Clean Seattle

PSE PUGET SOUND ENERGY

A Snapshot of Washington Today



DC Fast Charging in Washington Today



PUGET SOUND ENERGY

EV Project Infrastructure – 5 Years Later

Ben Farrow
Puget Sound Energy

John Halliwell
EPRI

IWC Meeting, Seattle, WA
June 8, 2016

Ben Farrow's Slides

Still Running

Knoxville, TN

A Little Rough (Dirty and No TV screens), but Still Running

Chattanooga, TN

ICEing…

Knoxville, TN

3 Out of 5 Dead (Grocery Store)

Chattanooga, TN

Being Replaced

Oak Ridge, TN

Replaced

(06/05/2016)

(2012)

Chattanooga, TN

Gone

Oak Ridge, TN

Still Standing, but Out of Service

Townsend, TN

Townsend, TN

Brand New Infrastructure – First Dual Cable System in Knoxville, TN (EZ-Stop Market)

EPRI Infrastructure Working Council

INTEGRATED DISTRIBUTED ENERGY RESOURCE PORTFOLIO PLANNING & ELECTRIFICATION OF TRANSPORTATION

June 8, 2016

Paul Stith, Solution Lead
SMART INTEGRATED INFRASTRUCTURE

BLACK & VEATCH
Building a world of difference.®

BLACK & VEATCH

A LEADING GLOBAL ENGINEERING, CONSULTING & CONSTRUCTION COMPANY

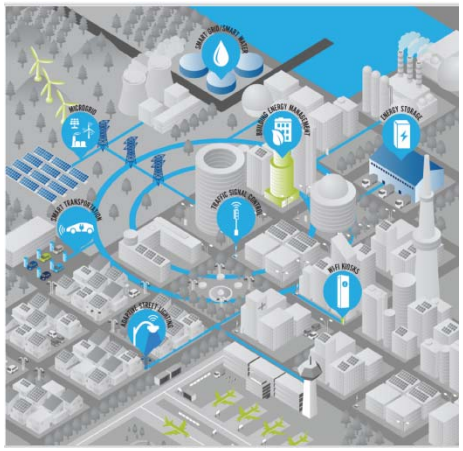
- Founded in 1915
- Global workforce ~ 11,000
- Employee-owned corporation
- $3.6 billion in annual revenues in 2013
- More than 110 offices worldwide
- Completed projects in more than 100 countries
- Typically 7,000 concurrent projects

ENERGY

WATER

TELECOMMUNICATIONS

SMART INTEGRATED INFRASTRUCTURE



Integrated Infrastructure

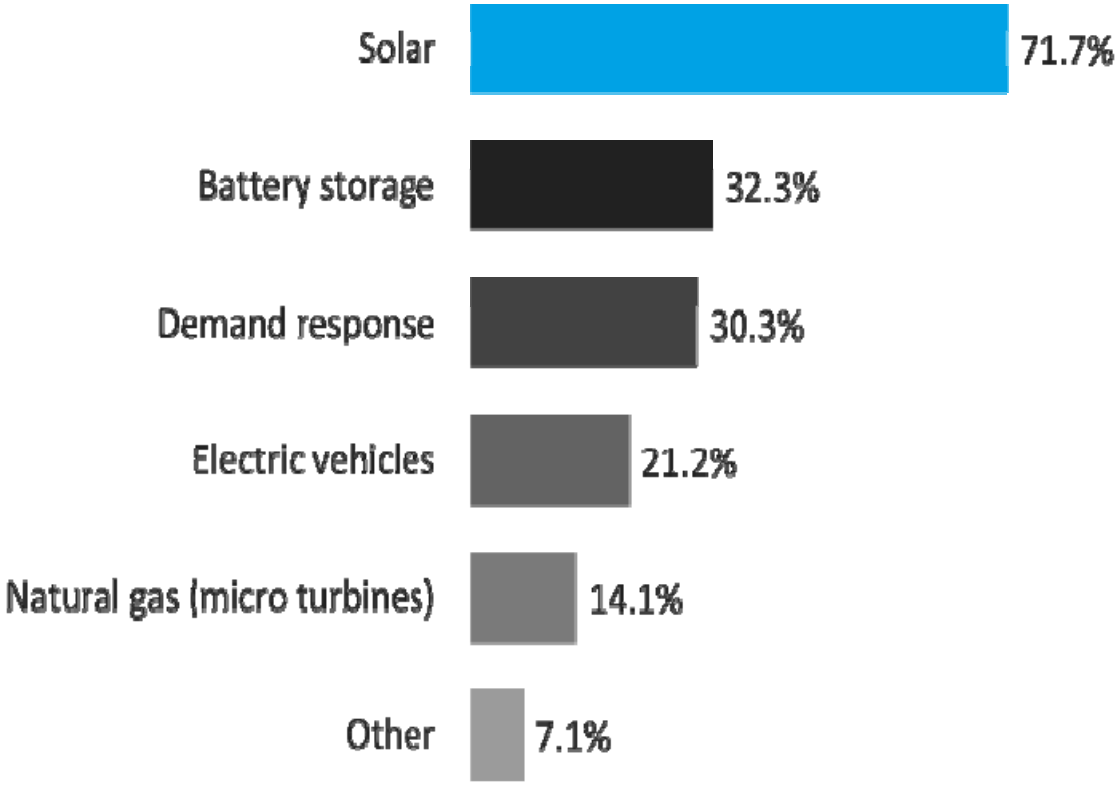
Improves system performance by leveraging synergies between multiple infrastructure systems

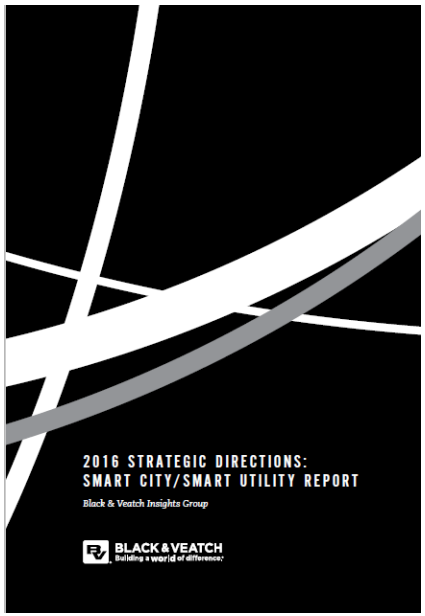
Smart Analytics

Improve asset and financial performance by transforming data into actionable intelligence

WE'RE *BUILDING A WORLD OF DIFFERENCE*. TOGETHER.

DISTRIBUTED ENERGY RESOURCES THAT WILL IMPACT ELECTRIC UTILITIES MOST





B&V 2015-16 SURVEY INCLUDING 206 ELECTRIC UTILITIES

Source: *2015-16 Strategic Directions: Smart Utilities/Smart Cities Survey Results, Black & Veatch Global Insights, published Feb. 2016.*

VALUE OF ELECTRIC VEHICLES TO THE GRID

- **Load Growth** – Residential, commercial fleets, workplace charging, public charging
- **Flexible Load** – Built-in vehicle or charging station timers can schedule charging to take advantage of Time of Use rates, smart charging allows charging to be controlled remotely with event or pricing signals
- **DER Aggregation** – Multiple potential ways to participate, dynamic based on where connected
- **Behind the Meter / Market Participation** – Opportunities for market participation, low cost to access market, stacking value streams similar to energy storage
- **Locational Value** – Vehicle loads can be optimized for conditions across distribution grid

Value of grid connected vehicle is different for each utility based on grid conditions, DER portfolio, clean energy objectives – and will change over time.

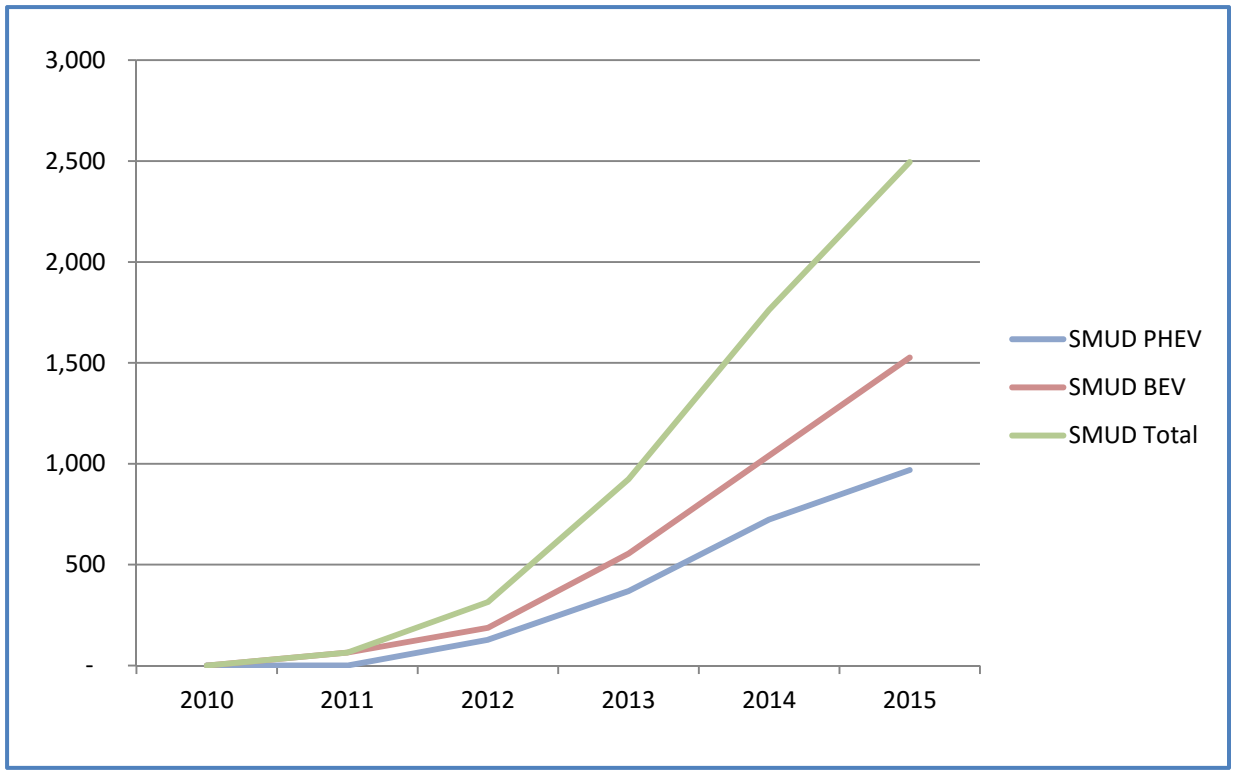
SAMPLE UTILITY SERVICE AREAS
MARCH 2010 - 2015 ELECTRIC VEHICLE REBATE CLAIMS

Utility Service Area	Vehicles	Annual Miles	MW (Power)	MWh (Energy)
SMUD	**2,456**	**29,472,000**	**604.18**	**8,420.57**
City of Anaheim	824	9,888,000	202.70	2,825.14
City of Azusa	55	660,000	13.53	188.57
City of Banning	2	24,000	0.49	6.86
City of Burbank	469	5,628,000	115.37	1,608.00
City of Cerritos	314	3,768,000	77.24	1,076.57
City of Colton	32	384,000	7.87	109.71
City of Glendale	789	9,468,000	194.09	2,705.14
Imperial Irrigation District	187	2,244,000	46.00	641.14
LADWP	13,423	161,076,000	3,302.06	46,021.71
City of Pasadena	768	9,216,000	188.93	2,633.14
City of Riverside	381	4,572,000	93.73	1,306.29
City of Vernon	14	168,000	3.44	48.00
Totals	**17,258**	**207,096,000**	**4,245.47**	**59,170.29**

Assumptions: Average Peak 6 KW, Miles/Year: 12,000, Efficiency: 3.5 Miles/KWh

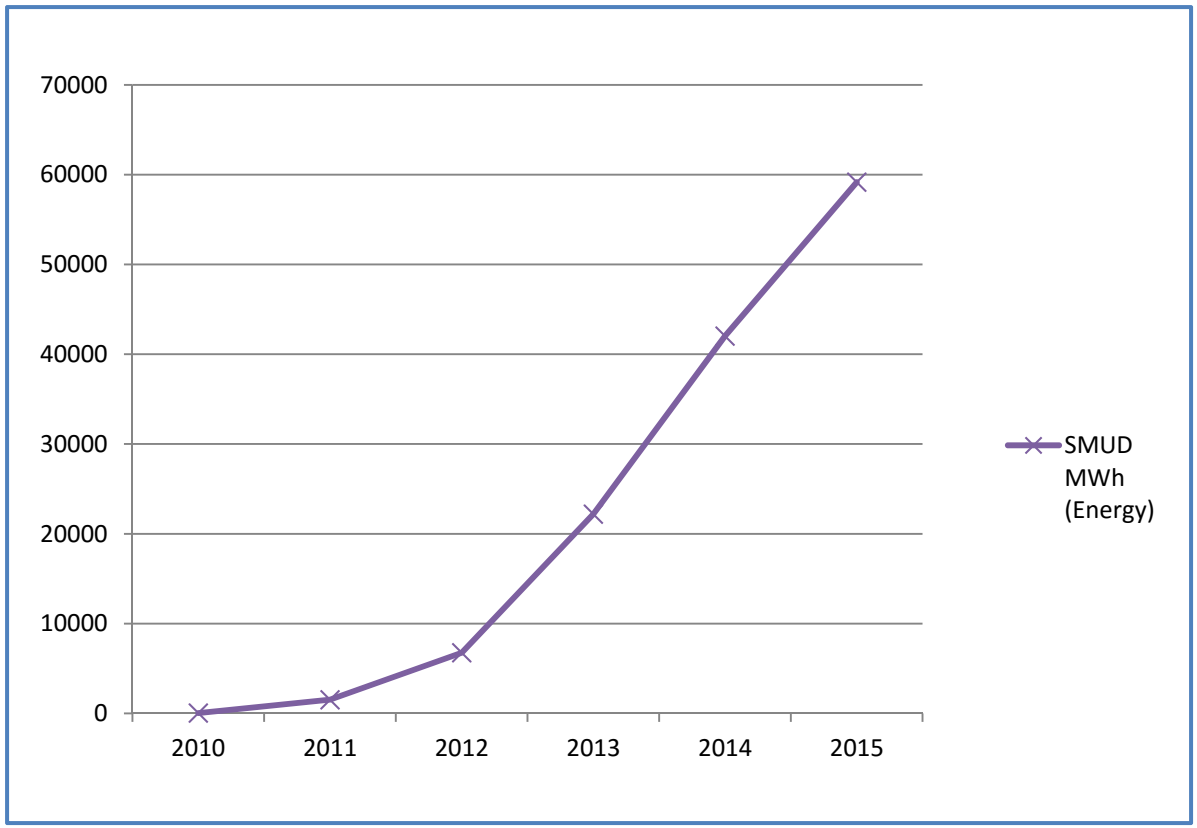
Data Source: Center for Sustainable Energy (2016). California Air Resources Board Clean Vehicle Rebate Project, Rebate Statistics. Data through November 20, 2015. Retrieved from https://cleanvehiclerebate.org/rebate-statistics SMUD Data through 12/31/2015.

SMUD SERVICE AREA
2010 – 2015 ELECTRIC VEHICLE REBATE CLAIMS



Data Source: Center for Sustainable Energy (2016). California Air Resources Board Clean Vehicle Rebate Project, Rebate Statistics. Data last updated November 20, 2015. Retrieved 06/05/2016 from https://cleanvehiclerebate.org/rebate-statistics

SMUD SERVICE AREA
ELECTRIC VEHICLE ENERGY CONSUMPTION GROWTH

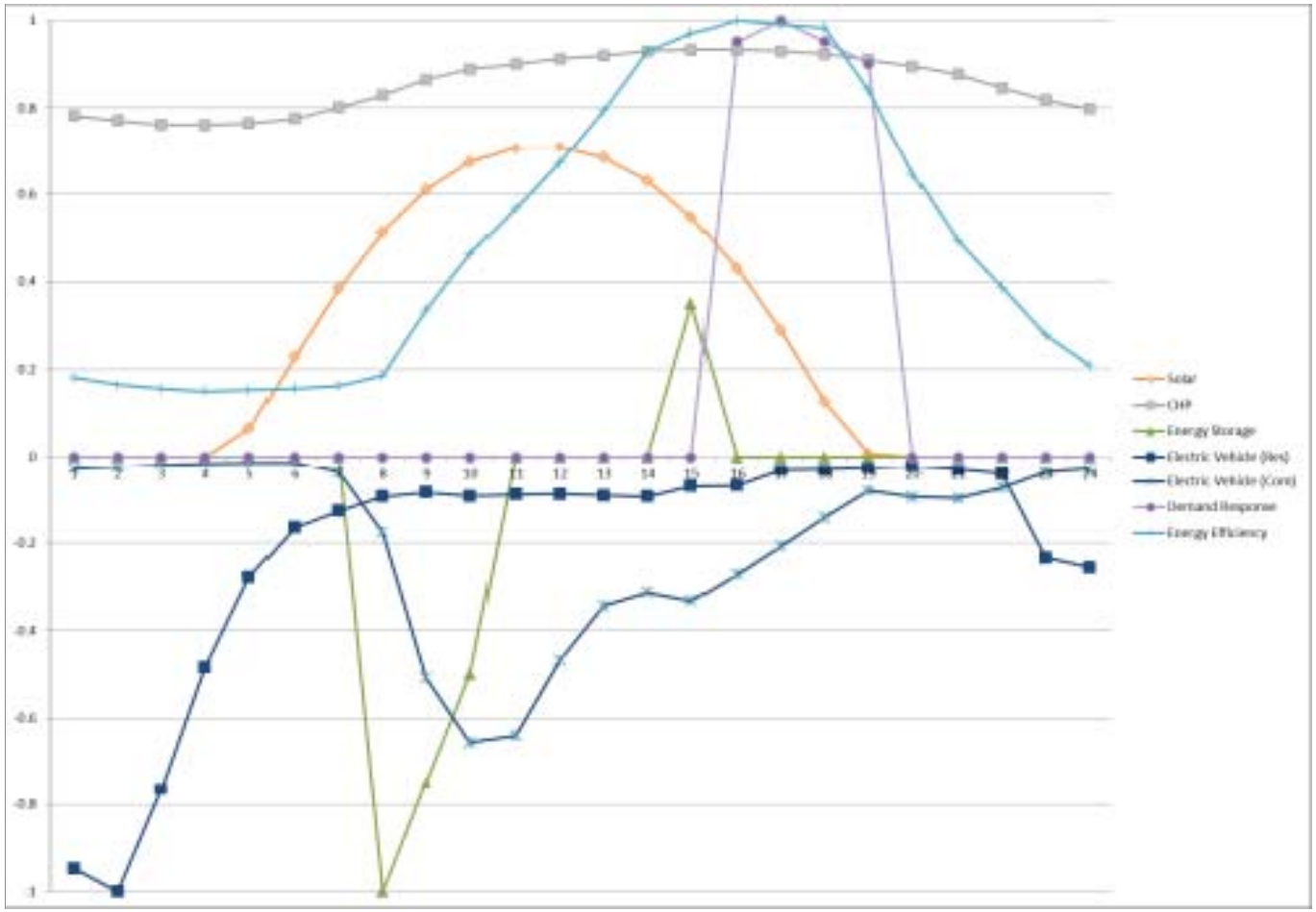


Based On: Miles/Year: 12,000, Efficiency: 3.5 Miles/KWh

Data Source: Center for Sustainable Energy (2016). California Air Resources Board Clean Vehicle Rebate Project, Rebate Statistics. Data last updated November 20, 2015. Retrieved 06/05/2016 from https://cleanvehiclerebate.org/rebate-statistics

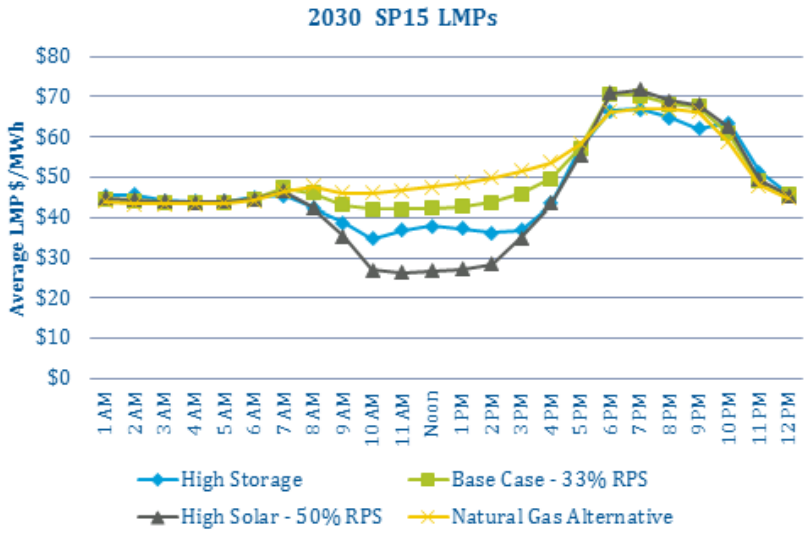
WHAT COULD POSSIBLY BE DIFFICULT TO FIGURE OUT?
DER LOAD PROFILE 2030 UTILITY CUSTOMER

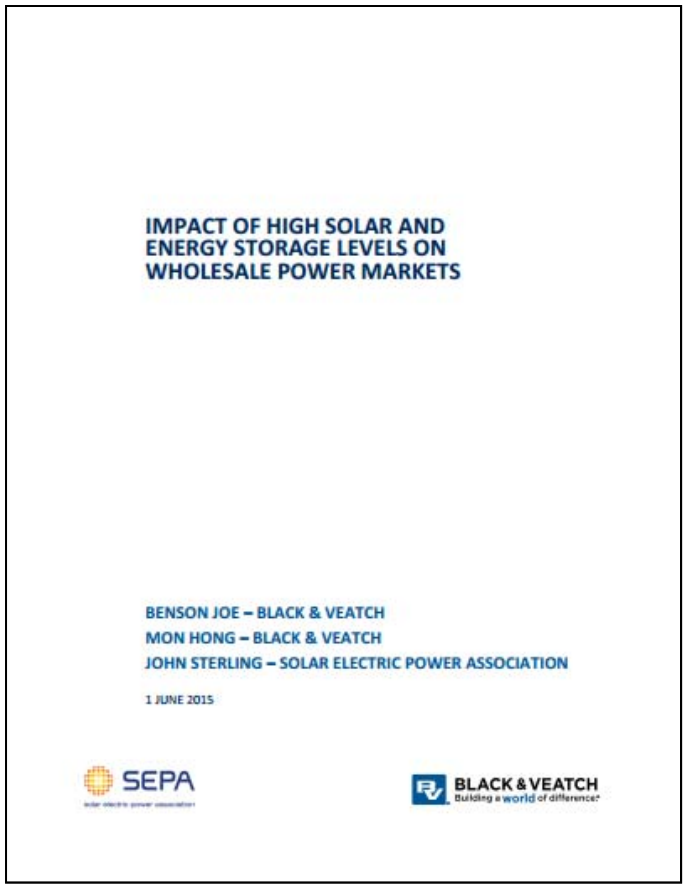
<- Load | Generation ->



ACTIVE INVOLVEMENT IN IMPACTS OF HIGH PENETRATION PV

- Utility and bulk scale modeling, previously
- New focus on impacts on distribution system





Source: https://www.solarelectricpower.org/media/350936/solar-and-energy-storage-impacts-on-wholesale-power-markets-final-report.pdf

- Background and Methodology
- Distribution System
  - DER Penetration Estimates
  - Impacts
- Bulk System Modeling and Impacts
- Recommendations for Future Analysis

BACKGROUND AND METHODOLOGY

SMUD BACKGROUND

- Community owned not-for profit utility formed in 1946
- Governed by independent locally elected governing Board of 7 members
- Serves electricity to 1.3 million people in Sacramento region
- 2,100 Employees
- 5th largest utility in the state
- Peak Demand of 3,300 MW
- Annual Sales ~11,000,000 MWh (~4% of state of California)

SMUD'S INTEREST AND RATIONALE

Dramatic increases in customer and 3rd party DER investments putting pressure on utility business model

Increased risk of stranded assets, overbuild, competitiveness challenges

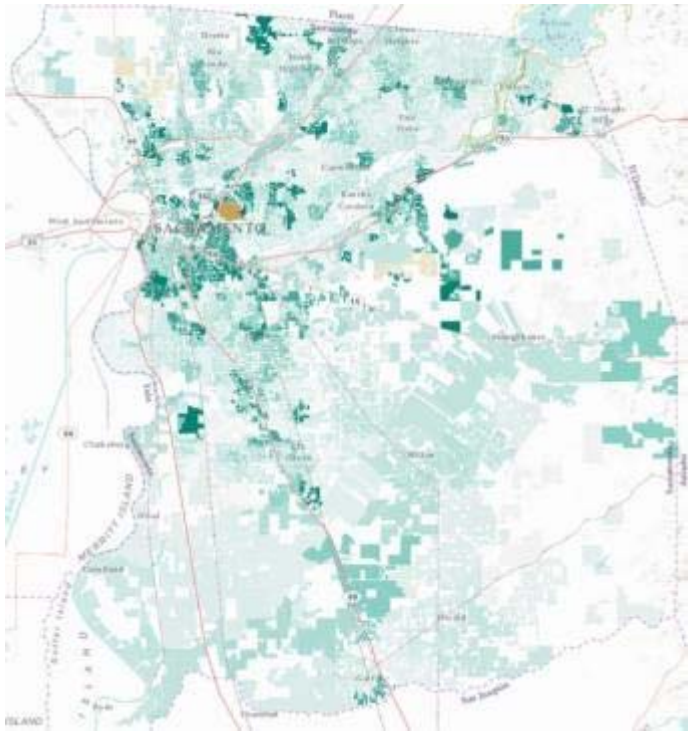
opportunity to leverage, optimize DER investments to create value for all of our customers

A first step to defining preferred levels of DERs, developing a strategy, and developing locational value estimates to influence optimal adoption

SMUD™

PROJECT BACKGROUND

- **SMUD engaged Black & Veatch to assist in assessing integrated Distributed Energy Resources (iDER)**
- **Major tasks**
  - Review of existing work and processes; tie together approaches
  - New, detailed assessments of potential through dispersion modeling
  - Distribution system (GRIDiant) modeling
  - Bulk system (PLEXOS) modeling
  - Economic valuation
  - Rooftop PV potential modeling
- **First of a kind study**



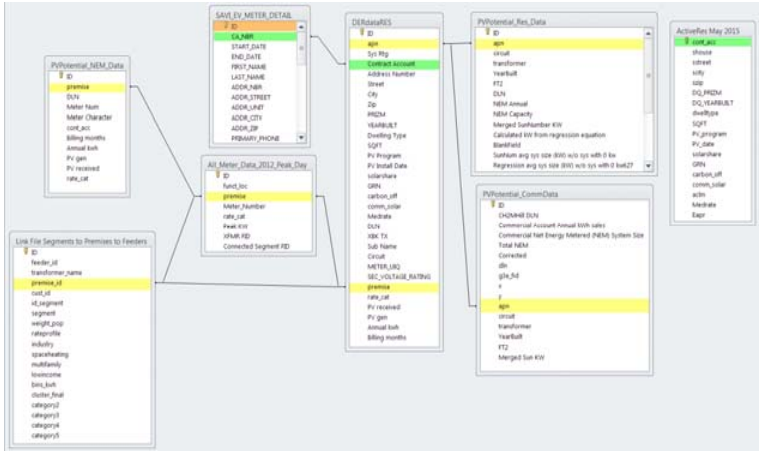
Projected DER Load Impacts

DISPERSION ANALYSIS PROCESS

Develop a customer database. → Identify DER potential and adoption propensity of each customer. → Select adopters for a target system potential. → Assign operation profile for each DER adopter.

Combine independent datasets

- Historic DER adoption
- Electricity usage (peak, annual)
- Meter locations (APN, circuit, sub)
- Customer segment (NAICS ID, PRIZM)
- Building attributes (ownership, multifamily, square footage)
- Customer behavior (Greenscore, program participation)



Critical to identify consistent ID across datasets, locational tags and consistent fill for missing data.

SMUD™

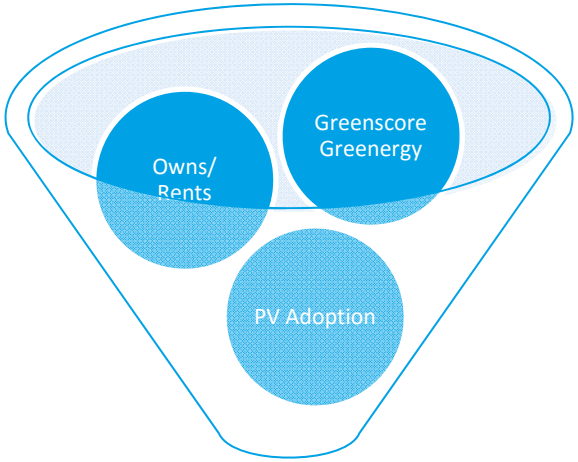
DISPERSION ANALYSIS PROCESS

Develop a customer database. → **Identify DER potential and adoption propensity of each customer.** → Select adopters for a target system potential. → Assign operation profile for each DER adopter.

Greenscore	Propensity
0	50 %
1	20 %
2	40 %
3	60 %
4	80 %

Owns/Rents	Propensity
Unclassified	50 %
Rents	30 %
Owns	70 %

Commercial EV Factor	Weight
Greenscore	0.40
Owns/Rents	0.30
Greenergy Participation 1	0.10
Greenergy Participation 2	0.05
Greenergy Participation 3	0.05
2030 PV Adoption	0.10



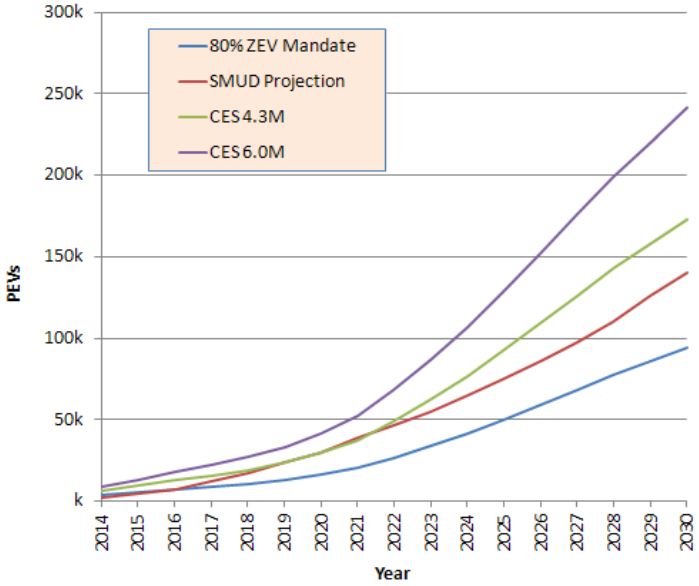
Propensity of EV Adoption

Used multiple weighting factors to determine a customer's EV adoption propensity.

SMUD™

TECHNOLOGIES REVIEWED

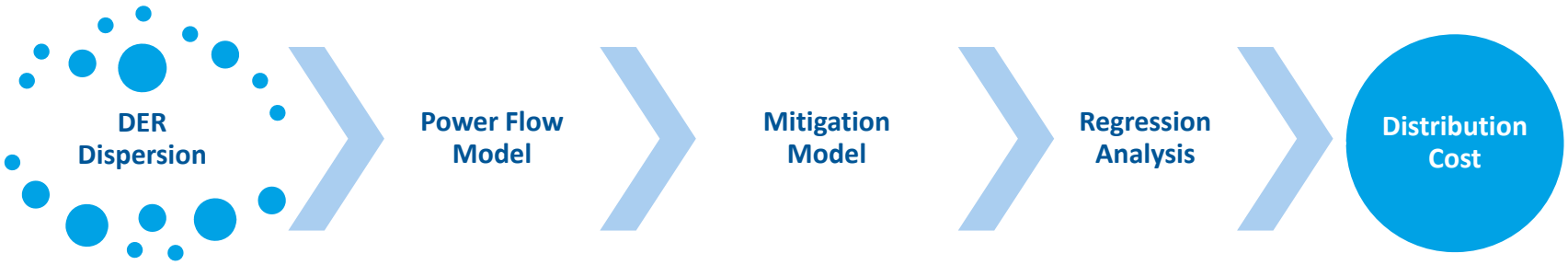
- **Technologies investigated:**
  - Distributed solar PV (PV)
  - Energy efficiency (EE)
  - Demand response (DR, dispatchable and nondispatchable, TOU rates)
  - Combined heat and power (CHP)
  - Energy storage (ES)
  - **Electric vehicles (EV)**



- **Other reviews**
  - Bioenergy potential and targets
  - Energy storage economic potential

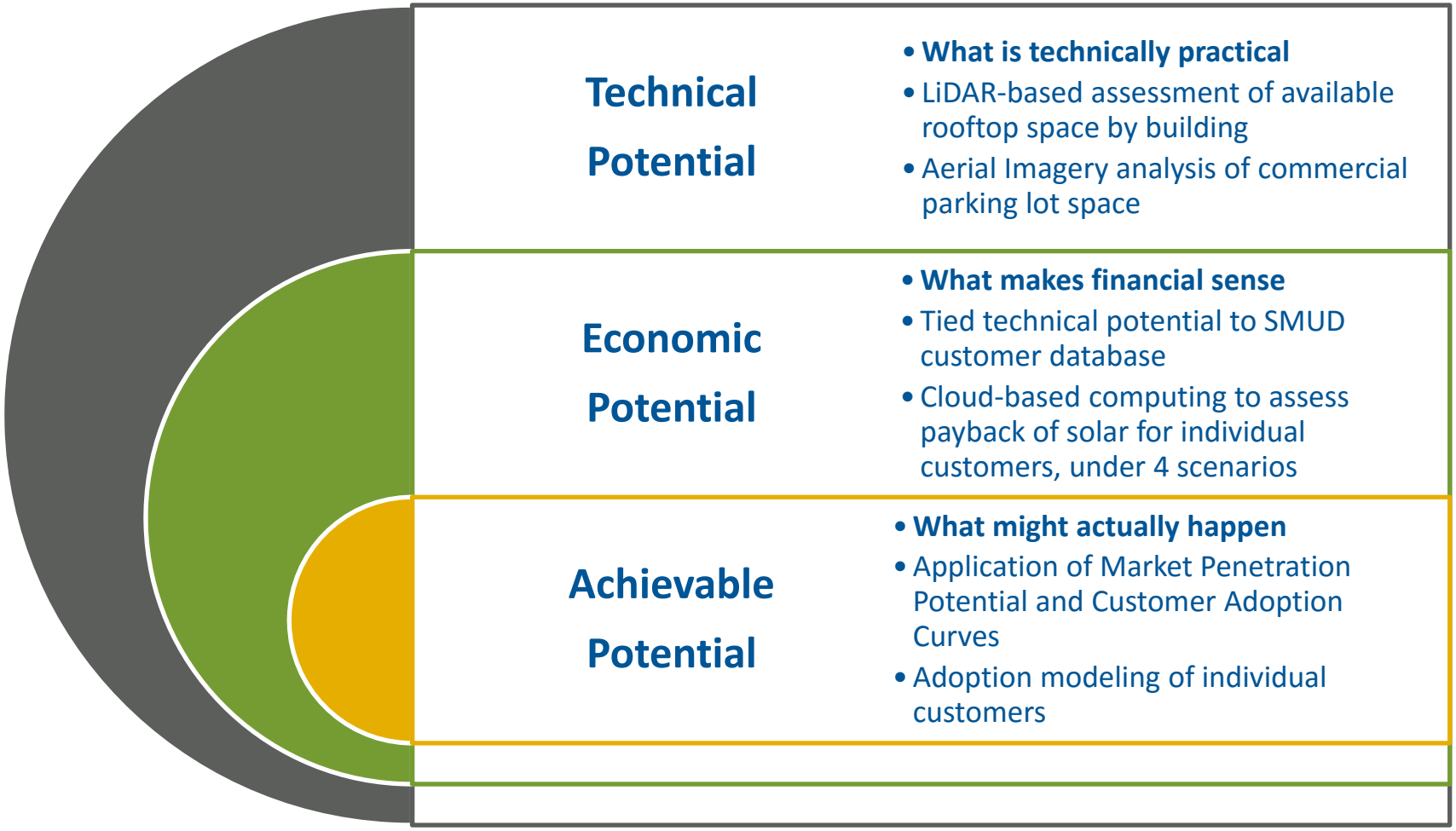
DISTRIBUTION SYSTEM PENETRATION ESTIMATES

DISTRIBUTION IMPACT & COST ASSESSMENT



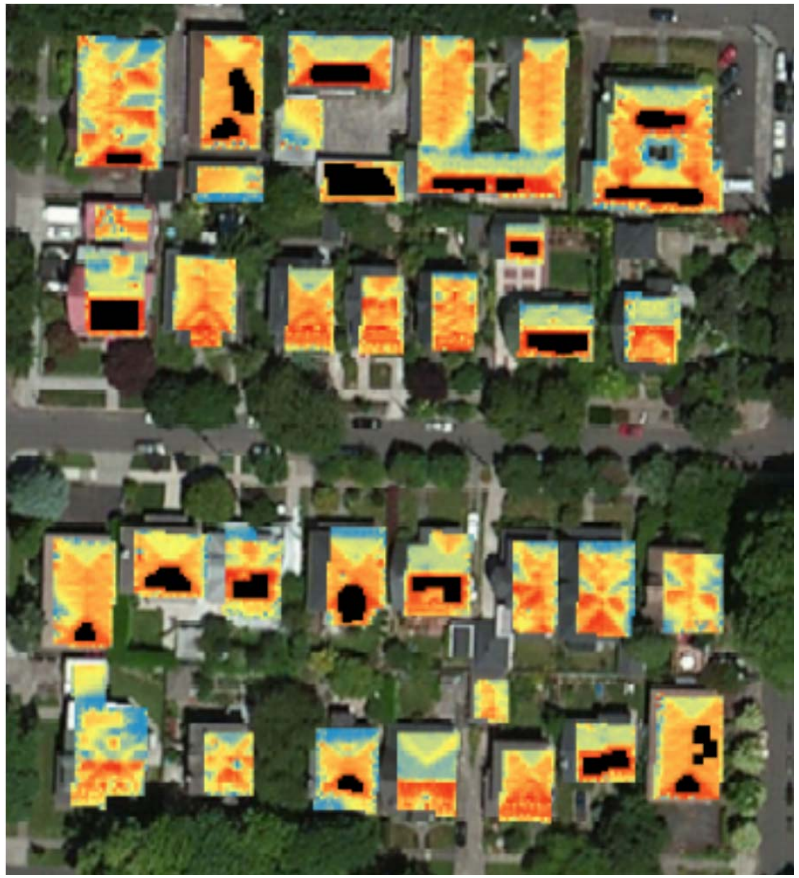
Full system	34 subs	4 feeders	Full system	Apply transformer replacement and voltage regulator costs to calculate total investment
B&V Excel	L+G GRIDiant	L+G GRIDiant	B&V Excel	
Meter scale	Service xfmr	Service xfmr	Substation	
Identify DER amount , type & 8760 shape for each customer	Model xfmr overloads and voltage issues per substation	Identify technologies to eliminate violations	Scale modeled issues and mitigation results	

DG SOLAR PV POTENTIAL APPROACH



SMUD™

SOLAR PV TECHNICAL POTENTIAL: ROOFTOPS + PARKING LOTS



- 3,000 MW of rooftop potential identified
- 4,600 MW of commercial parking lot potential identified
- Detailed analysis estimating customer adoption used to forecast amounts and locations

SMUD™

USE OF MAXIMUM MARKET PENETRATION AND ADOPTION CURVES

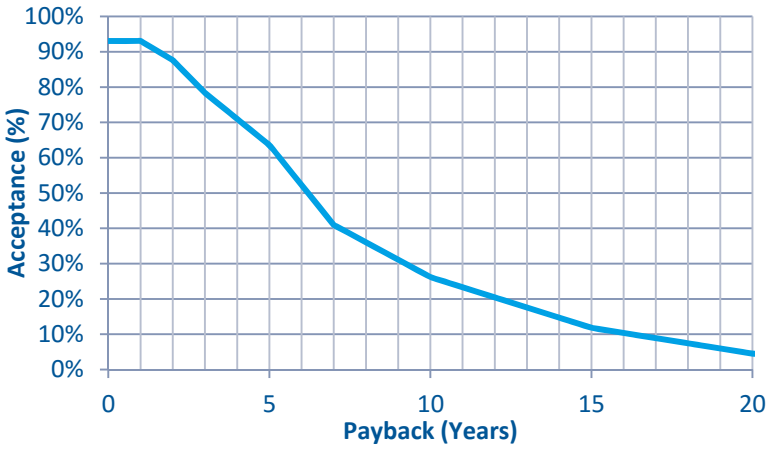
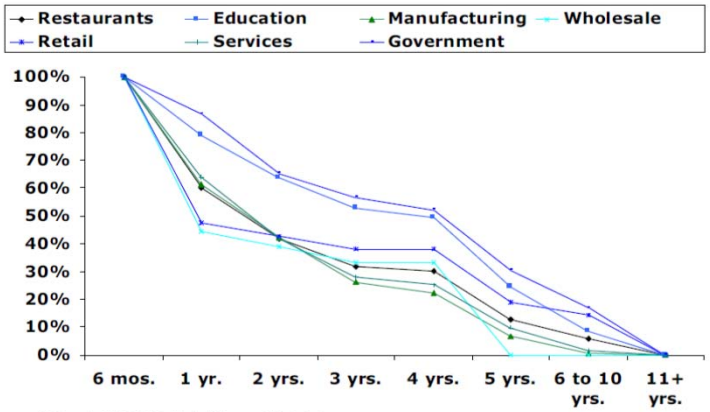
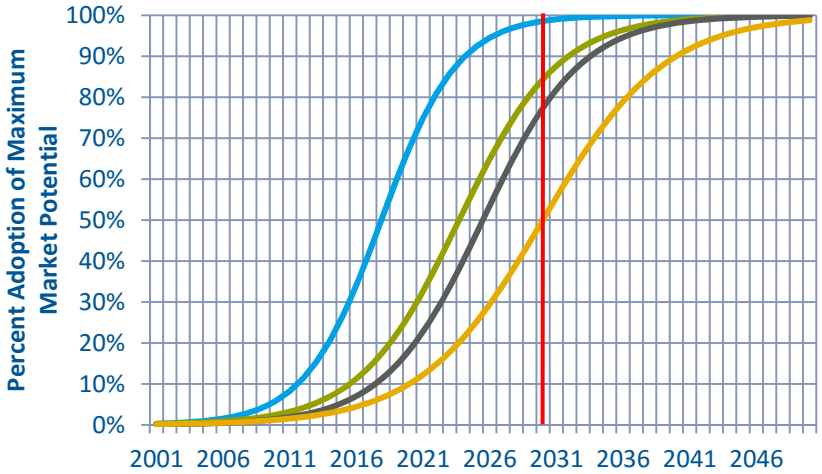
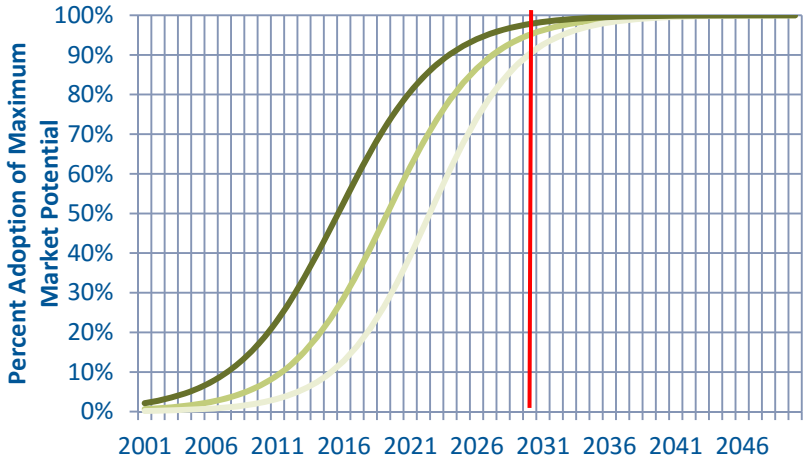


Figure 8: Customer Payback Acceptance Curve



Source: *Primen's 2003 Distributed Energy Market Survey*

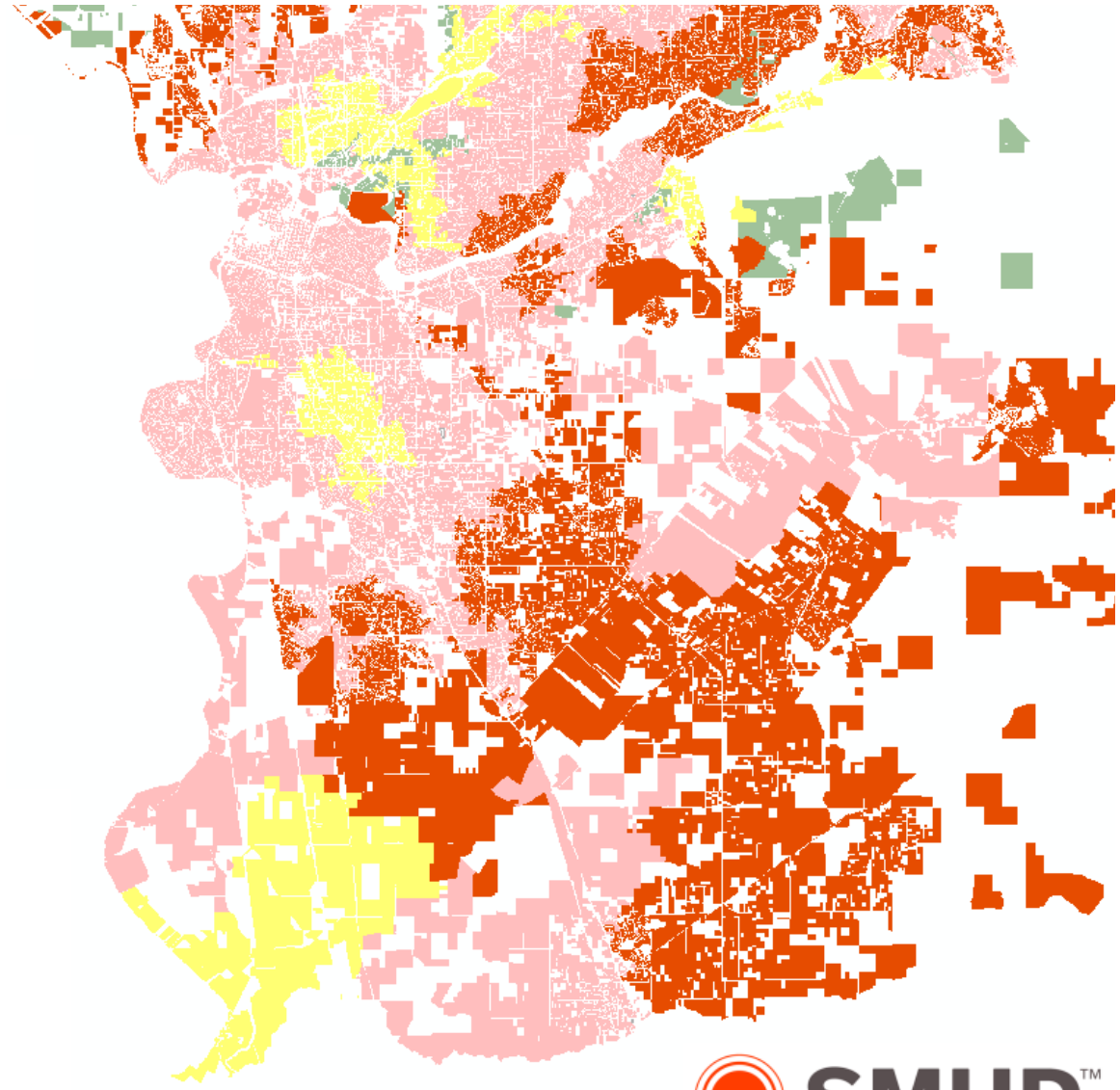




SMUD™

OVER 12,000 TRANSFORMERS MAY NEED TO BE UPGRADED DUE TO EVS, 17% OF TOTAL

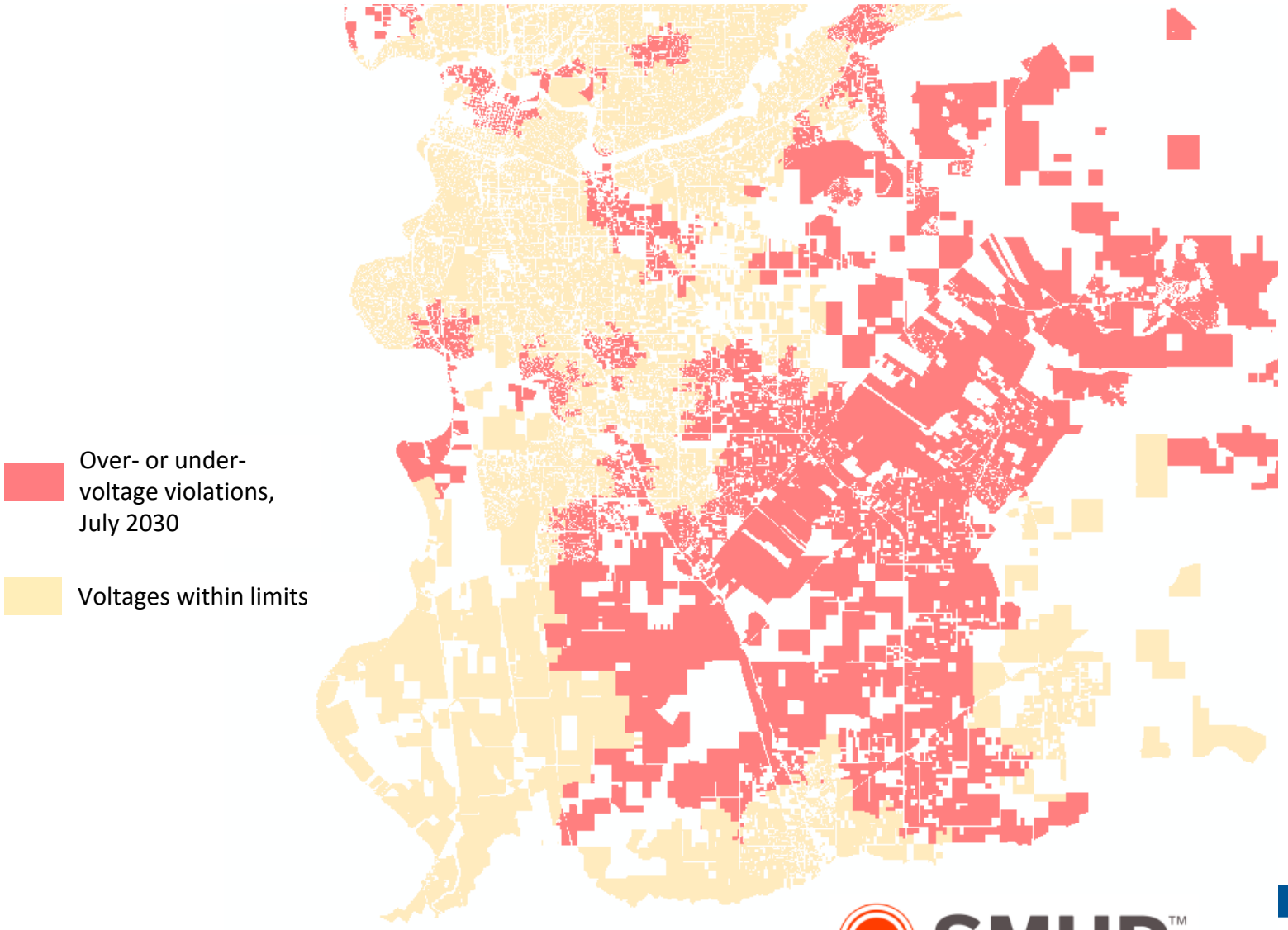
PERCENT OF TRANSFORMERS STRESSED DUE TO EVS



REPRESENTS A HIGH EV, UNOPTIMIZED CHARGING SCENARIO

SMUD™

51 SUBSTATIONS (26%), COULD HAVE VOLTAGE VIOLATIONS AT SERVICE TRANSFORMERS DUE TO PV



SMUD™

MITIGATION COSTS DEPEND ON ASSUMPTIONS

Transformer Upgrade Criteria?

- "Oil Boils" SMUD Quote
- 150% SMUD Pole Mount
- 140% Est. Wghtd Avg.
- 130% SMUD Pad Mount
- 115% SMUD EV HotSpotter
- 100% L+G Analysis

Residential Upgrade Cost Per Transformer

- $5k Pole Mount H/W+Labor
- $7k Pad Mount H/W+Labor
- $7.4k Wghtd Avg. SMUD HotSpotter
- $8k Conductor & Svc Upgrade
- $15k Pad Mount + Conductor

Voltage Control Technologies

- Smart Inverters
- Voltage Regulators at Svc. Xfmr
- Optimal Battery Placement
- Increase Conductor Capacity
- Increase Transformer Capacity

SMUD™

DISTRIBUTION SYSTEM FINDINGS

- **Caveats**
  - IRP base case will have lower impacts
  - Consider other options available to mitigate costs

- **May need to consider EV charging management**
  - Spreading out and managing charging may reduce the stress and defer upgrades
  - Requires iterating the iDER analyses: changing rates changes EV dispersion
  - EV cost impact range $50 - $220 per vehicle depending on assumptions, expect $100 per vehicle without managed charging

- **PV Cost Impact Range expected between $0.02/Watt - $0.08/Watt**
  - Voltage impacts on distribution system only

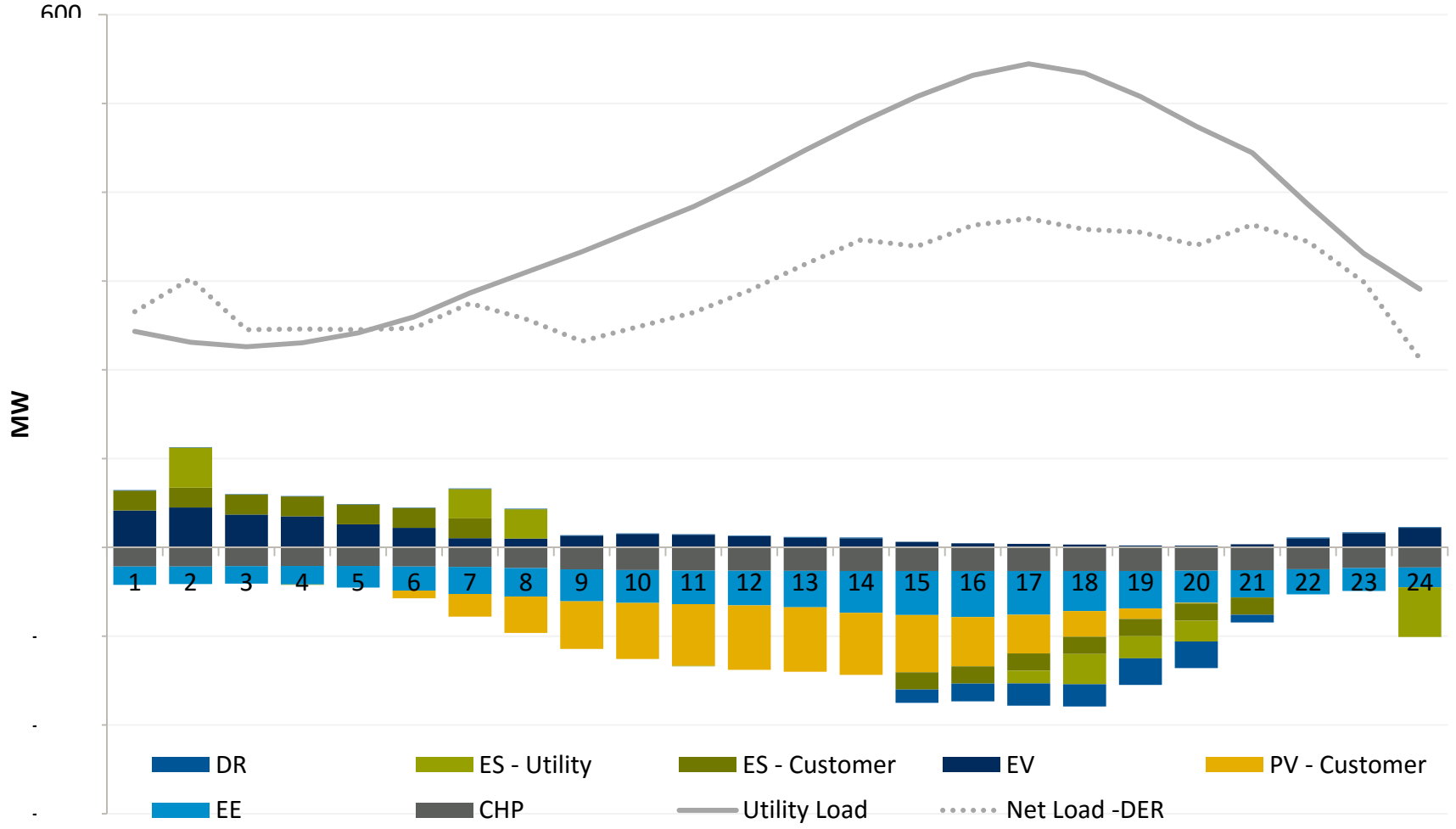
BULK SYSTEM MODELING AND IMPACTS

BULK SYSTEM DER SCENARIOS

Technology	Existing	PLEXOS 2020		PLEXOS 2025		PLEXOS 2030	
	2015	IRP	Change	IRP	Change	IRP	Change
PV DG (MW)	80	106	220	159	360	186	500
PV (utility) (MW)	0	0	0	83	83	167	167
DR (MW, TOU Impact)	0	0	86	0	86	0	86
DR (MW, dispatchable)	0	0	216	0	260	0	274
EE (GWh)	183	1,007	517	1,535	793	1,647	1,032
EV (Cars)	951	30 k	45k	74.7k	140k	140k	240k
ES (customer) (MW)	0	0	10	0	20	0	40
ES (utility) (MW)	0	0	20	0	90	0	160
CHP (MW)	19	19	77	19	106	19	127

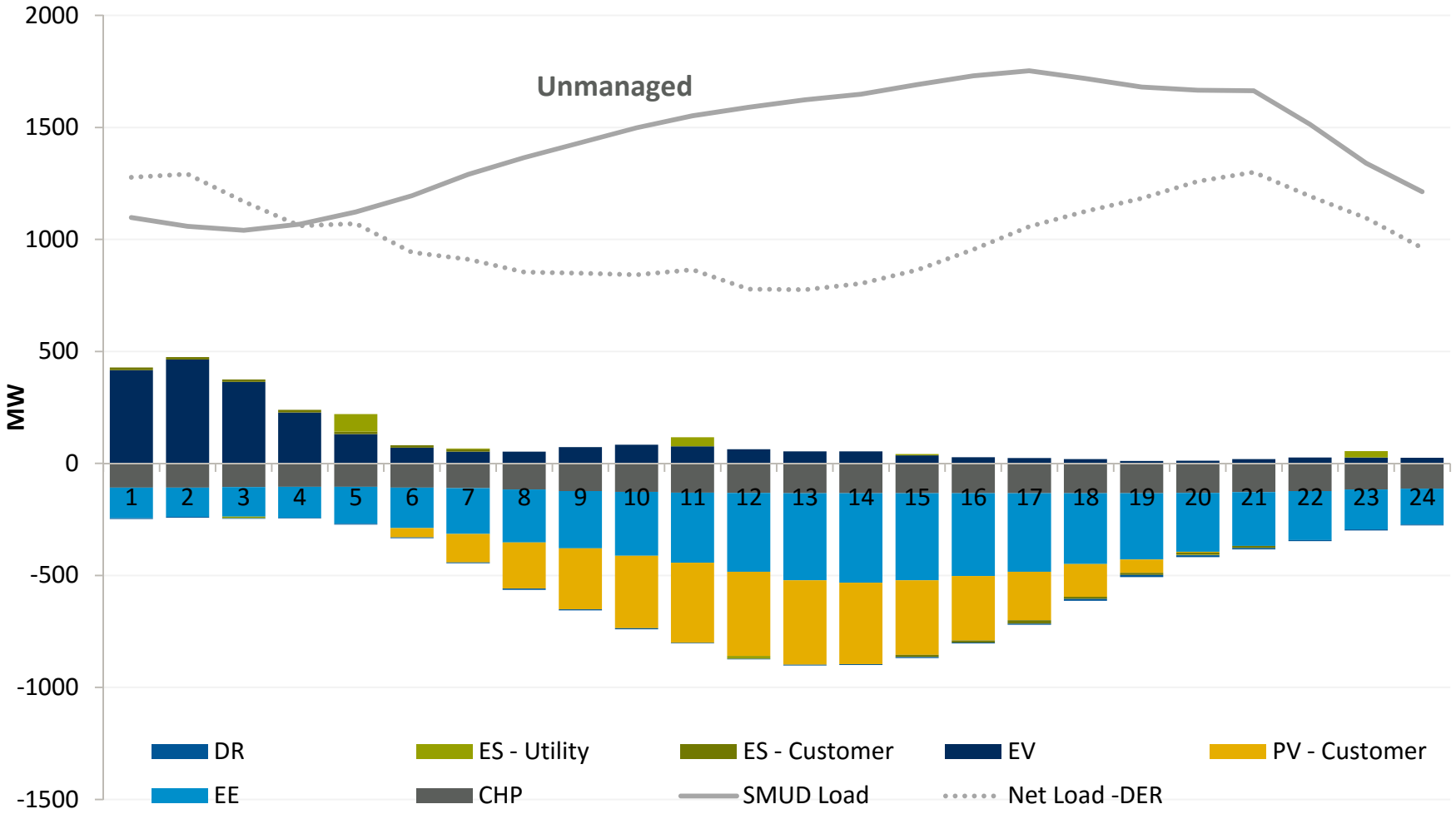
- Bulk system PLEXOS changes cases run independently (to isolate impact)
- Combined DER case run to determine combined effects

POTENTIAL DER IMPACTS – NET LOAD

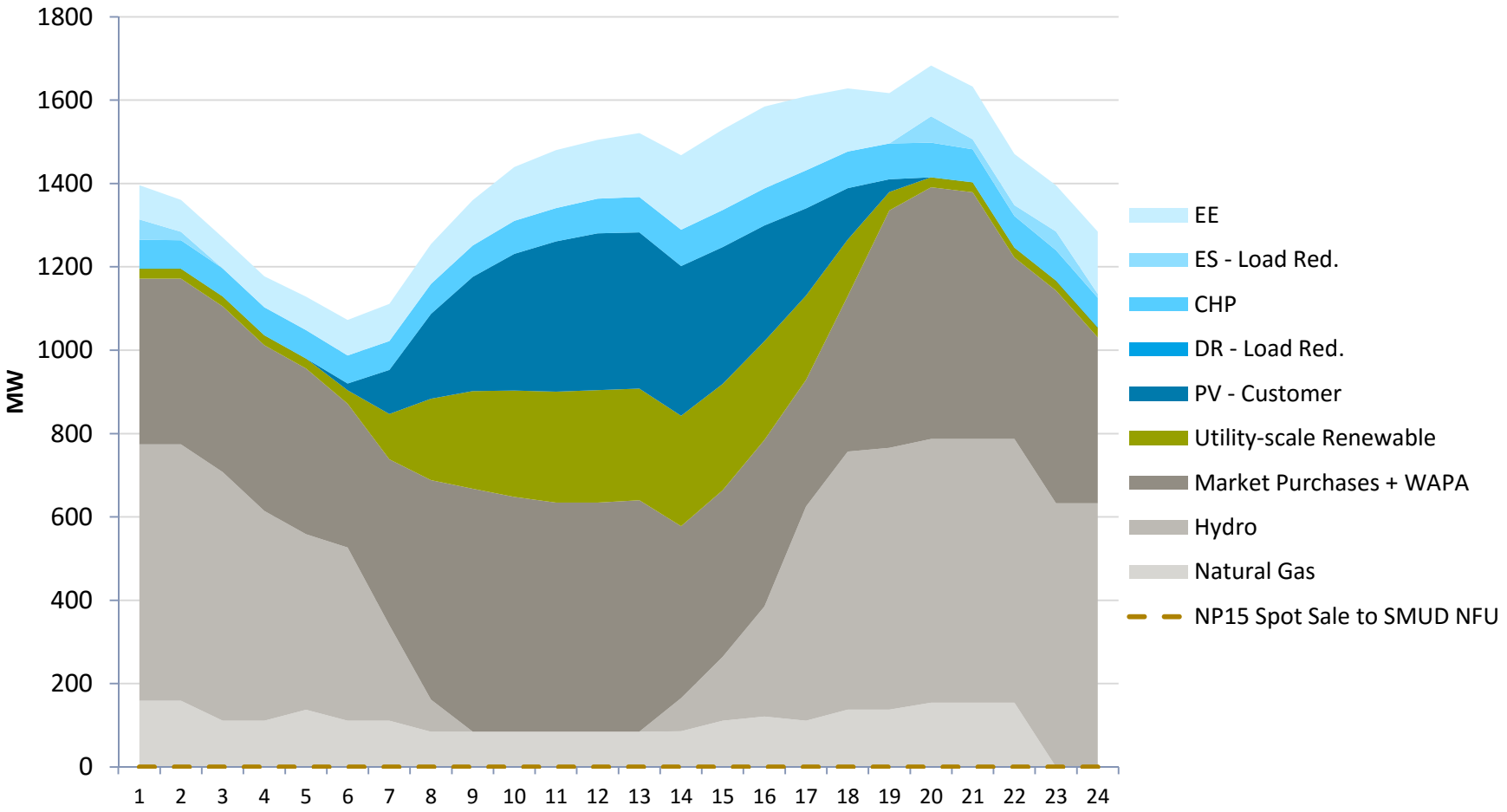


SMUD™

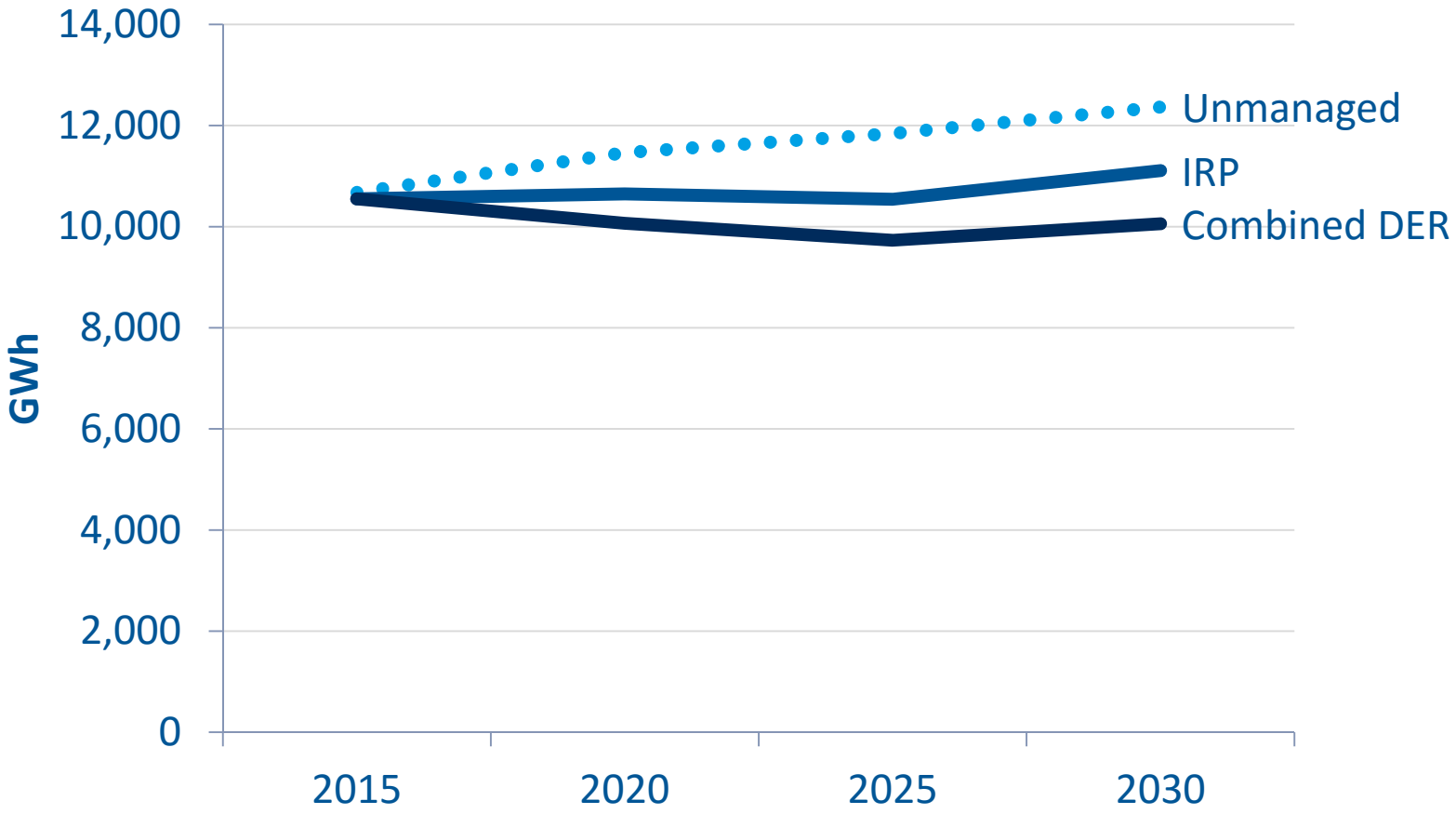
MAXIMUM DER PENETRATION (52%) – JUNE 25, 2030



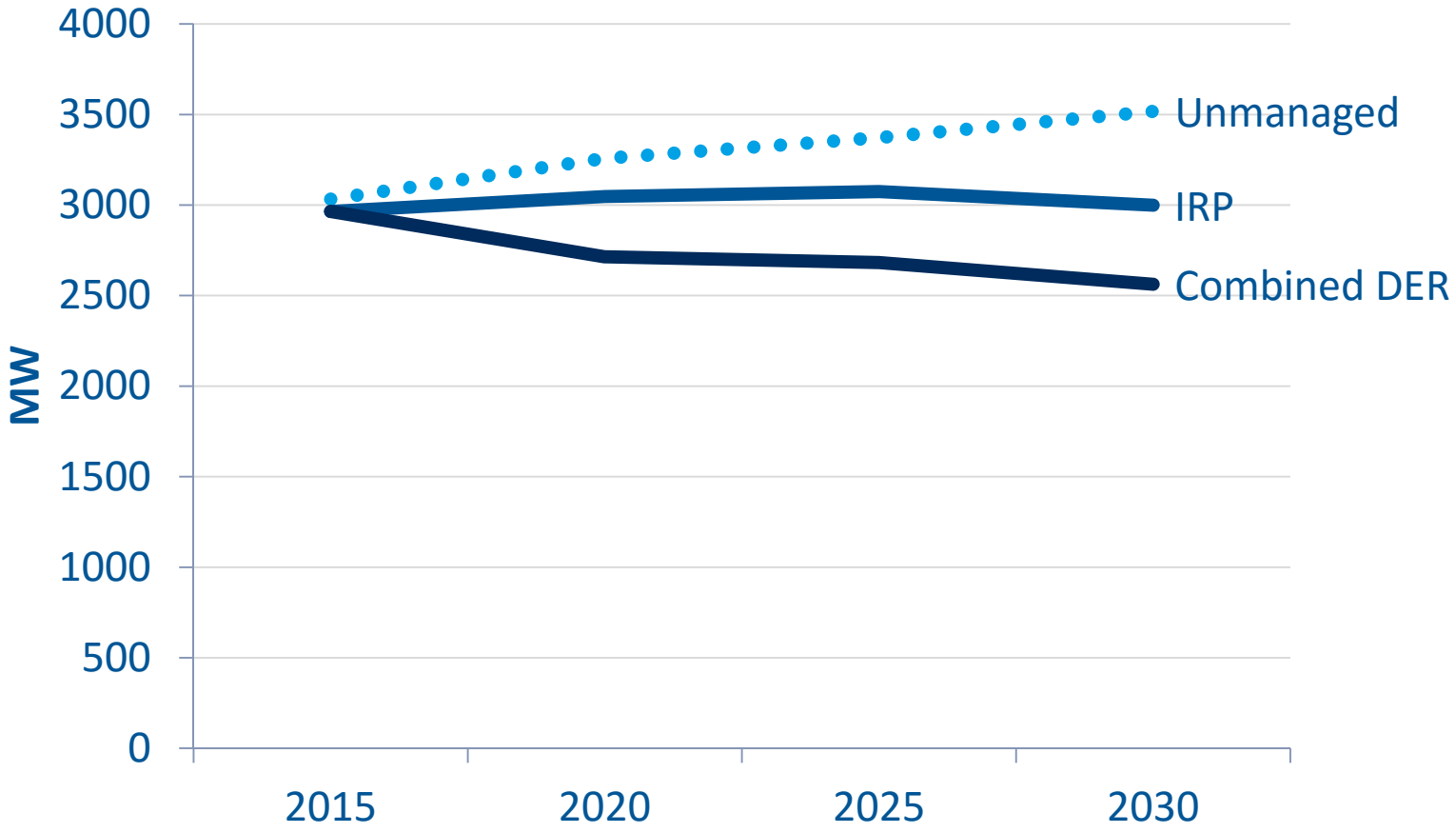
MINIMUM LOAD (985 MW) – MAY 5, 2030



CHANGE IN RETAIL SALES



CHANGE IN PEAK LOAD



DER IMPACT ON RAMPING

- Evaluated maximum and average 3 hour ramp up rates from PLEXOS runs (2020-2030)
- When compared to unmanaged load (no DERs), the results show that DERs clearly reduce ramp rates

	Maximum Ramp Up	Average Ramp Up
Unmanaged	749 MW	101 MW
IRP Base Case	689 MW	81 MW
Combined DER	680 MW	72 MW

RESOURCE VALUE APPROACH

- Compare individual DER change cases against the IRP base case to calculate PLEXOS production cost changes (mostly savings)
- Compare against incremental SMUD program costs (incentives, labor, etc.)
- Compare against lost revenue from customers (2017 rate structure)

RESOURCE VALUE APPROACH

- **Included**
  - Changes in renewable and thermal energy purchases
  - Carbon cost
  - O&M and fuel requirements
  - Capacity purchases
  - ISO Charges
  - Program costs
  - Lost revenue from customers
  - EV carbon credits (Low Carbon Fuel Standard)

- **Not Included**
  - Societal costs or benefits
  - Transmission and distribution system impacts

SMUD™

ECONOMIC ANALYSIS RESULTS ($2015)

Program Administrator Benefit = Production Cost Savings – Program Cost

Energy Resources

Technology	2030 PLEXOS Change Case Targets	2020-2030 Production Cost Savings* ($/MWh)	Incremental Program Cost* ($/MWh)	Incremental Program Administrator Benefit ($/MWh)
EE	1,032 GWh	$84 - 100	$17	$67 - 83
PV	500 MW	$69 - 81	$3	$66 - 78
CHP	127 MW	$79 - 90	$1	$78 - 89
EV	240,000 Cars	($72) - (75) (higher sales)	$16	($88) - (91) (higher sales)

Demand Resources

Technology	2030 PLEXOS Change Case Targets	2020-2030 Production Cost Savings* ($/kW-yr)	Incremental Program Cost* ($/kW-yr)	Incremental Program Administrator Benefit ($/MWh)
DR Dispatch (Utility)	274 MW	$42 - 89	$40	$2 - 49
DR TOU (Customer)	86 MW	$56 - 96	$0	$56 - 96
ES (Customer)	40 MW	$14 - 26	$0	$14 - 26
ES (Utility)	160 MW	$96 - 165	$263	($98) - (167)

*Incremental from PLEXOS base case to change case.

SMUD™

ECONOMIC ANALYSIS RESULTS ($2015)

Compared to Revenue Loss from Customers

Energy Resources

Technology	2030 PLEXOS Change Case Targets	2020-2030 Production Cost Savings* ($/MWh)	Incremental Program Cost* ($/MWh)	Revenue Loss* ($/MWh)
EE	1,032 GWh	$84 - 100	$17	$126
PV	500 MW	$69 - 81	$3	$128
CHP	127 MW	$79 - 90	$1	$101
EV	240,000 Cars	($72) - (75) (higher sales)	$16	($86) (sales)

Demand Resources

Technology	2030 PLEXOS Change Case Targets	2020-2030 Production Cost Savings* ($/kW-yr)	Incremental Program Cost* ($/kW-yr)	Revenue Loss* ($/kW-yr)
DR Dispatch (Utility)	274 MW	$42 - 89	$40	$18
DR TOU (Customer)	86 MW	$56 - 96	$0	$77
ES (Customer)	40 MW	$14 - 26	$0	$72
ES (Utility)	160 MW	$96 - 165	$263	$0

*Incremental from PLEXOS base case to change case.

SMUD™

ECONOMIC ANALYSIS RESULTS ($2015)

Net Value = Production Cost Savings – Program Cost – Revenue Loss

assumes no change in 2017 rate structure

Energy Resources

Technology	2030 PLEXOS Change Case Targets	2020-2030 Production Cost Savings* ($/MWh)	Incremental Program Cost* ($/MWh)	Revenue Loss* ($/MWh)	Net Value ($/MWh)
EE	1,032 GWh	$84 - 100	$17	$126	($43) - (59)
PV	500 MW	$69 - 81	$3	$128	($50) - (62)
CHP	127 MW	$79 - 90	$1	$101	($12) - (23)
EV	240,000 Cars	($72) - (75) (higher sales)	$16	($86) (sales)	($2) - (5)

Demand Resources

Technology	2030 PLEXOS Change Case Targets	2020-2030 Production Cost Savings* ($/kW-yr)	Incremental Program Cost* ($/kW-yr)	Revenue Loss* ($/kW-yr)	Net Value ($/kW-yr)
DR Dispatch (Utility)	274 MW	$42 - 89	$40	$18	$31 - (16)
DR TOU (Customer)	86 MW	$56 - 96	$0	$77	$19 - (21)
ES (Customer)	40 MW	$14 - 26	$0	$72	($46) - (58)
ES (Utility)	160 MW	$96 - 165	$263	$0	($98) - (167)

*Incremental from PLEXOS base case to change case.

SMUD™

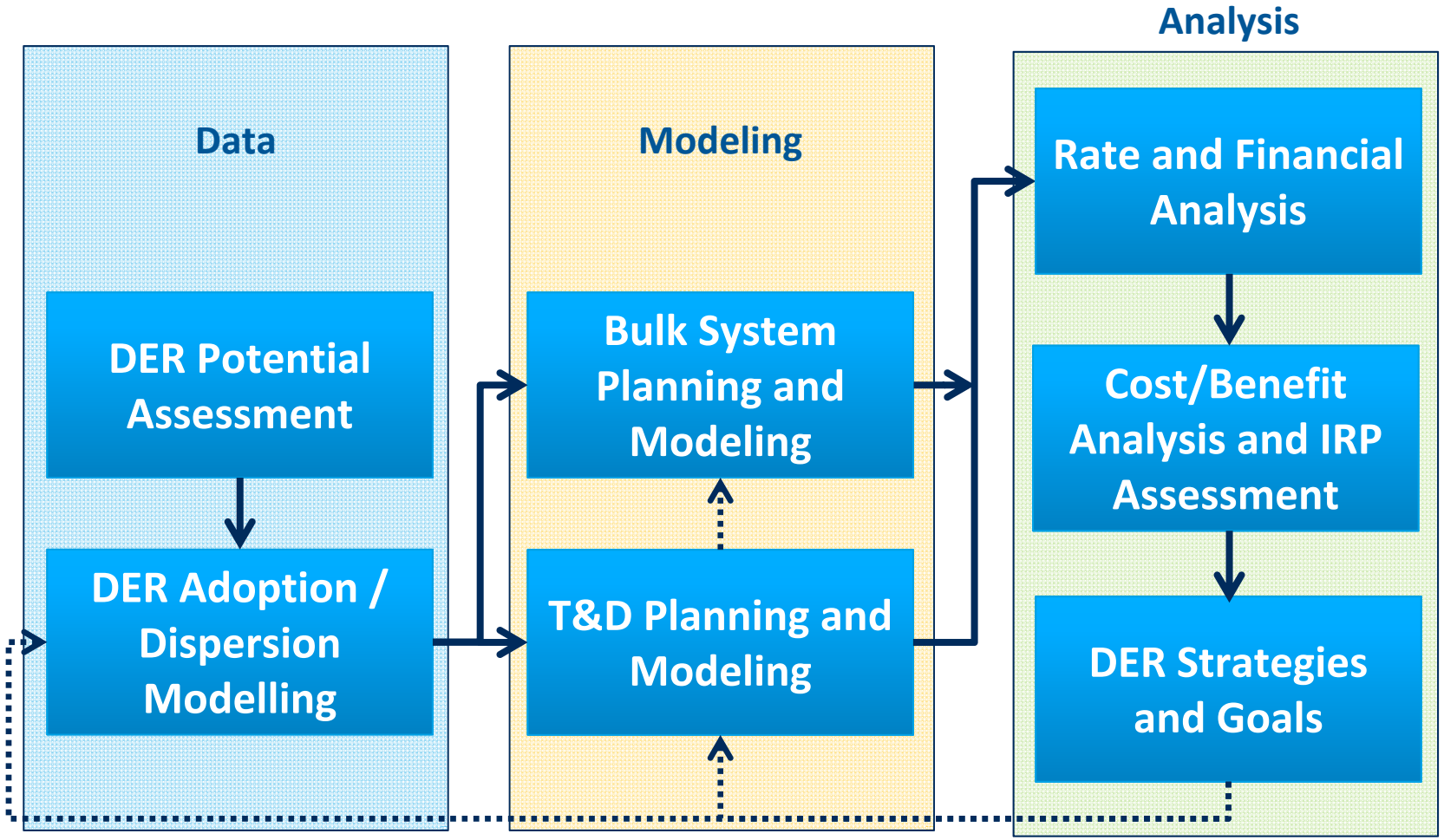
RESOURCE VALUATION FOR ALL DERS

- **Without rate structure adjustments, lost revenue is larger than SMUD savings for most incremental DERs**
  - Opportunity to refine rates and programs

- **DER specific results**
  - Energy resources (EE, PV, CHP, EVs) provide comparable production cost savings ($70-100/MWh)
    - Differing program costs
  - DR generally cost effective, but high uncertainty
  - ES economics challenged without additional value consideration (e.g., distribution)

FUTURE ANALYSIS RECOMMENDATIONS

RECOMMENDED PROCESS



NEXT STEPS FOR SMUD

- Developing pilot projects to demonstrate locational value of DERs
- Identifying appropriate timing of planning processes to ensure comprehensive valuation and create distribution investment deferral opportunities
- Identify gaps in software tools to allow rapid iteration and scenario analysis, overall DER portfolio optimization

Thank you!

Paul Stith, Solution Lead
Smart Integrated Infrastructure
StithP@BV.com

353 Sacramento Street, 19th Floor
San Francisco, CA 94111

Learn more:
www.BV.com/SII

Follow us @BVSII

BLACK & VEATCH
Building a world of difference.®

Electric Transportation State of the Industry

John Halliwell
Technical Executive, Electric Transportation

EPRI IWC, Seattle, WA
June 8, 2016

Contents

I. State of the PEV Industry
Q1 PEV Headlines

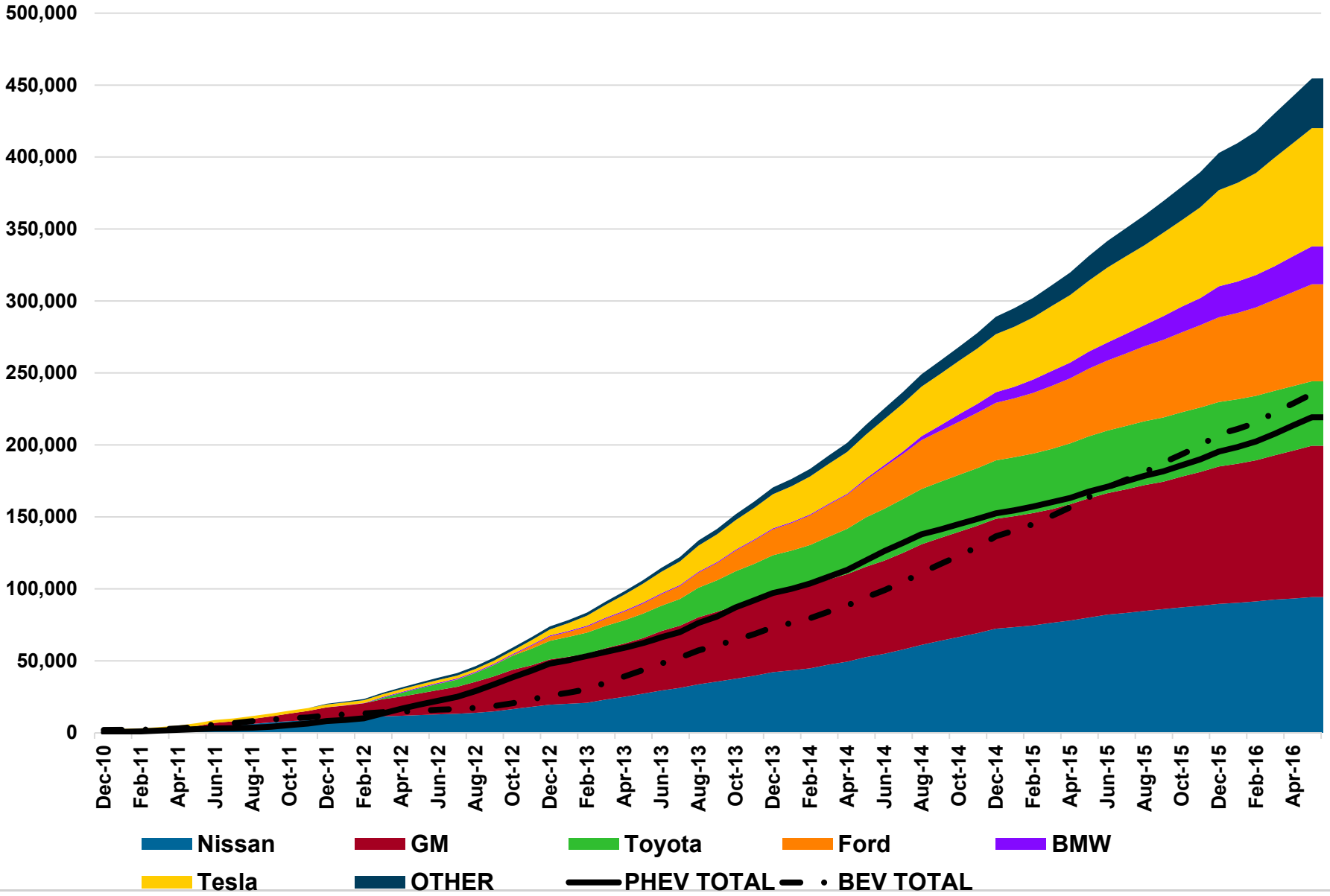
- Sales
  - ✓ Q1 2016 US sales up 18.5% over Q1 2015 (27.7K vs. 23.4K)
  - ✓ March 2016 strongest month ever of US PEV sales 13,725 (April 1, 2016)
  - ✓ Tesla Model S outsold Mercedes S-Class in Europe 2015 (15,787 vs. 14,990)

- New Product
  - ✓ Tesla Model 3 – 276K deposits in three days (325K in one week) (April 7, 2016)
  - ✓ Customer choice increasing – 20 new PEVs in 2016; 13 in 2017 – 2019

- Investment
  - ✓ GM invested $1B in autonomous driving startup Cruise Automation (March 11, 2016)
  - ✓ BYD investing $614M in second bus factory in China (April 2, 2016)

- Policy & Regulatory
  - ✓ US FTC filed suit against VW for false advertising (March 29, 2016)
  - ✓ The Netherlands proposing banning gas & diesel cars by 2025 (March 30, 2016)
  - ✓ New York state offering $2,000 rebate (April 5, 2016)
  - ✓ India set goal of 100% electric cars by 2030 (April 6, 2016)

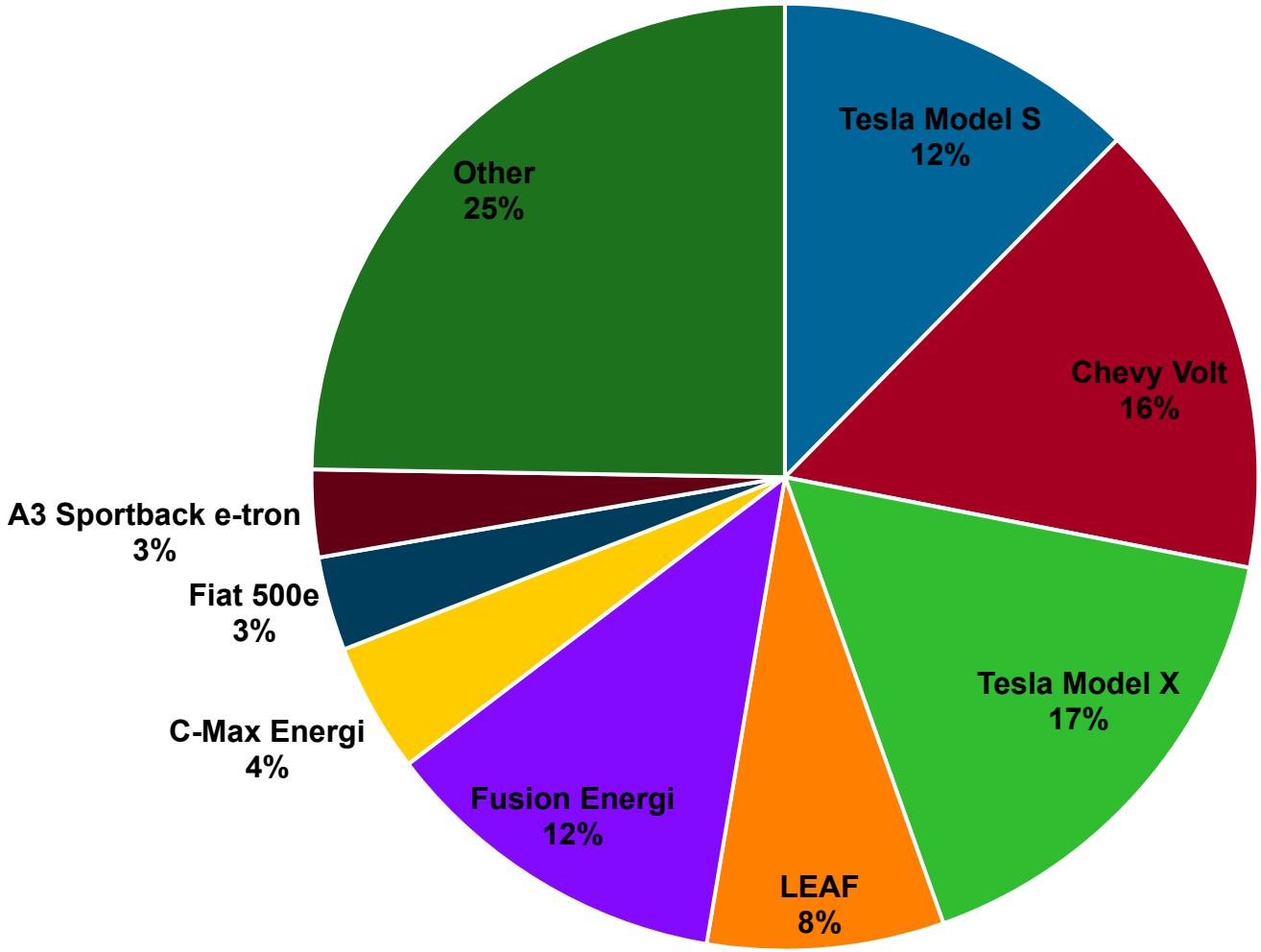
US PEV Sales to Date by Make



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Percentage of May PEV Sales by Nameplate

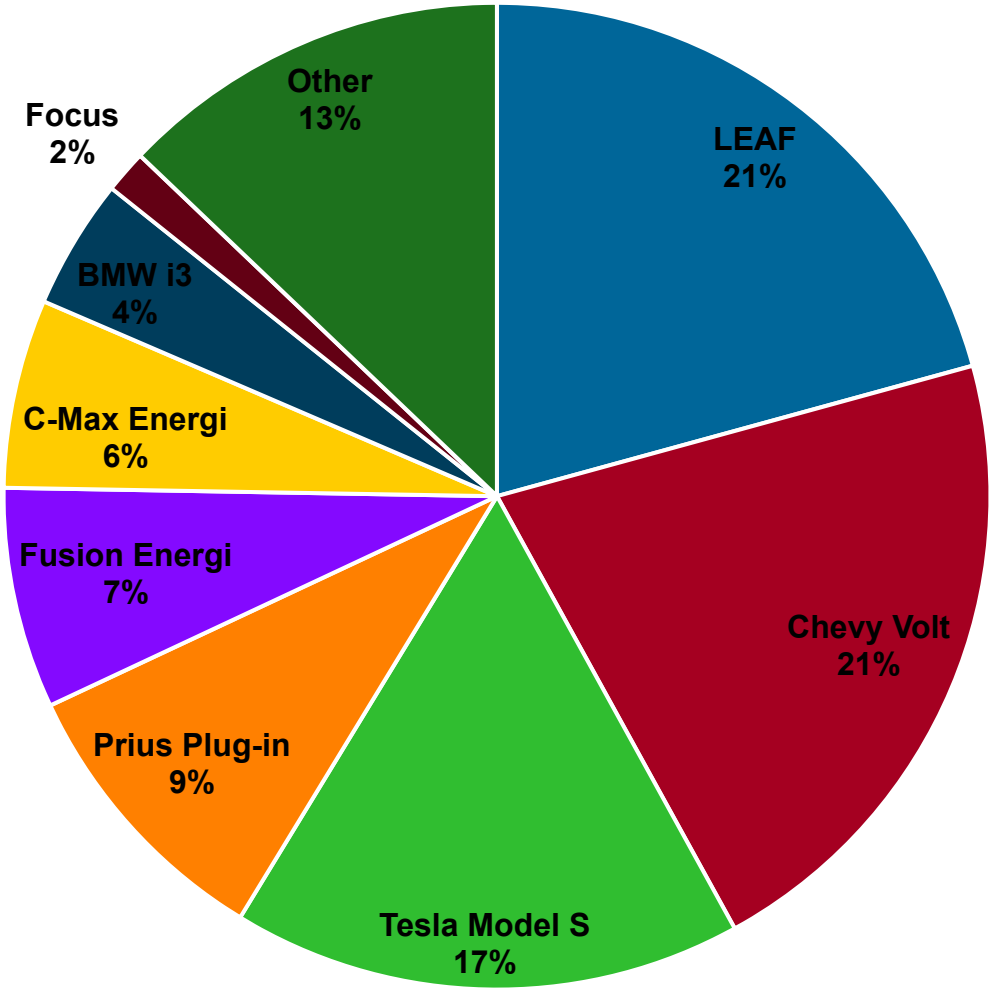
May-16



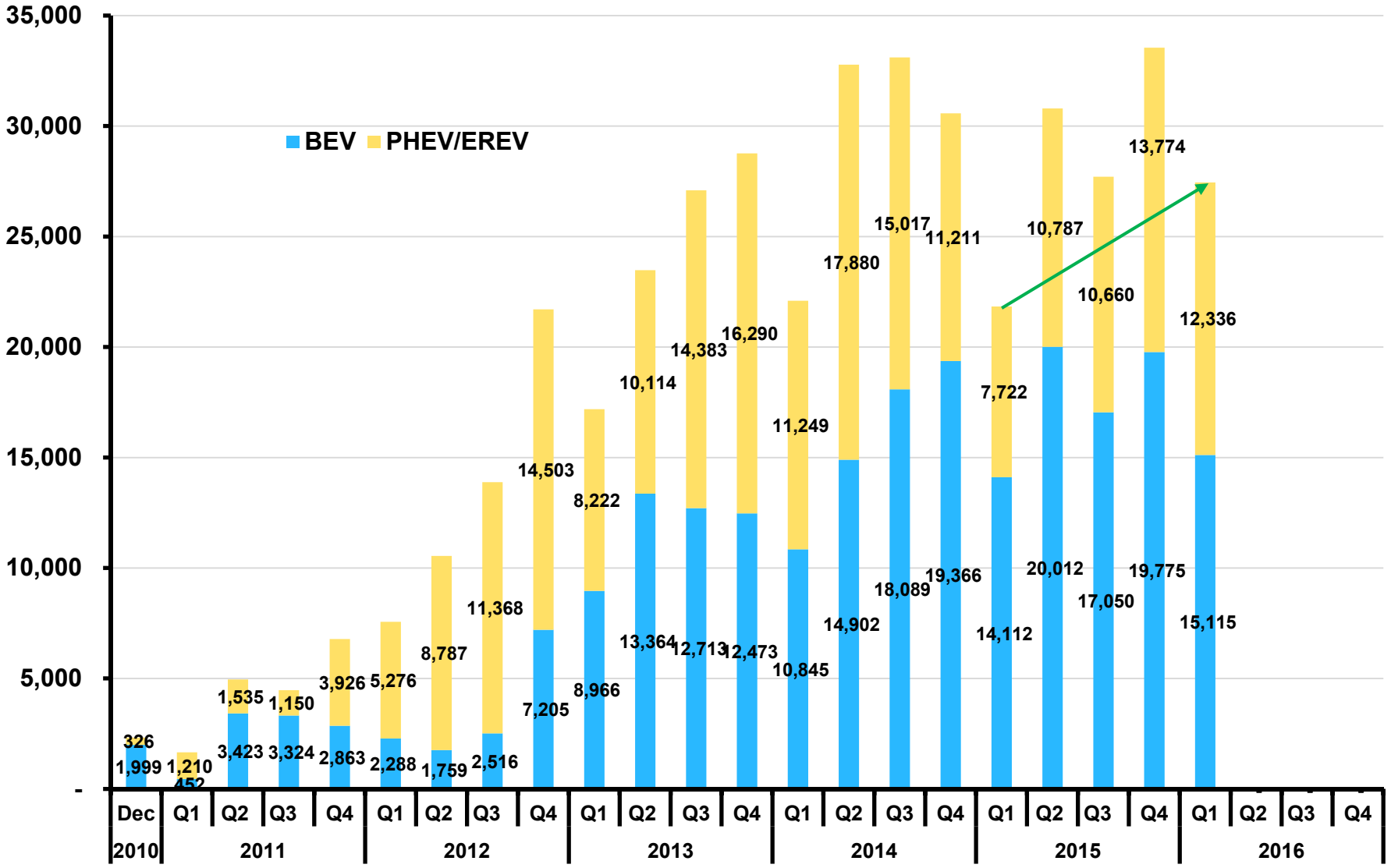
EPRI ELECTRIC POWER RESEARCH INSTITUTE

Cumulative Sales

May-16



US PEV Sales by Quarter – Q1 2016



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Customer choice is increasing
~32 new PEVs coming in 2016-2019









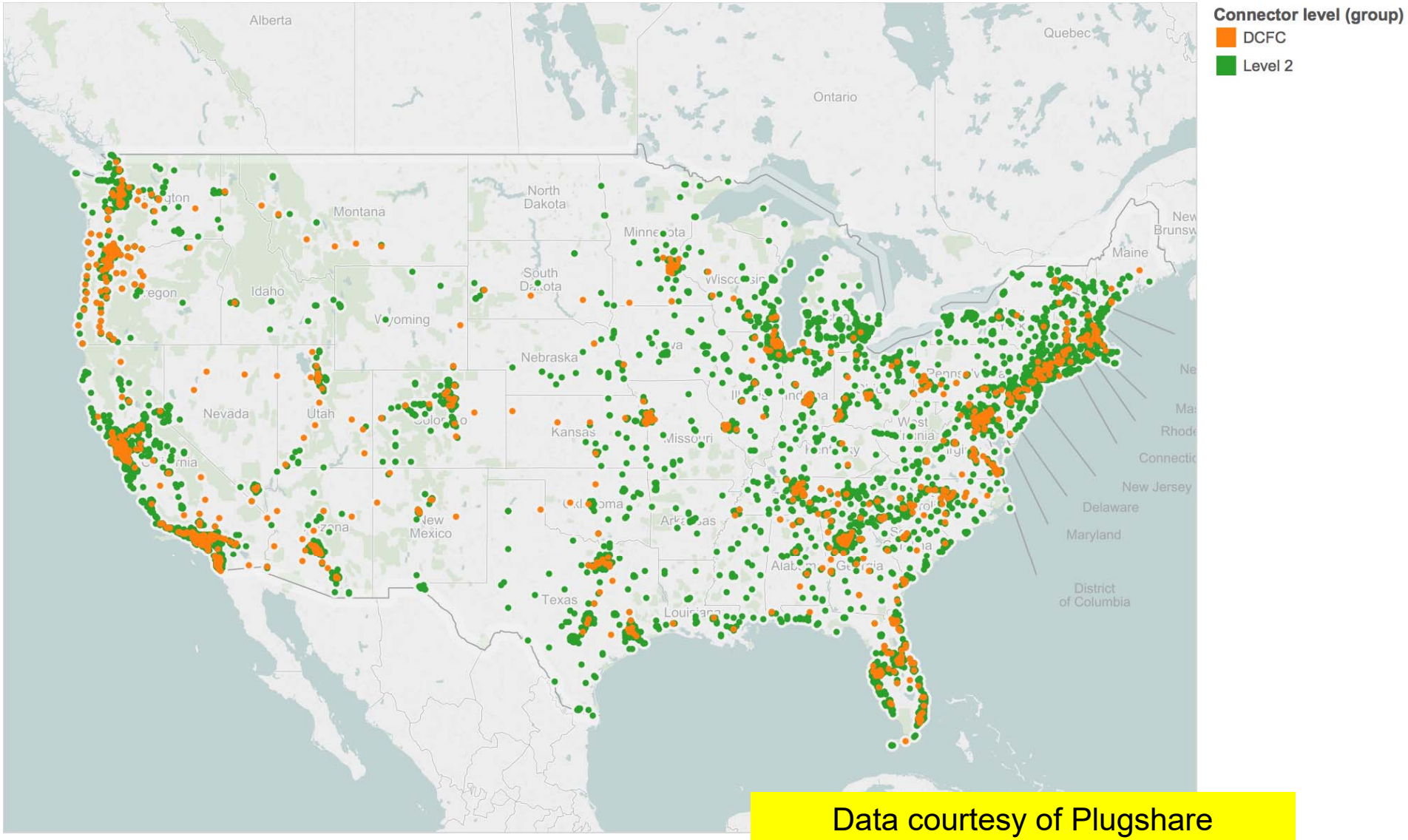





II. Utility Charging Infrastructure & Market Support Current Activities Across North America

States	Utilities
Washington	Avista
Oregon	PG&E
Utah	SCE
British Colombia	LADWP
Ontario	SDG&E
Quebec	HydroQuebec
	Indianapolis Power & Light
	KCP&L
	LG&E and KU
	Georgia Power

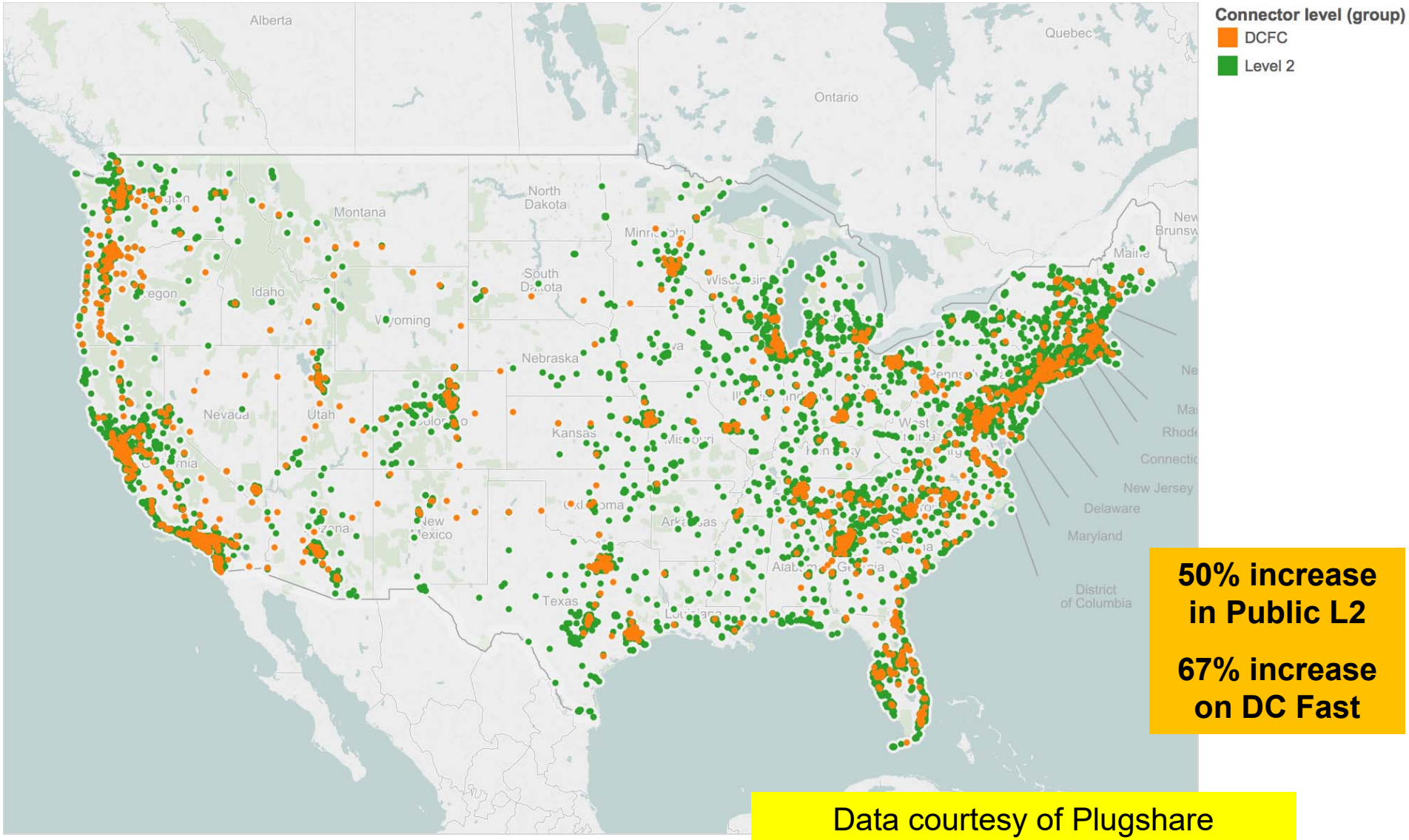
Charging Infrastructure - 2015



Data courtesy of Plugshare

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Charging Infrastructure - 2016



50% increase in Public L2

67% increase on DC Fast

Data courtesy of Plugshare

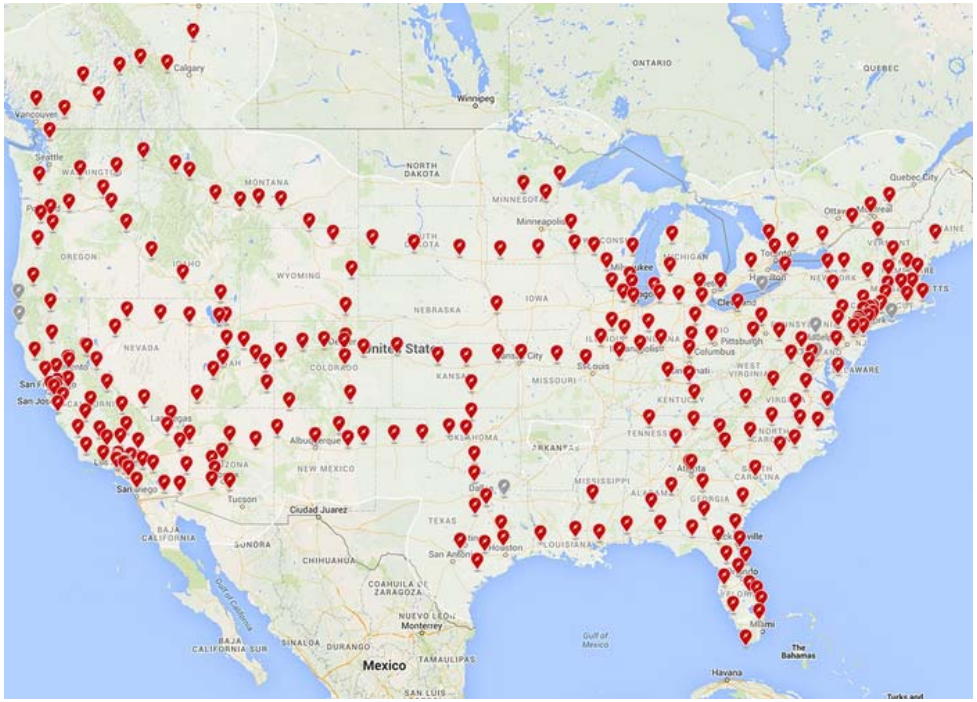
EPRI ELECTRIC POWER RESEARCH INSTITUTE

III. Looking Ahead
Tesla and The Market

- 325,000 deposits after one week
- Good for Tesla's procurement and supply chain
- Challenges
  - Liquidity
  - Gigafactory
  - Infrastructure charging
  - Federal tax credits step down after 200,000 OEM sales

III. Looking Ahead
Tesla and The Market

- Demand exists
  - Role of gas prices?
- Non-traditional players
- Charging infrastructure
  - Short-term
    - 50-120 kW
    - Multiple standards
  - Long-term
    - High-power DC fast charging
      - 200 kW to 350 kW
      - ~400 charging plazas
      - Open access
      - Need to prepare now



2016 EPRI Calendar
Electric Transportation

Key Upcoming Meetings

- June 19-22, EVS29, Montreal, Canada
- July 7, EPRI Electric Transportation Q2 2016 webcast to advisors
- Sept 19-21, Fall PDU Advisory, Hollywood (Miami), Florida
- October 6, EPRI Electric Transportation Q3 2016 webcast to advisors
- Nov 15-17, Truck and Bus & IWC, PG&E, San Francisco, California

Fitting Distributed Energy Resources in an Evolving Electricity Landscape

Jennifer S. Szaro
Senior Director, Programs
SEPA

Smart Electric Power Alliance

About SEPA

educational 501(c)3 non-profit

Supporting utility integration and deployment of solar, storage, demand response & other enabling technologies

Membership

560+ Utilities

550+ Stakeholders

Smart Electric Power Alliance

2016 Key Themes

- **Transforming the grid**
- **Adapting the utility business model**
- **Proactively engaging consumers**
- **Diversifying energy portfolios**

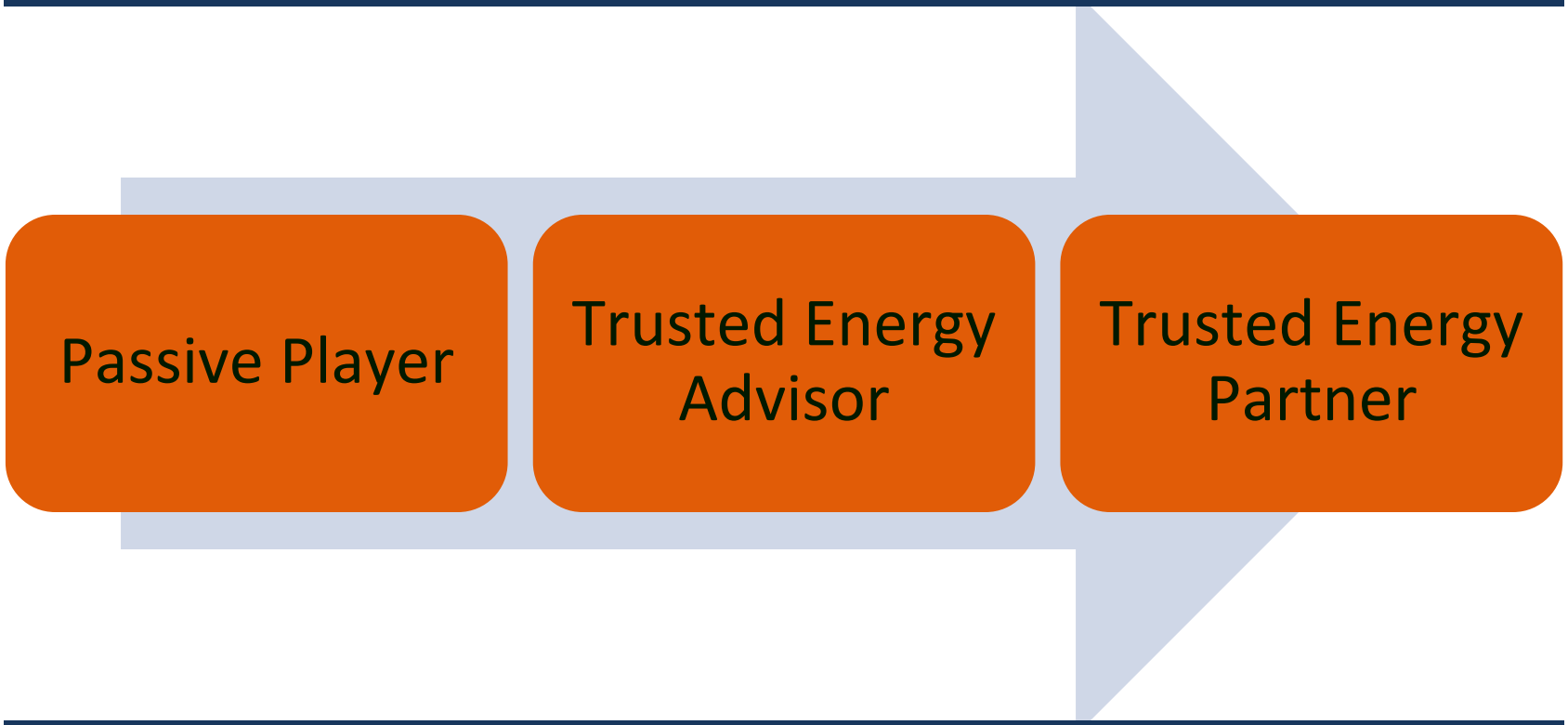
- Market trends
- Rate reform and tariff design
- Program design, including customer engagement
- Utility Scale Solar & Storage in Integrated Resource Planning
- Distributed Resource Planning
- Distribution grid integration
- Wholesale markets integration
- Asset management
- Energy analytics
- Clean Power Plan Implementation

Growth of the Distributed Generation Market

It is projected by EIA that the global market for distributed energy generation market will grow from 156.6 GW in 2015 to 169.5 GW in 2016 at a year-on-year growth rate of 8.3%.

Industry Trend – The Proactive Utility Strategy

Transitioning from a passive player …



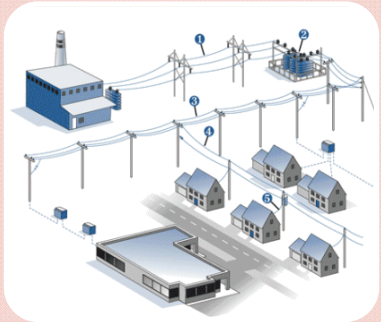
…to a proactive partner for customers.

Smart Electric Power Alliance

Integrated Approach: Utility Strategies

Smart Inverters

Storage



Distribution Resource Planning

Integrated Customer Offerings

Smart Electric Power Alliance

Grid Integration Tools

- Interconnection Queue Management Tools
- Distributed Energy Resource Management Systems (DERMS)
- Interoperable Communication Platforms
- Storage and Microgrid Systems for Smoothing
- Intelligent Behind the Meter Technologies
- 3rd Party DER Aggregators

How Grid Integration Tools Can Help

Interconnection Queue Management Tools	Software based tools that allow utilities to screen and expedite interconnection applications based on location and system parameters
Distributed Energy Resource Management Systems (DERMS)	Interfaces with utility DMS and DER technology platforms to allow for visibility and control
Interoperable Communication Platforms	Maximize utility of smart grid investments and mitigate technology integration costs
Storage and Microgrids	Provides resource smoothing and shifting capability as well as grid stabilization and supplement to spinning reserves
Intelligent Behind the Meter Technologies	Offer enhanced demand response options and grid transparency
3rd Party DER Aggregators	Can provide DER bundling services for single seamless interface with utility and customers

Examples: Utility Integrated DER Offerings

- HECO partnership with STEM to deliver storage plus demand response to reduce peak and balance load
- Steele-Waseca Co-op Electric – Community Solar + Load Management + Load Growth!
- Green Mountain Power – offering customers purchase or lease of Tesla Powerwall (goal: peak demand reduction)
- OUC commercial EVSE service offering including financing, installation and operation. Potential to combine with workplace solar arrays

Smart Electric Power Alliance

Hawaii Case Study

Smart Electric Power Alliance

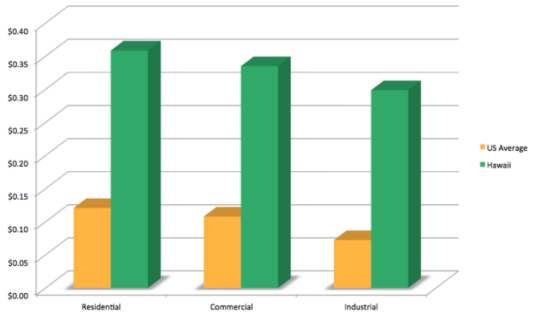
Hawaii - Challenges

Reverse Power flow is New Normal

Circuit Integration Level	No. of Circuits			Percentage of Circuits		
	Hawaiian Electric	Hawai'i Electric Light	Maui Electric	Hawaiian Electric	Hawai'i Electric Light	Maui Electric
> 250% Daytime Minimum Load ("DML")	45	8	4	10.8%	5.9%	2.9%
> 120% up to and including 250% DML	95	32	37	22.8%	23.7%	27.0%
> 100% up to and including 120% DML	40	19	10	9.6%	14.1%	7.3%
> 75% up to and including 100% DML	38	22	10	9.1%	16.3%	7.3%
< 75% DML	198	54	76	47.6%	40.0%	55.5%
TOTAL	416	135	137	100.0%	100.0%	100.0%

Approaching the point where 50% of Circuits backfeed at the substation

HI Rates vs. US Mainland



Source: USDOE Energy Information Administration, Electric Power Monthly,5.6.A: Average Retail Price to End User, September 2011 release (data for June 2011). (http://www.eia.gov/electricity/monthly/index.cfm)

- Not subject to FERC/NERC
- High load factor (~70%)
- Strong duck curve shape due to heavy customer PV penetration
- High rates due to limited resources and no interconnections
- Exponential uncontrolled distributed PV growth
- 100% renewable energy goal

Smart Electric Power Alliance

Hawaii - Solutions

Technical

- Utility scale storage
- Distributed storage paired with demand response
- SEAMS network system to improve system transparency and control

Business

- New programs that encourage loads during high capacity periods – EV charging, AC load
- Better customer communication
- 3rd party DER partnerships

Key DER Takeaways from the 50th State

Operational and Technical Issues

- –Expect that the grid can take more.
- –The right mix of DER technologies can alleviate system stress – if well coordinated
- –Ensure you can see what's happening on your system

Customer and Stakeholder Relations

- –Recognize that market drivers currently outpace the regulatory and utility planning cycles
- –Be the enabler of solutions saying "yes, and…"

Leadership

- –Stakeholder alignment is crucial to success.
- –Anticipate change and get ahead of it before it overwhelms you.
- –Don't strive for perfection—iterate and improve.

Things to Consider

- **Distributed Energy Resource growth will continue**, based on increasingly compelling economics, across all market types. But DERs won't be a mature and truly valuable power resource until they become smart…

- The biggest constraint facing DER adoption regardless of technology type is **integration challenges** – business strategy, engineering and operations.

- Utilities are learning how to turn this "threat" into an **opportunity** – for both customers and shareholders.

- DERs have the potential to be **one part of a clean energy portfolio**, which will include a mix of bulk power and distribution system scale resources.

SEPA's 51st State Initiative

Created to provide a collaborative platform across the power sector to discuss the future of the electric industry. Designed as an alternative to today's contentious debates.

The 51st State is a safe space for experts and industry leaders to present, sound out, and provide feedback on utility sector evolution.

SEPA's 51st State Initiative

SEPA51.ORG

- **Phase I** – Crowdsourced Vision for the Energy Market of the Future
- **Phase II** – Crowdsourced Roadmaps that articulate how we get from "here" to "there"

Smart Electric Power Alliance

Jennifer Szaro

Senior Director, Programs

202-559-2023

jszaro@solarelectricpower.org

Smart Electric Power Alliance

@EVSymposium29
#EVS29

Electric Vehicle Symposium & Exhibition

June 19-22, 2016 | du 19 au 22 juin 2016

Montréal, Québec, Canada

Organized by: EDTA Electric Drive Transportation Association

Hosted by: EDTA Electric Drive Transportation Association, nrcan, Electric Mobility Canada

In Collaboration with: AVERE, EVAAP

Platinum Sponsors: Québec, Hydro Québec, Investissement Québec

DRIVE ELECTRIC INNOVATION
PROPULSER L'INNOVATION EN MOBILITÉ ÉLECTRIQUE

EVS29.ORG

EV Everywhere or EV Anytime?

Co-locating multiple DC fast chargers improves both operator cost and access reliability

Parastoo Jabbari
Don MacKenzie
Department of Civil & Environmental Engineering
University of Washington

Bottom Line Up Front

Establishing a self-sustaining DCFC market is harder than we thought

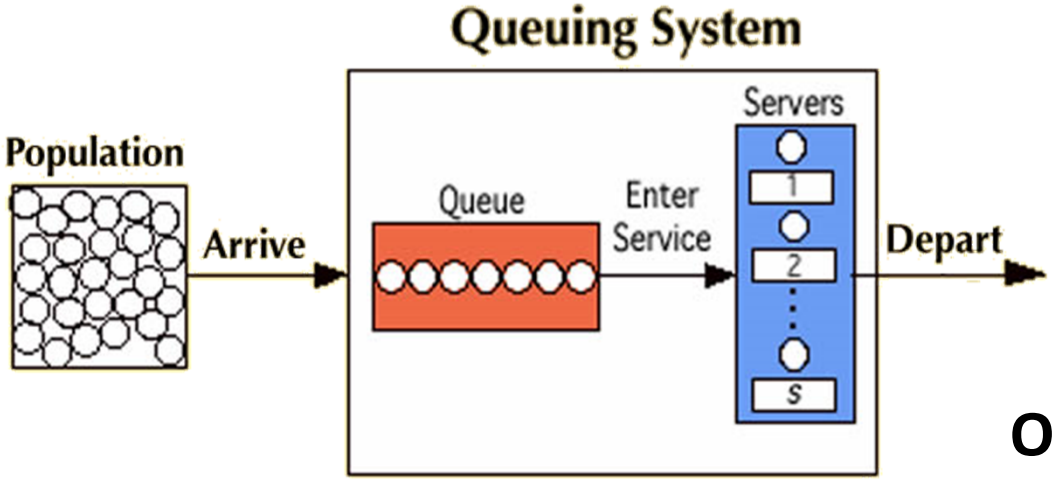
For EV market to really grow, we posit…

- Energy cost per mile should meet or beat gasoline
- Fast charging must be reliably **available** when travelers want it
  - Spatially
  - Temporally
- DCFC infrastructure needs high **utilization** to pay off

High Availability
Charger Always Available

Low Utilization
Charger Never Gets Used

A QUEUE MODEL HAS 3 ESSENTIAL ELEMENTS



Inputs

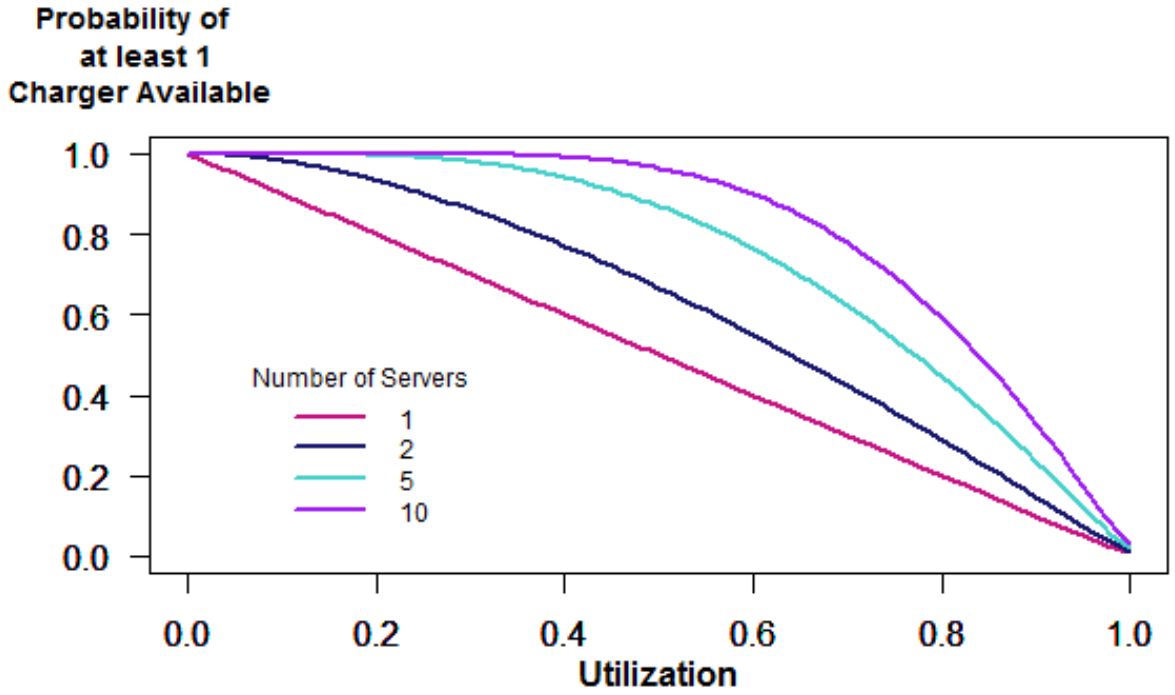
- Arrival process
- Number of servers
- Service process

Outputs

- Availability
- Utilization

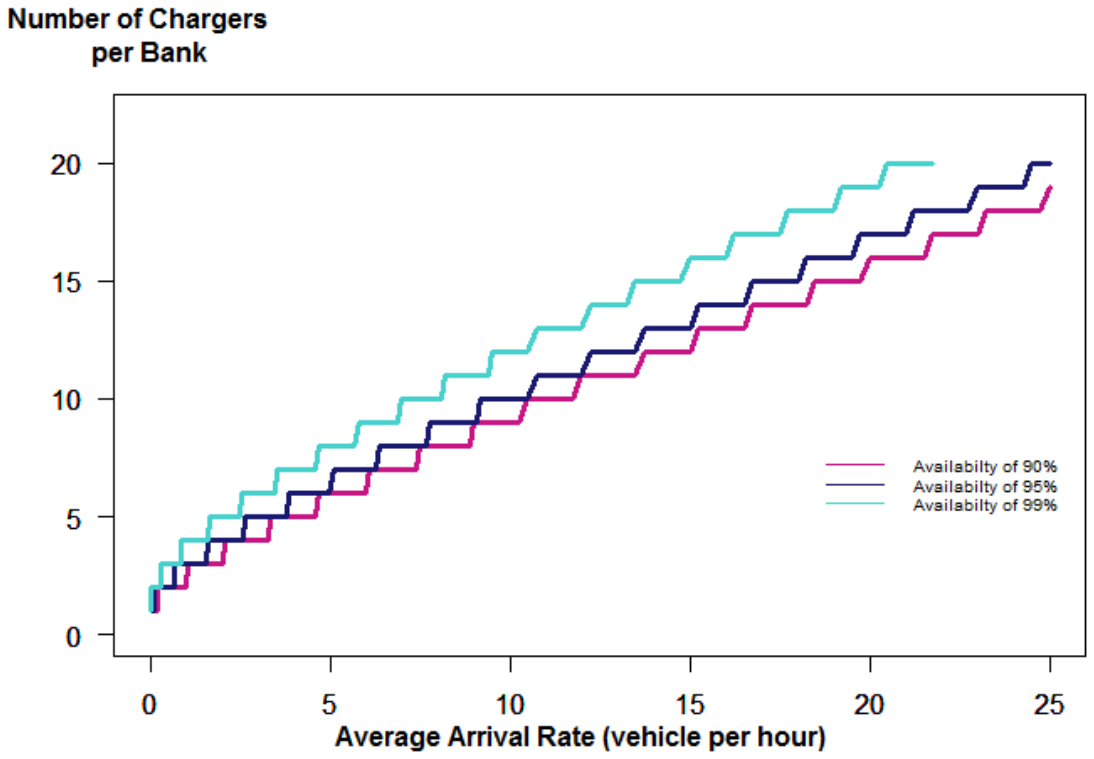
http://www.me.utexas.edu/~jensen/ORMM/computation/unit/dynamic_programming/dp_data/finite_queue/

More servers → better utilization AND better availability!

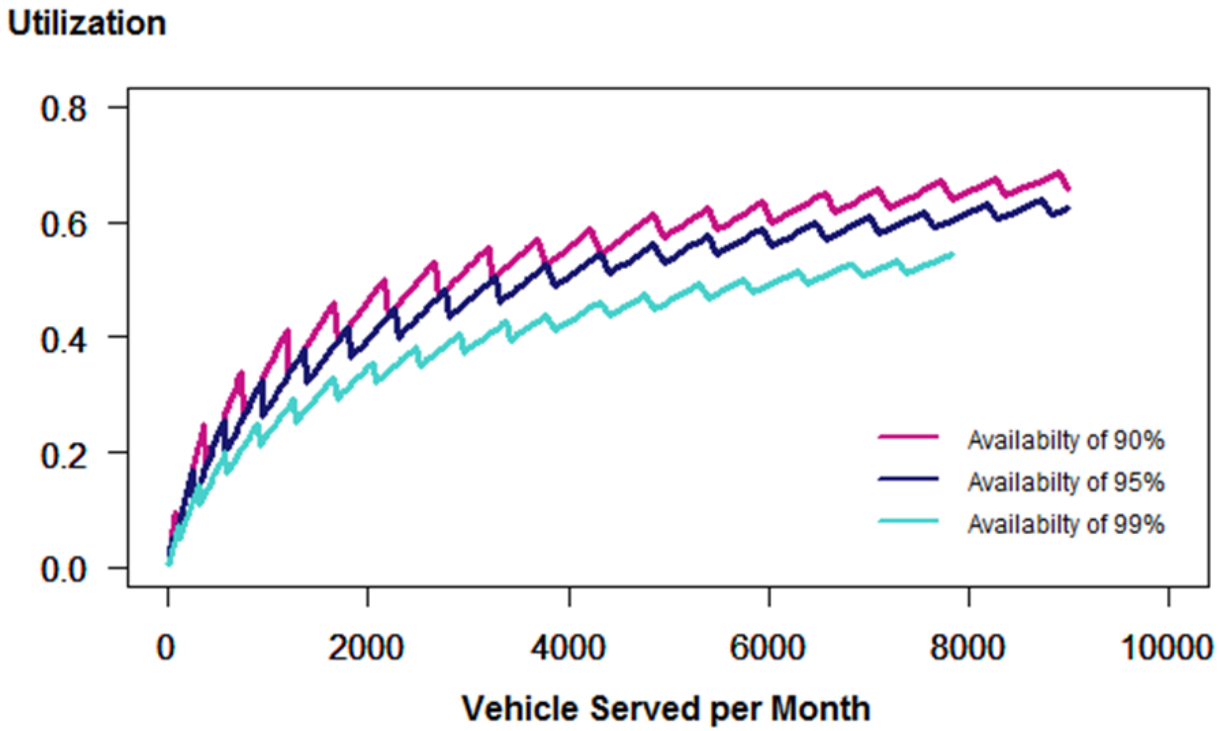


We need sufficient demand to justify investment in chargers

When availability drops below target level, add another server



As number of EVs grows, the utilization rate increases…



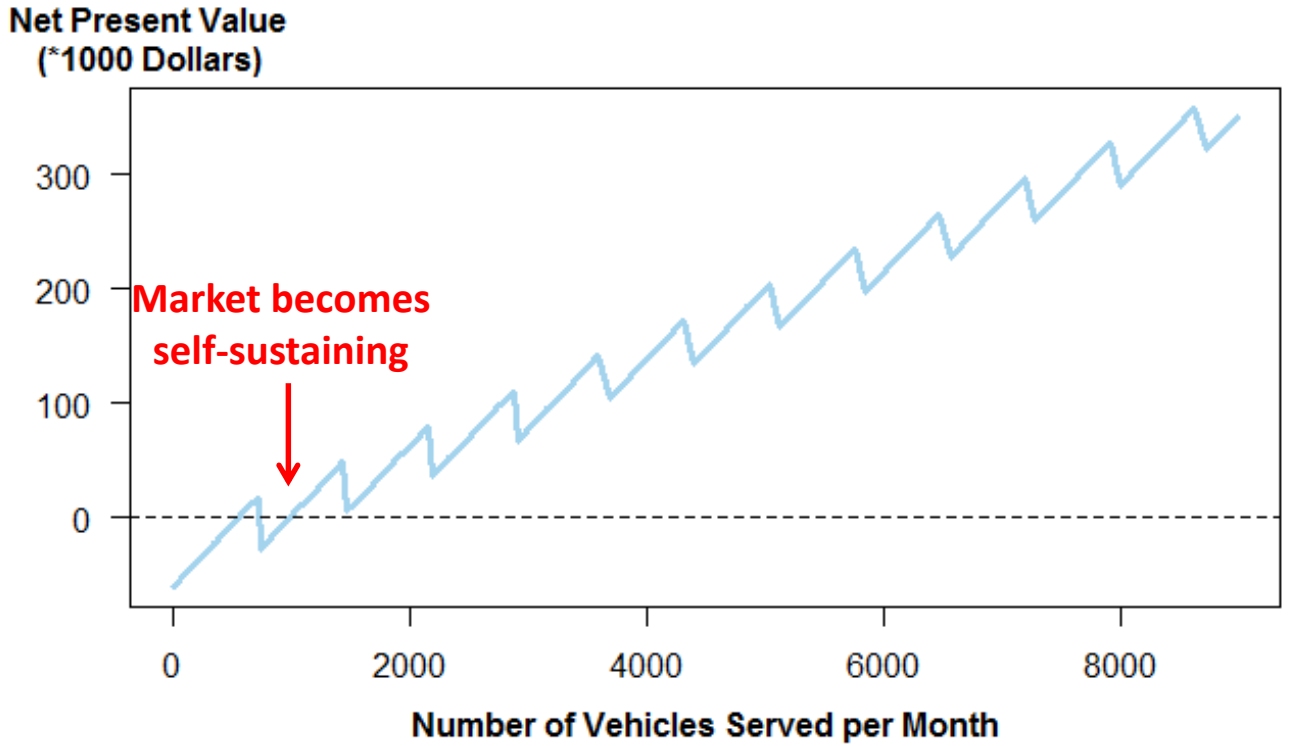
We integrate queue model into a business model of DCFC stations

Costs		Assumptions
Capital Costs		
	Hardware	$7000 per charger
	Shipping	$300 per charger
	Installation	$1000 per site + $1000 per charger
	Taxes	9.6%
Operating Costs		
	Maintenance	$1700 per charger per year
	Meter Charges	$200 per station per month
	Demand Charges	$600 per charger per month
	Energy Charges	$0.11 per kWh

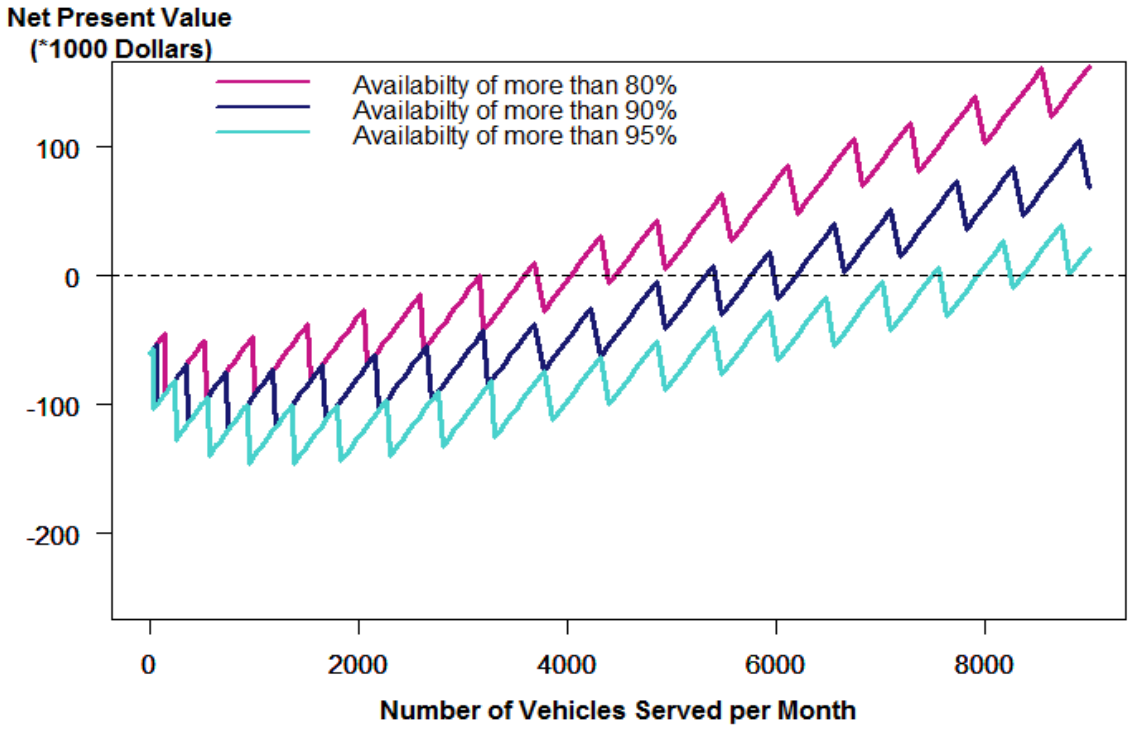
Charging Operations	Assumptions
Max Power	60 kW
Energy per Charge	20 kWh
Avg Charging Time	30 minutes
Operating Hours	12 hours / day
Price of Charging	$0.20 / kWh

Financial	Assumptions
Project Life	10 years
Discount Rate	15%

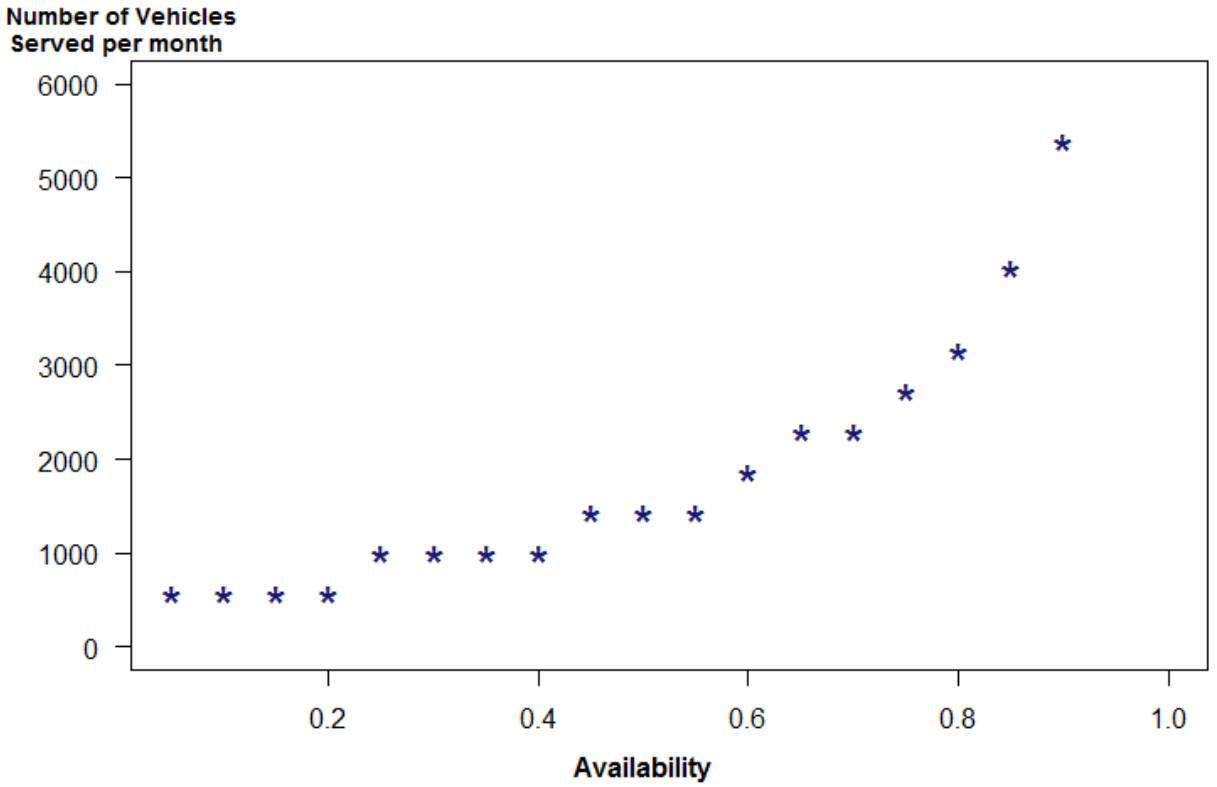
DCFC investment looks reasonable, *if we ignore* availability constraint



Maintaining reliable access creates “Valley of death” for DCFC market



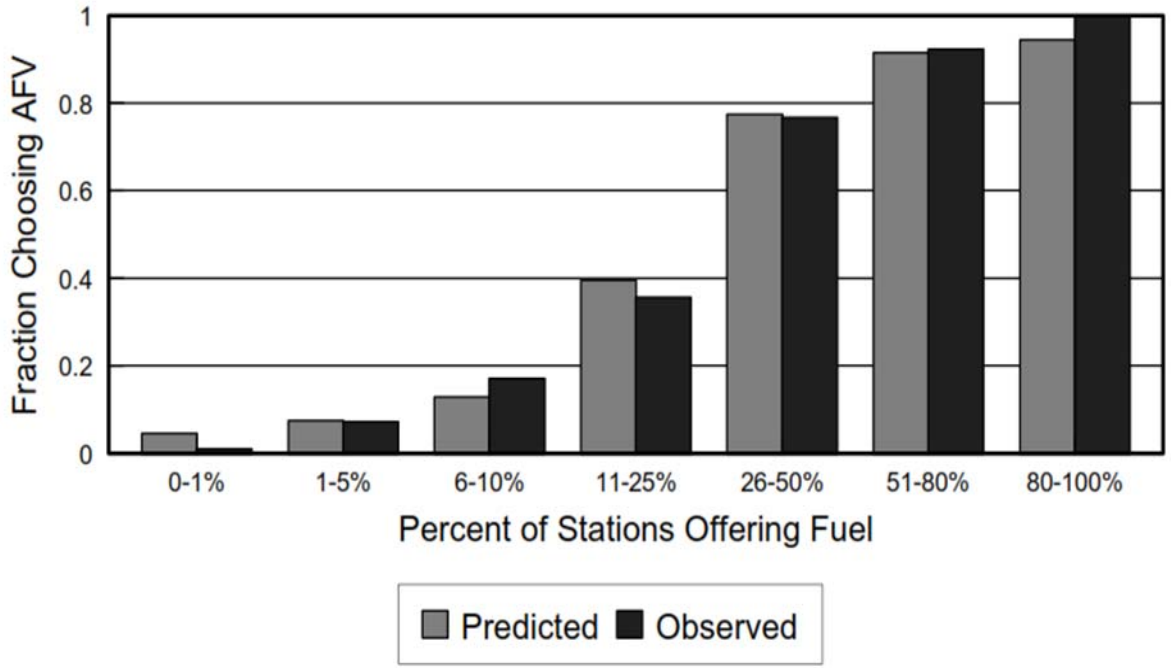
Minimum volume required to provide positive net present value, for each level of availability



Our findings show…

- Maintaining reliable access limits utilization in the near term
- Will be even harder to reach the stage where there is clear business case for DC fast charging
- *How many vehicles do we need to deliver adequate availability* ***while creating an attractive investment opportunity****?*

Alternative fuel stations <25% of number of gas stations → much lower adoption



With 168,000 Gas Stations in U.S (www.fueleconomy.gov)

we need **42,000** DCFC locations

D. L. Greene, *Survey evidence on the importance of fuel availability to the choice of alternative fuels and vehicles*. Energy Studies Review 8.3 (1998).

To break even (NPV = 0) while maintaining 80% availability

- Need about 4000 charges per station per month

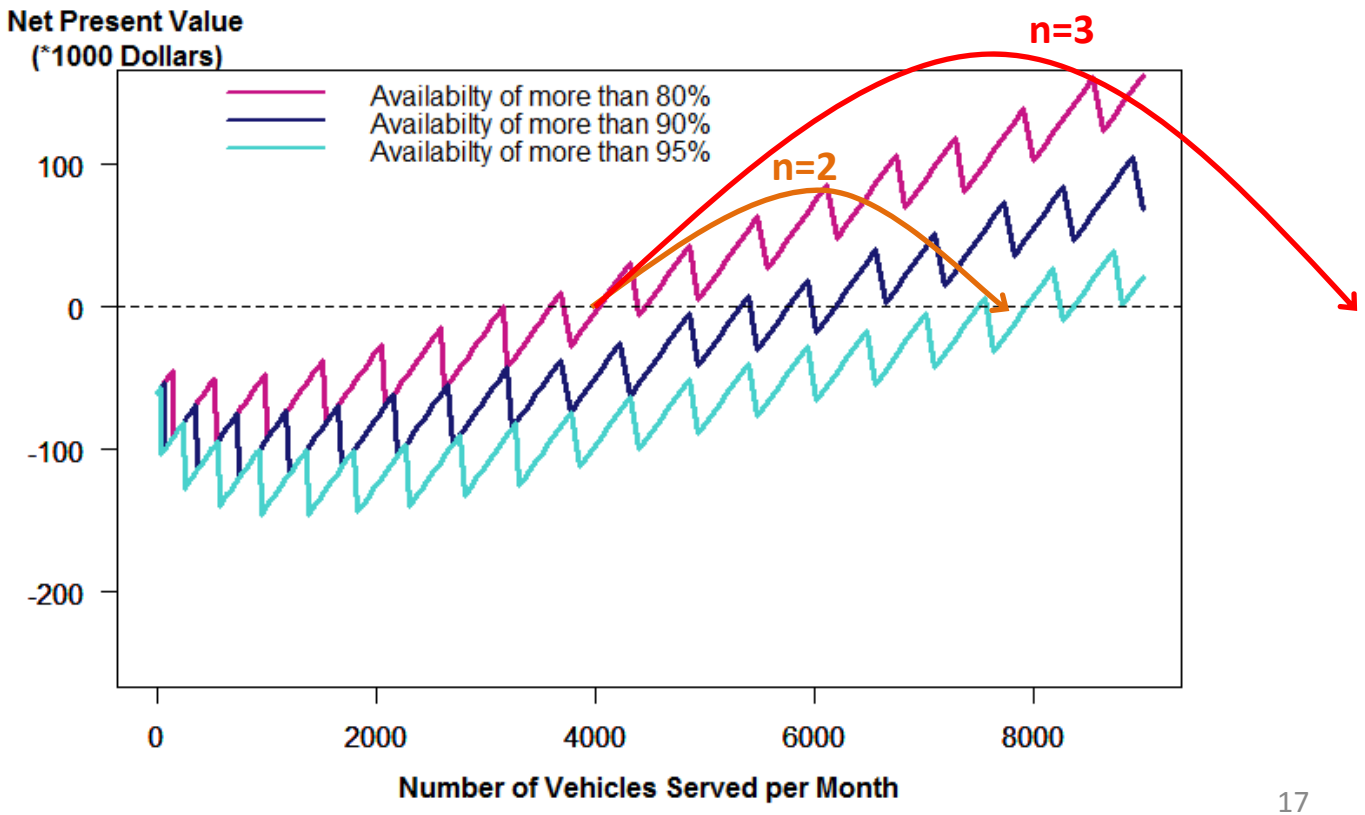
- Assuming average of one fast charge every 3 days, each EV would make 10 fast charges per month per vehicle

42,000 * 4000 / 10 = 16,800,000

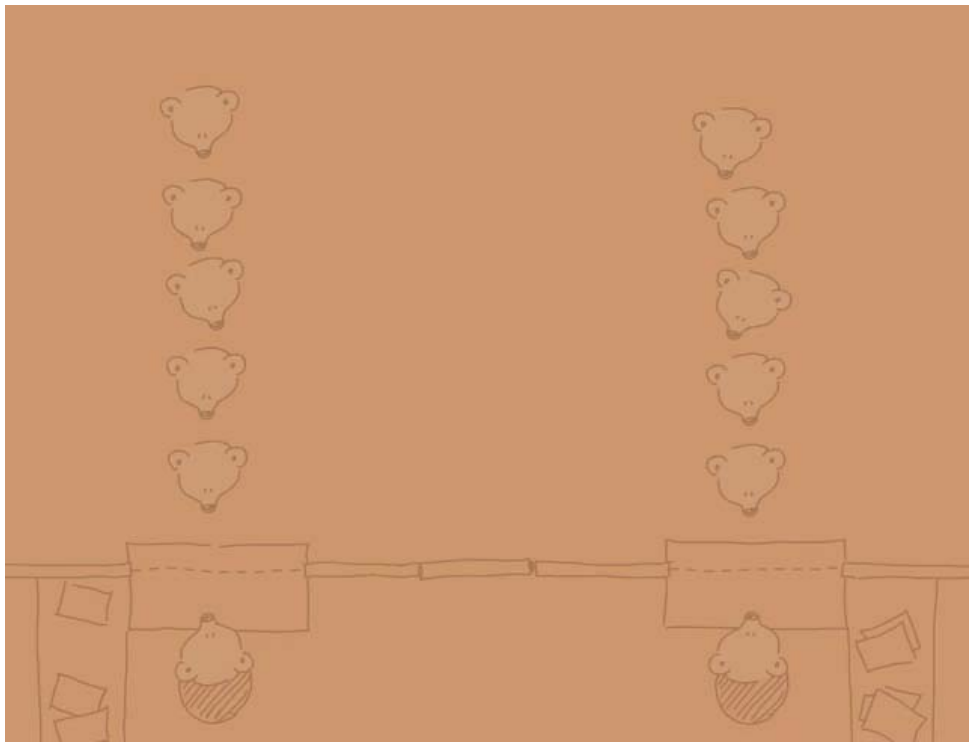
- **….We would need around 17 million EVs in the U.S.**

Increase in range of electric vehicles → less frequent charging events → less attractive investment while maintaining availability

A single DCFC standard makes infrastructure market self-sustaining sooner



Focus on multi-charger stations in strategic locations (or do so virtually using ICT & reservations)



Open questions

- What level of availability is sufficient?
- Is availability even the right metric?
- How high can your price per kWh actually go?

Thank you!

BTCPower

www.btcpower.com

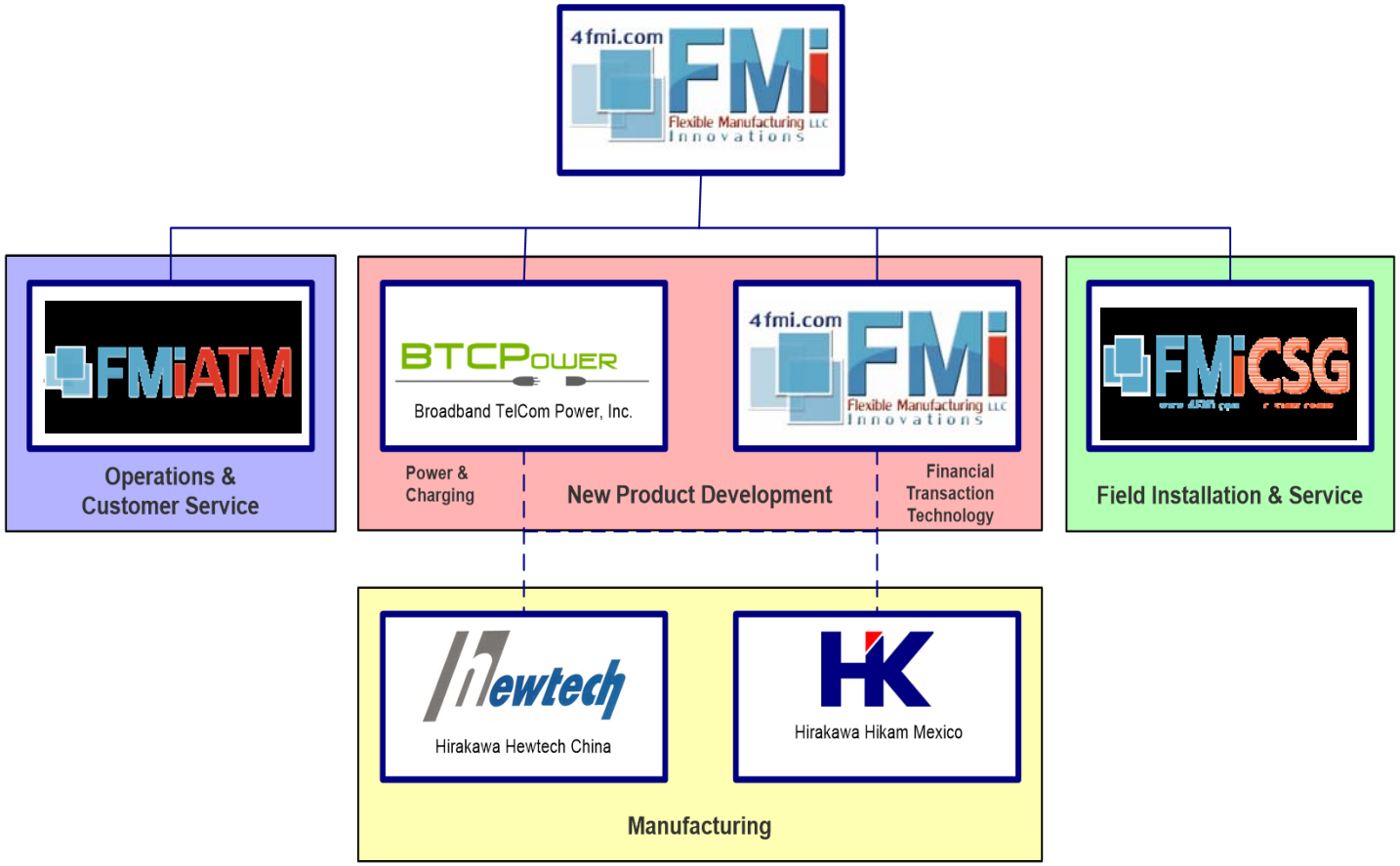
A leading power electronics design firm specializing in vehicle battery charging

Broadband Telco Power Inc.

BTC.

- **BTC is a leading power electronics design company and related services provider**
- **BTC focuses on the following verticals**
- **Electric Vehicle charging, Fork lift charging (material handling), eGSE, and related payment systems**
- **Current projects in DC Fast Charging**

Broadband Telco Power Inc.



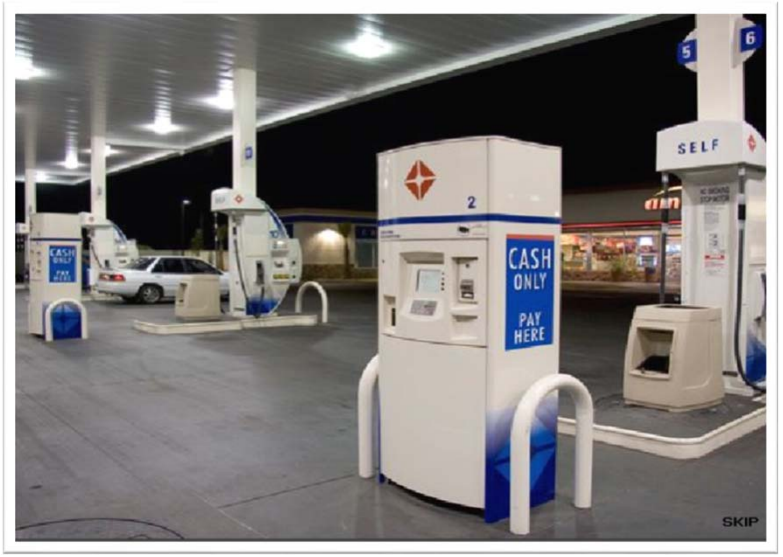
Industrial Charging

BTCPower
www.btcpower.com

Customers

- *IKEA*
- *Walmart*
- *Coca-Cola*
- *Sketchers*
- *PriceSmart*
- *RiteWay*
- *Ocean Spray*
- *Sunny Delight*
- *Custom Foods*
- *Westside Foods*
- *Earthbound Farm*
- *SYSCO*

Manufacturing and Production



"FMi is one of largest financial Kiosk deployment and management companies in the U.S. with over 5,000+ financial kiosks deployed and serviced by FMi. Including: 4,500+ Payment Island Cashiers (PICs) at ARCO am/pm service stations West of the Rockies, 600+ Fully Functional Financial Kiosks and over 1,100 ATMs"

- ✓ *FMi Equipment processes over $4.3 Billion in cash every year for BP-ARCO*
- ✓ *Cash Accepted = (4,500 machines) ($8,000 / 3-day) (30-day / month) (12 month / year) = $4.32 B*

50 kW DC Fast Charger

- Dual Port
  CHAdeMO & SAE J1772 Combo
- 15” outdoor color display with touch screen
- Payment System (supports all major credit cards)
- Loyalty System (customer engagement program)
- Microphone
- Speakers
- Camera
- Cord Retractor on top – (Lanyard retractor)

Technical Specification	
Power Rating	50kW
Connectors	CHAdeMO, SAE J1772 Combo
Network	EVP, Credit Cards, Loyalty
Input Power	208VAC, 3-Phase / 480VAC, 3-Phase
Input Breaker	160A/100A
Frequency	50Hz/60Hz
Efficiency Rating	>90%
Nominal Output DC Current	125 A
Max Output DC Voltage	50-500V
Operating Temperature	-35 C to 50 C
Dimensions	38”[w] x 72.75”[h] x 27.6”[d]
Safety Compliance	UL2202, UL2231-1, UL 2594

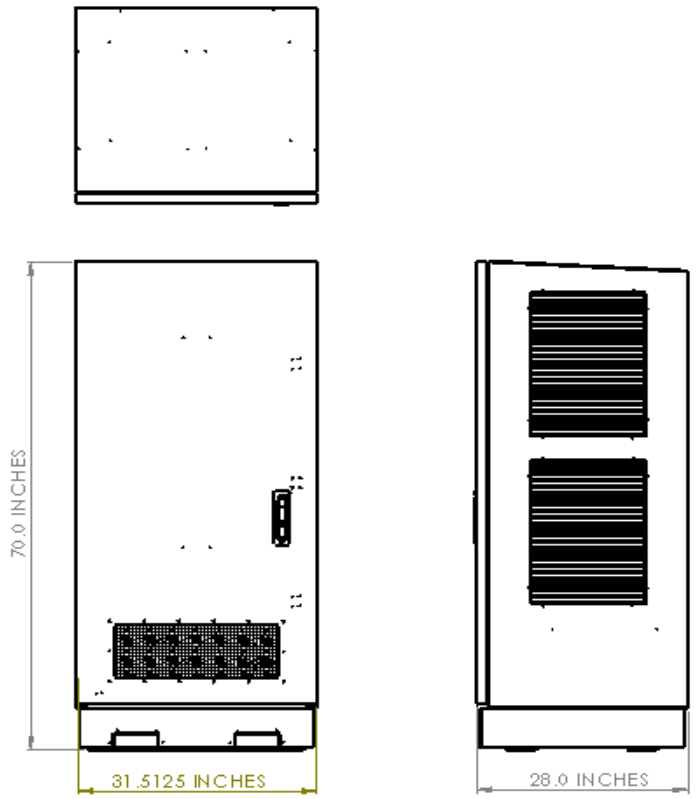
BTCPower
www.btcpower.com

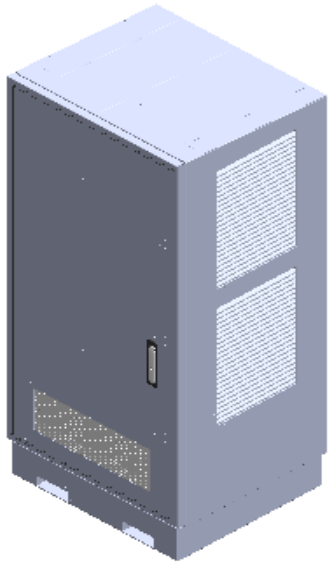
50 KW Single Pedestal DC FC
155 KW Pedestal + Separate Converter

Dual Fast Charger


Pump
BTCPower

REVISIONS				
ZONE	REV.	DESCRIPTION	DATE	APPROVED
1	A	100 KW DC FAST CHARGER CUBE	4/11/2015	COPIES





NOTES:
1. ALL DIMENSIONS IN INCHES

	NAME	DATE
DRAWN		
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
ANGULAR: MACH ± BEND ±
TWO PLACE DECIMAL ±
THREE PLACE DECIMAL ±
INTERPRET GEOMETRIC TOLERANCING PER:
MATERIAL
FINISH
NEXT ASSY | USED ON
APPLICATION
DO NOT SCALE DRAWING

Broadband Telcom Power Inc.

TITLE:
150 KW Converter

SIZE	DWG. NO.	REV
B	TCC-001	A

SCALE: 1:20 WEIGHT: | SHEET 1 OF 1

Agenda

DC Fast Charging Life Cycle

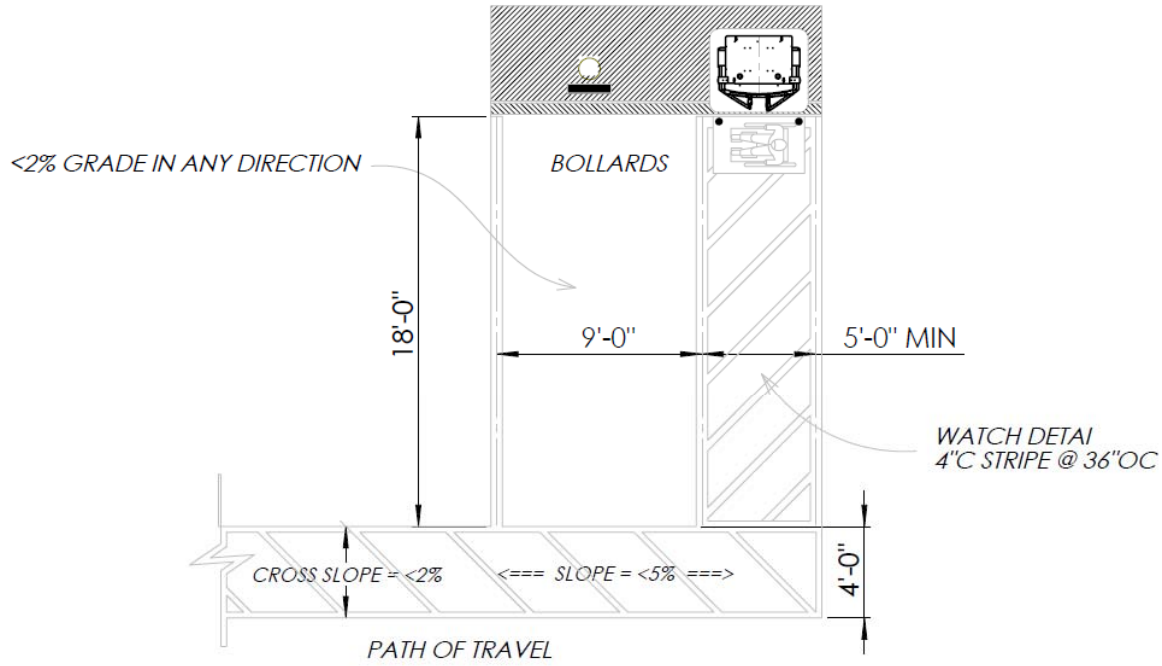
1. Site Development
2. Dynamic Commissioning (payment system)
3. Site host training
4. Installation
5. Start Up
6. Operation
   - Revenue
   - Costs of Operation
   - Maintenance
7. Upgrade path to keep up with new vehicles

Items to consider during site development

- ***Electrical Infrastructure***
  - ✓ ***Available power 208 VAC, 480 VAC***
  - ✓ ***Safety switches installed per NEC***
- ***Signage***
- ***Equipment protection***
  - ✓ ***Bollard placement***
  - ✓ ***Bollard protection***
- ***Stenciling and striping***
- ***Lighting – safety***
- ***Hardscape***
- ***Landscape***
- ***ADA Design***

Site Development

SINGLE ADA PARKING SPOT



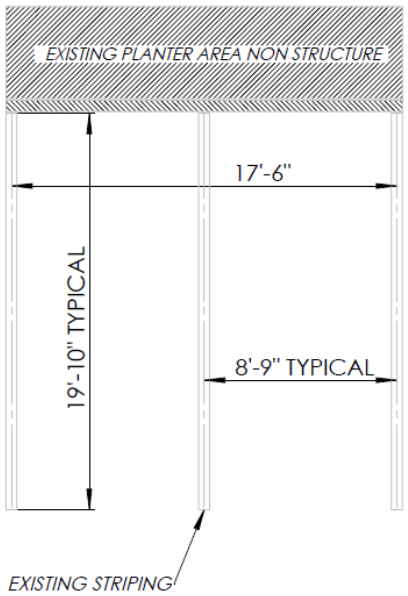
EXISTING CONCRETE OR ASPHALT PARKING AREA

BTC Power Inc.

DWG.
EVP-50 PARKING GUIDELINES #1

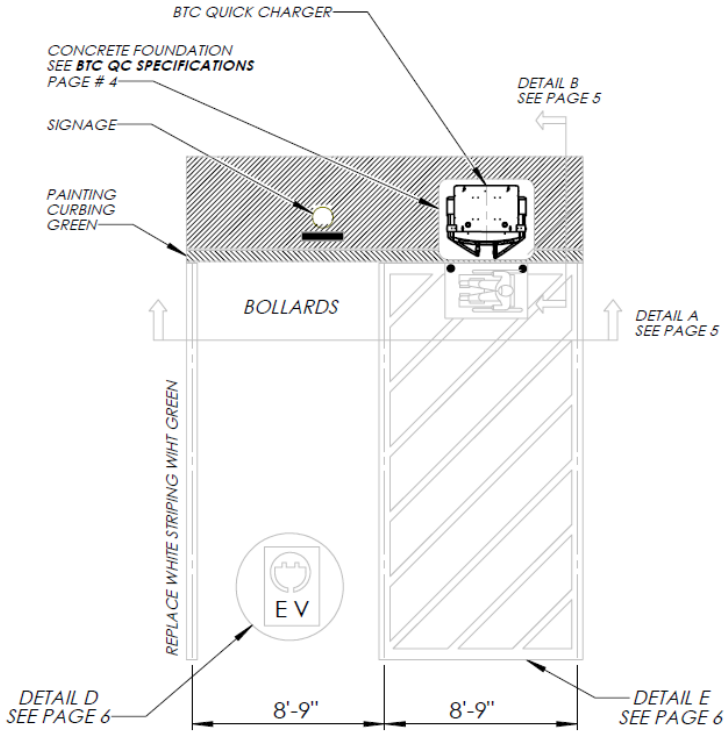
DRAWN:	APPR:	DATE:	SHEET:
A.Lopez	C. Cortes	06/07/16	1 OF 1

DUAL PARKING SPOT CONVERSION



CONCRETE OR ASPHALT PARKING AREA

Standard Parking Area



CONCRETE OR ASPHALT PARKING AREA

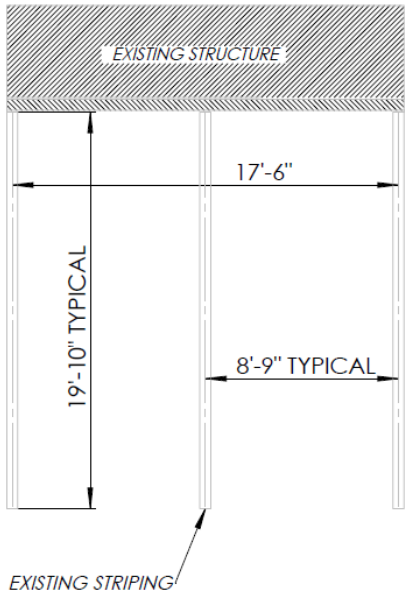
Standard Parking Area Reconfigured
For Quick Charger ADA Compliance

BTC Power Inc.

DWG.
EVP-50 PARKING GUIDELINES #2

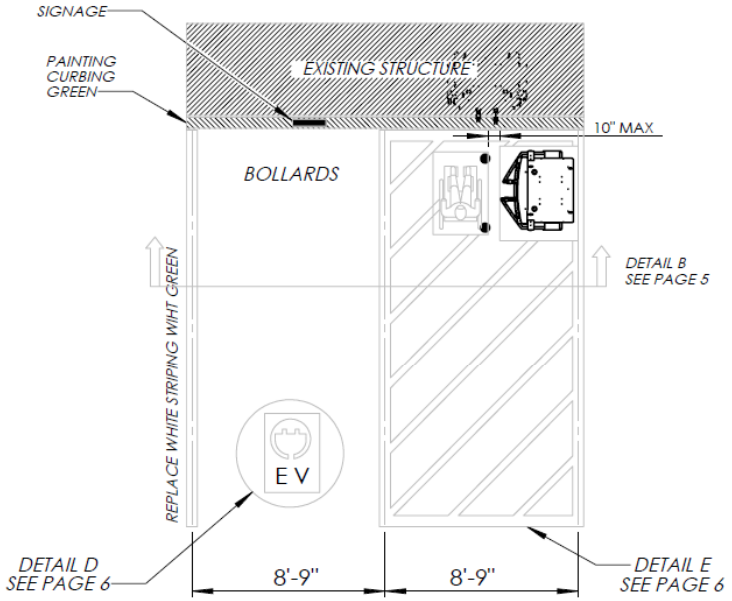
DRAWN:	APPR:	DATE:	SHEET:
A.Lopez	C. Cortes	06/07/16	1 OF 1

DUAL PARKING SPOT CONVERSION (Alternate)



CONCRETE OR ASPHALT PARKING AREA

Standard Parking Area



CONCRETE OR ASPHALT PARKING AREA

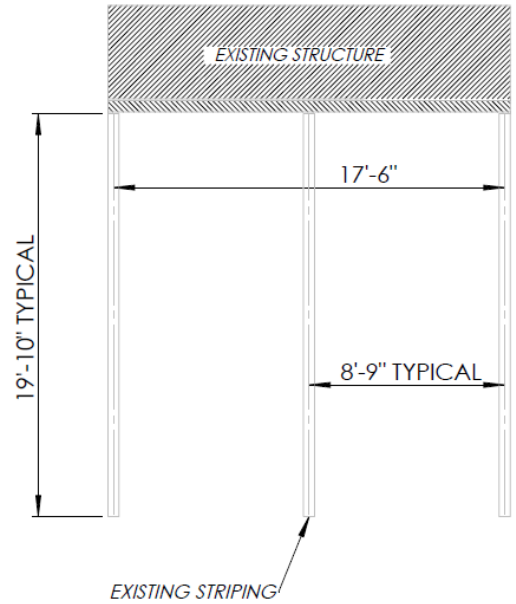
Standard Parking Area Reconfigured For Quick Charger ADA Compliance

BTC Power Inc.

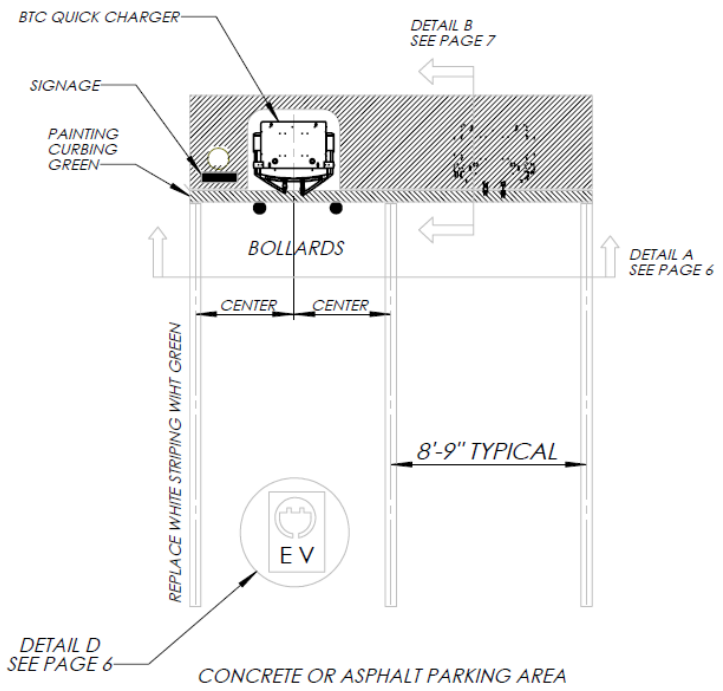
DWG.
EVP-50 PARKING GUIDELINES #3

DRAWN:	APPR:	DATE:	SHEET:
A.Lopez	C. Cortes	06/07/16	1 OF 1

DUAL PARKING SPOT CONVERSION (Non ADA)



Standard Parking Area

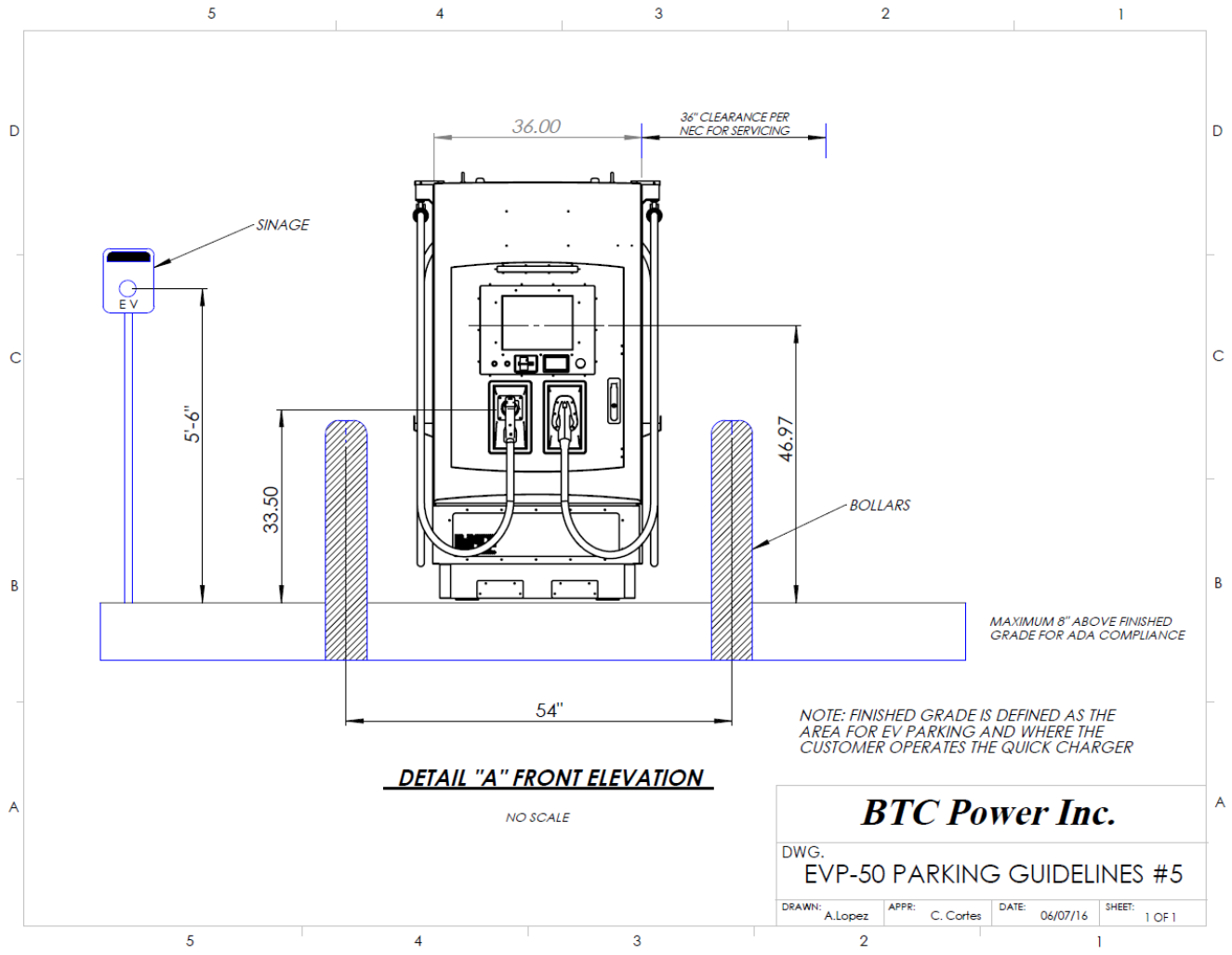


Standard Parking Area

BTC Power Inc.

DWG.
EVP-50 PARKING GUIDELINES #4

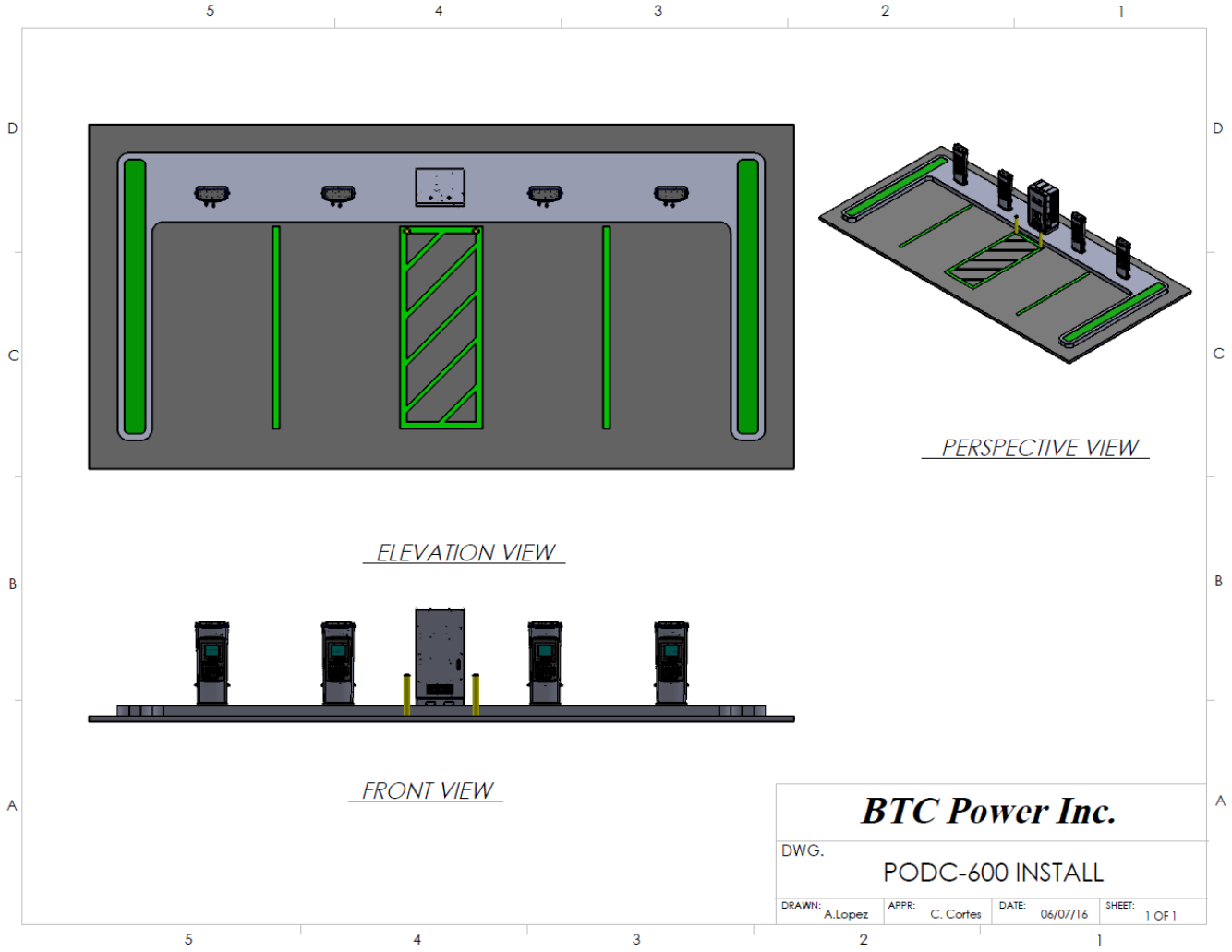
DRAWN:	APPR:	DATE:	SHEET:
A.Lopez	C. Cortes	06/07/16	1 OF 1



50 KW DC Fast
With cord retractors

Detail A – Front Elevation

High powered charging site in development



- 150 KW System in development
- 4 x Charging pedestals
- 1 x 150 KW power converter, 480 VAC input


Self Storage
MAILBOX
NEWSSTAND
ESPRESSO TIME
FedEx
ELECTRIC VEHICLE CHARGING ONLY


EV FAST CHARGING
RESERVED FOR
ELECTRIC VEHICLE
CHARGING
E.V.

Lessons Learned

- Flexible design layouts – sites are widely varied
- 208 vs 480 VAC equipment and proximity to power
- Set up a knowledge base website
  - Certify your installers
- Start up and commissioning done prior to shipment and automatically
- Cellular setup pre commissioned and set up
- BTC backend account setup
- Merchant account setup process
- After sale support process
  - FAQs

Average Costs

CHARGER TYPE	COST	COST	TOTAL COSTS	AVERAGE TIME TO CHARGE 80%
AC Level 2	**HARDWARE**	**AVERAGE INSTALL**	**HARDWARE + INSTALL**	
7.5 KW				
240 VAC	$5500 (Commercial)	$3000 - $5000		
DC FAST				
50 KW				
480 VAC	$ 25,000.00	$10,000 - $21,800	$ 38,000.00	30 min
208 VAC	$ 27,000.00	$10,000 - $17,000	$ 39,800.00	
DC FAST				
150 KW	$ 48,000.00	$ 22,000.00	$ 70,000.00	16 min
480 VAC				

Report Period: Month of March, 2016

50kW DC Fast Charger

Total Transactions	**152**
Successful Transactions	**146**
CHAdeMO Transactions	*58*
SAE Transactions	*88*
Unsuccessful Transactions	**6**
Connection timeout [CHAdeMO]	*1*
No Prox [SAE]	*3*
Vehicle Permission [CHAdeMO]	*2*
Yield %	**96.05%**

CHAdeMO vs SAE first pass yield similar

Gen 2 CHAdeMO vs SAE coupler consumer ease of use similar

BTCP Charger Statistics

DC Fast Charge Sessions California		
3/31/2016		97.4%
2/29/2016		95.4%
1/31/2016		96.2%

Note:

Issues

Credit Card

Communication issues

Connector prox SAE

Connector seating Chademo

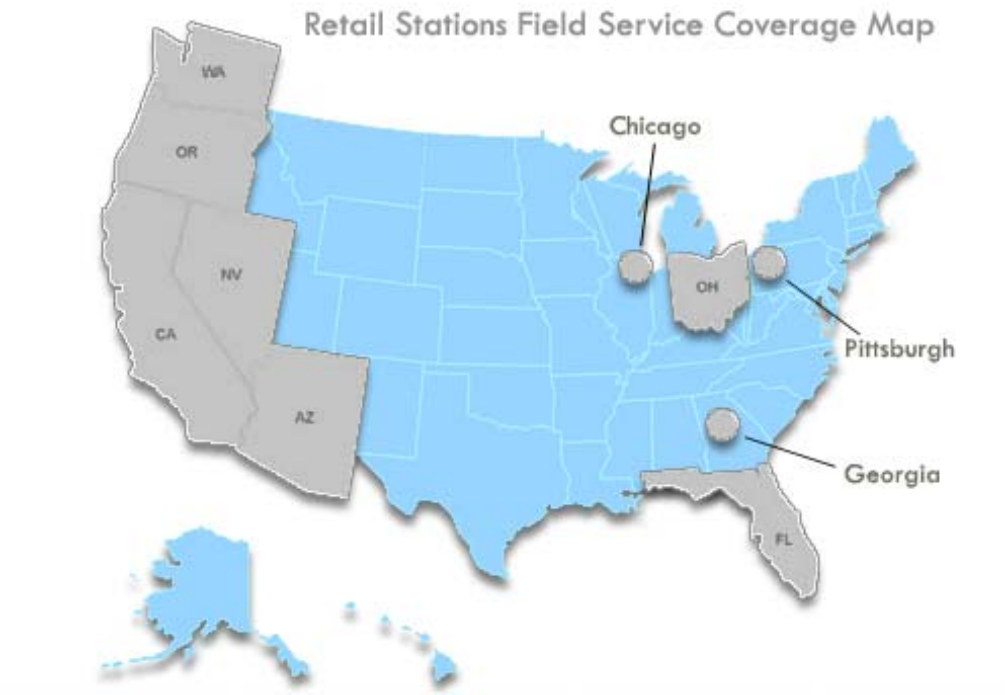
Charger Fault

Markets Served

Georgia	In Market
Colorado	In Market
California	In Market
Washington	In Market
Ohio	In Market
New York	In Market
Illinois	In Market
Florida	In Market
Arizona	In Market
Nevada	In Market
Oregon	In Market
North Carolina	In Market
South Carolina	In Market
Massachusets	In Market
Connecticut	In Market
New Jersey	In Market

CSG Services
Markets served

Nation wide maintenance program



BTCPower Deployments:

5,000+ Payment systems deployed on the west coast

7,500+ Forklift charging systems deployed nation wide

BTCPower through its parent company FMi services its own equipment with certified personnel in the following regions

CA, NV, AZ, WA, OR, PA, FL OH, IL

Process	Task	Responsible
1	Verify equipment is installed	Xavier
2	Create user web portal	Harish S.
3	Assign equipment to user web portal	Harish S. / Xavier
4	Verify equipment in field has correct credentials for pay	Joe Marlow / Hai Cao
5	Perform trial transaction	Joe Marlow / Hai Cao
6	Verify trial goes into correct location	Joe Marlow / Hai Cao
7	Send out FAQ	Xavier / Keri
8	Follow up with a phone call to site	Xavier / Keri
9	Schedule phone call training	Xavier / Keri
10	On going credit card settlement verification	Sunil / Eddie
11	Phone support	Juan Rosas / CSG Team

Support process

Level 2 AC Station Wall Mount

- Wall-Mount Installation
- 7” outdoor color display with touch screen
- Payment System (supports all major credit cards)
- Loyalty System (customer engagement program)
- Microphone
- Speakers
- Camera

Technical Specification	
Network	EVP, Credit Cards, Loyalty
Input Power	208/240 VAC
Input Breaker	40A
Output Current	30A
Output Charging Power	6kW
Output Voltage	208/240 VAC
Connector	SAE J1772
Operating Temperature	-20C to 45C
Dimensions	16”[w] x 36.8”[h] x 12.98”[d]
Safety Compliance	UL2594, UL2231-1, UL2231-2

BTCPower
www.btcpower.com

BTCP Products

Level 2 AC Station Dual Port

- Dual Port – SAE J1772
- Pedestal Installation
- 7” outdoor color display with touch screen
- Payment System (supports all major credit cards)
- Loyalty System (customer engagement program)
- Microphone
- Speakers
- Camera
- Product dimensions: 18”[w] x 56.25” [h] x 10” [d]

Technical Specification	
Network	EVP, Credit Cards, Loyalty
Input Power	208/240 VAC
Input Breaker	40A per side (2 separate panel breakers required)
Output Current	30A per side
Output Charging Power	6kW per side
Output Voltage	208/240 VAC
Connector	SAE J1772
Operating Temperature	-20C to +45C
Safety Compliance	UL2594, UL2231-1, UL2231-2

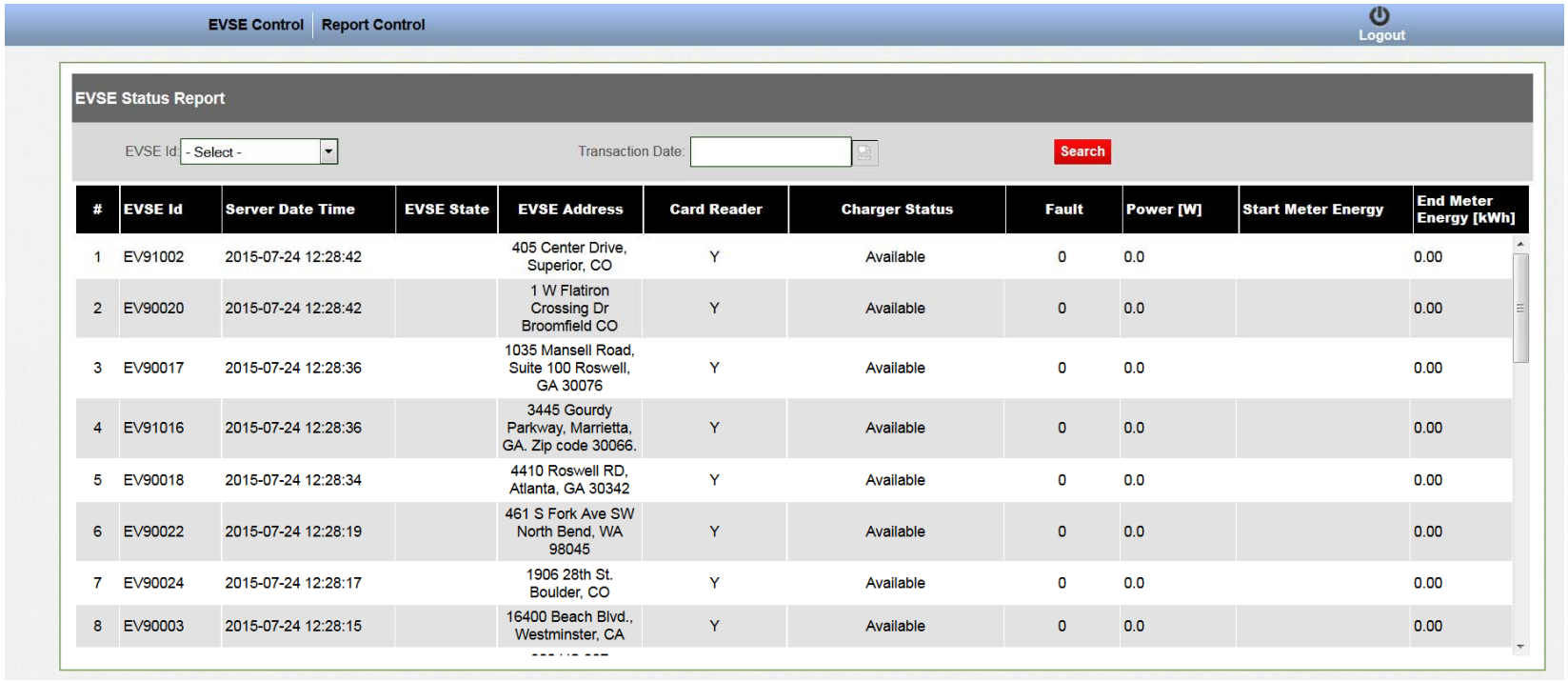
BTCPower
www.btcpower.com

Level 2 Electric Charger Product Line

BTCPower
www.btcpower.com

	Level 2 Pedestal	Level 2 Pedestal with Cord Retractor	Level 2 Wall mount	Level 3 DC Fast Charger
Input Voltage & Current	208/240 VAC, 30A	208/240 VAC, 30A	208/240 VAC, 30A	208 VAC, 3-Phase 80-200A
Output Connector	J1772, 18ft Cable	J1772, 18ft Cable	J1772, 18ft Cable	SAE Combo, CHAdeMO
Payment System	Yes, Mag Strip Card Reader	Yes, Mag Strip Card Reader	Yes, Mag Strip Card Reader	Yes, Mag Strip Card Reader
Display	VF Display	Color, Touch screen	Color, Touch screen	15” Color Touch Screen
Cord Retractor	No	Yes, Motorized	No	Yes, Lanyard
LED Indicator	No	Yes	No	NO
Product Images				

Reporting System Features



#	EVSE Id	Server Date Time	EVSE State	EVSE Address	Card Reader	Charger Status	Fault	Power [W]	Start Meter Energy	End Meter Energy [kWh]
1	EV91002	2015-07-24 12:28:42		405 Center Drive, Superior, CO	Y	Available	0	0.0		0.00
2	EV90020	2015-07-24 12:28:42		1 W Flatiron Crossing Dr Broomfield CO	Y	Available	0	0.0		0.00
3	EV90017	2015-07-24 12:28:36		1035 Mansell Road, Suite 100 Roswell, GA 30076	Y	Available	0	0.0		0.00
4	EV91016	2015-07-24 12:28:36		3445 Gourdy Parkway, Marrietta, GA. Zip code 30066.	Y	Available	0	0.0		0.00
5	EV90018	2015-07-24 12:28:34		4410 Roswell RD, Atlanta, GA 30342	Y	Available	0	0.0		0.00
6	EV90022	2015-07-24 12:28:19		461 S Fork Ave SW North Bend, WA 98045	Y	Available	0	0.0		0.00
7	EV90024	2015-07-24 12:28:17		1906 28th St. Boulder, CO	Y	Available	0	0.0		0.00
8	EV90003	2015-07-24 12:28:15		16400 Beach Blvd., Westminster, CA	Y	Available	0	0.0		0.00

“View EVSE Status Report”

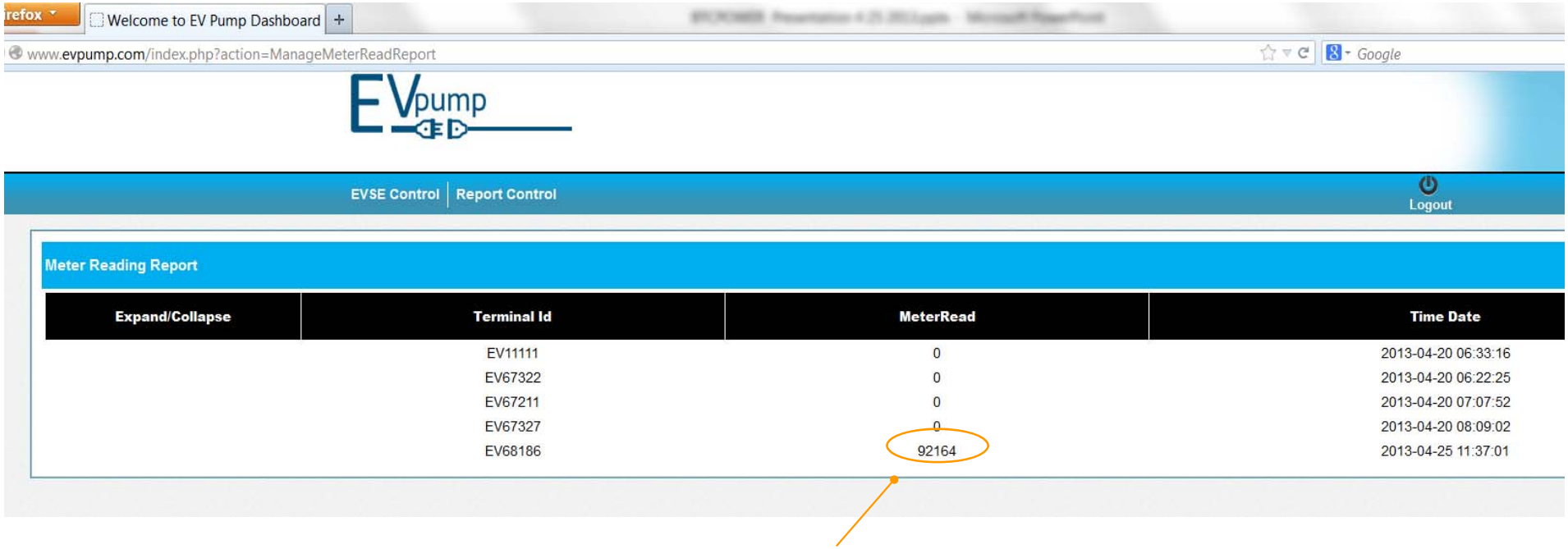
Report available under Report Control

Up time management

Major components are all monitored 7 / 24. System issues automatic service tickets for anything which requires maintenance

Reporting System Features

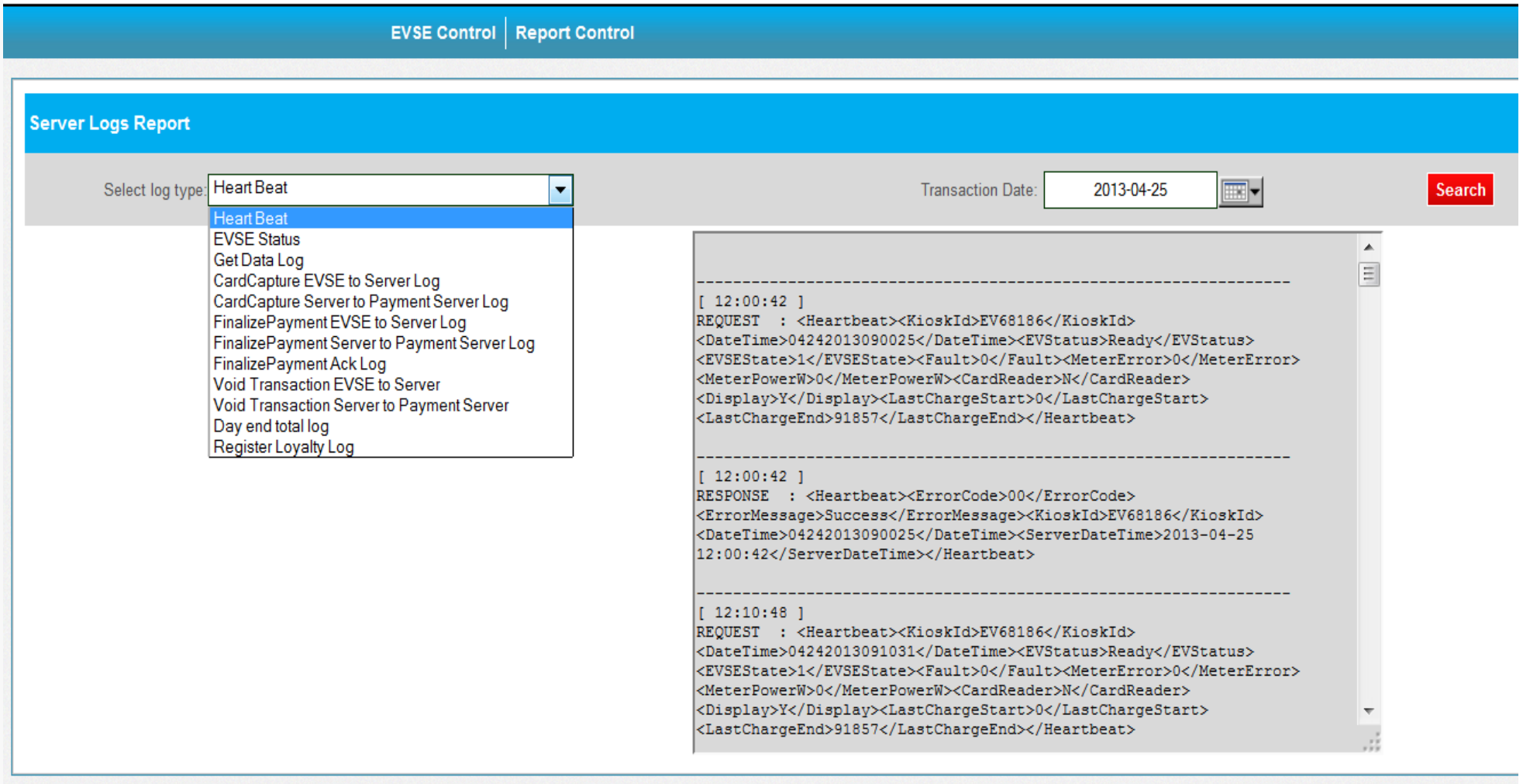
EVSE Meter Read Report



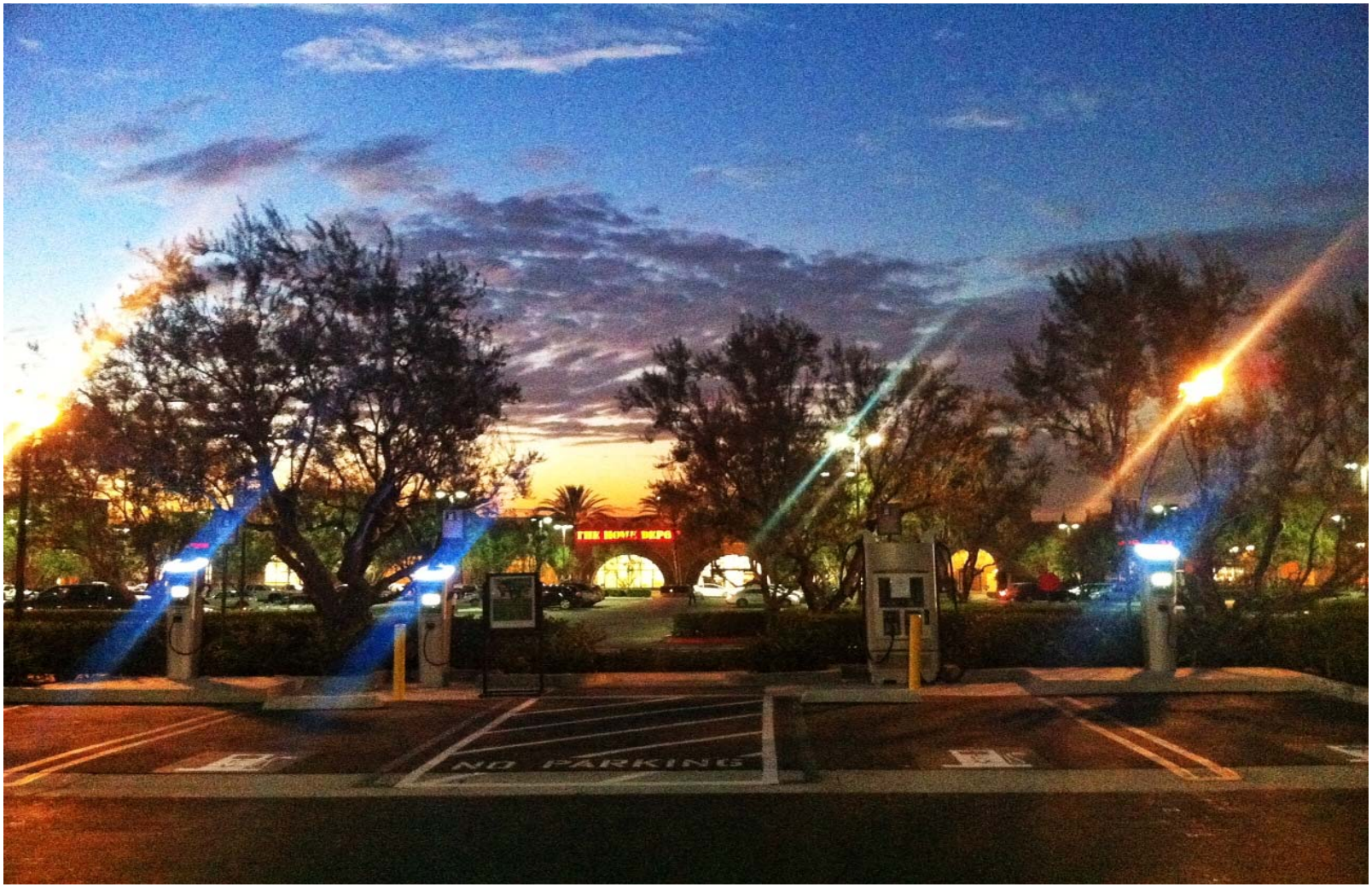
Value continues to be reported and added to previous readings
This value comes directly from the e Meter

EVSE DR Report

This report is populated as events are captured by the Xbee interface

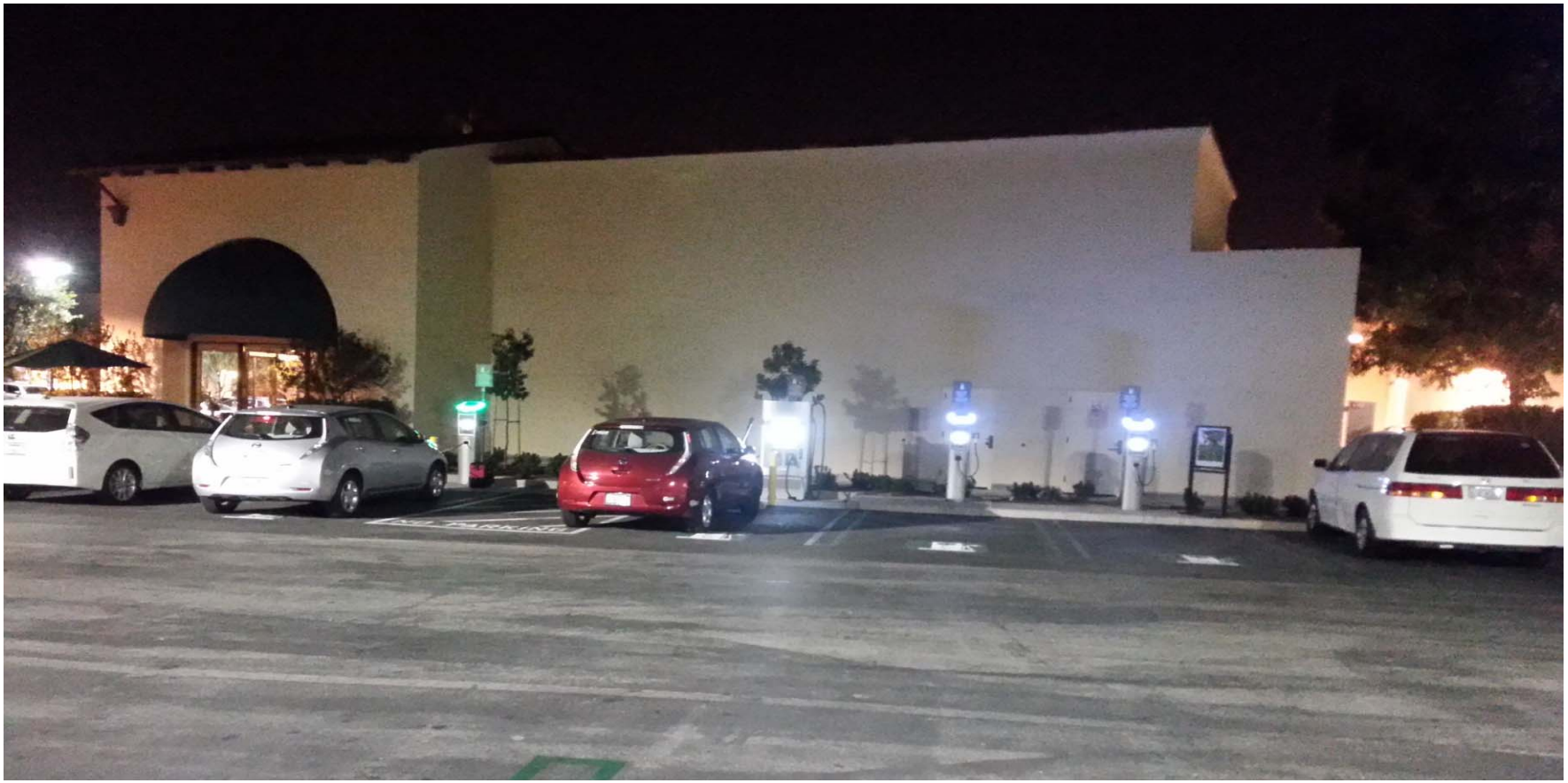

EVSE Control
Report Control
Server Logs Report
Select log type:
Heart Beat
Heart Beat
EVSE Status
Get Data Log
CardCapture EVSE to Server Log
CardCapture Server to Payment Server Log
FinalizePayment EVSE to Server Log
FinalizePayment Server to Payment Server Log
FinalizePayment Ack Log
Void Transaction EVSE to Server
Void Transaction Server to Payment Server
Day end total log
Register Loyalty Log
Transaction Date:
2013-04-25
Search
[12:00:42]
REQUEST : <Heartbeat><KioskId>EV68186</KioskId>
<DateTime>04242013090025</DateTime><EVStatus>Ready</EVStatus>
<EVSEState>1</EVSEState><Fault>0</Fault><MeterError>0</MeterError>
<MeterPowerW>0</MeterPowerW><CardReader>N</CardReader>
<Display>Y</Display><LastChargeStart>0</LastChargeStart>
<LastChargeEnd>91857</LastChargeEnd></Heartbeat>
[12:00:42]
RESPONSE : <Heartbeat><ErrorCode>00</ErrorCode>
<ErrorMessage>Success</ErrorMessage><KioskId>EV68186</KioskId>
<DateTime>04242013090025</DateTime><ServerDateTime>2013-04-25
12:00:42</ServerDateTime></Heartbeat>
[12:10:48]
REQUEST : <Heartbeat><KioskId>EV68186</KioskId>
<DateTime>04242013091031</DateTime><EVStatus>Ready</EVStatus>
<EVSEState>1</EVSEState><Fault>0</Fault><MeterError>0</MeterError>
<MeterPowerW>0</MeterPowerW><CardReader>N</CardReader>
<Display>Y</Display><LastChargeStart>0</LastChargeStart>
<LastChargeEnd>91857</LastChargeEnd></Heartbeat>

Charge Stations



Gallery

Charge Stations



Gallery

Charge Stations

Charge Stations – Fast Charging

EPRI ELECTRIC POWER RESEARCH INSTITUTE

SAE J1772™
Status Update

John Halliwell
Technical Executive

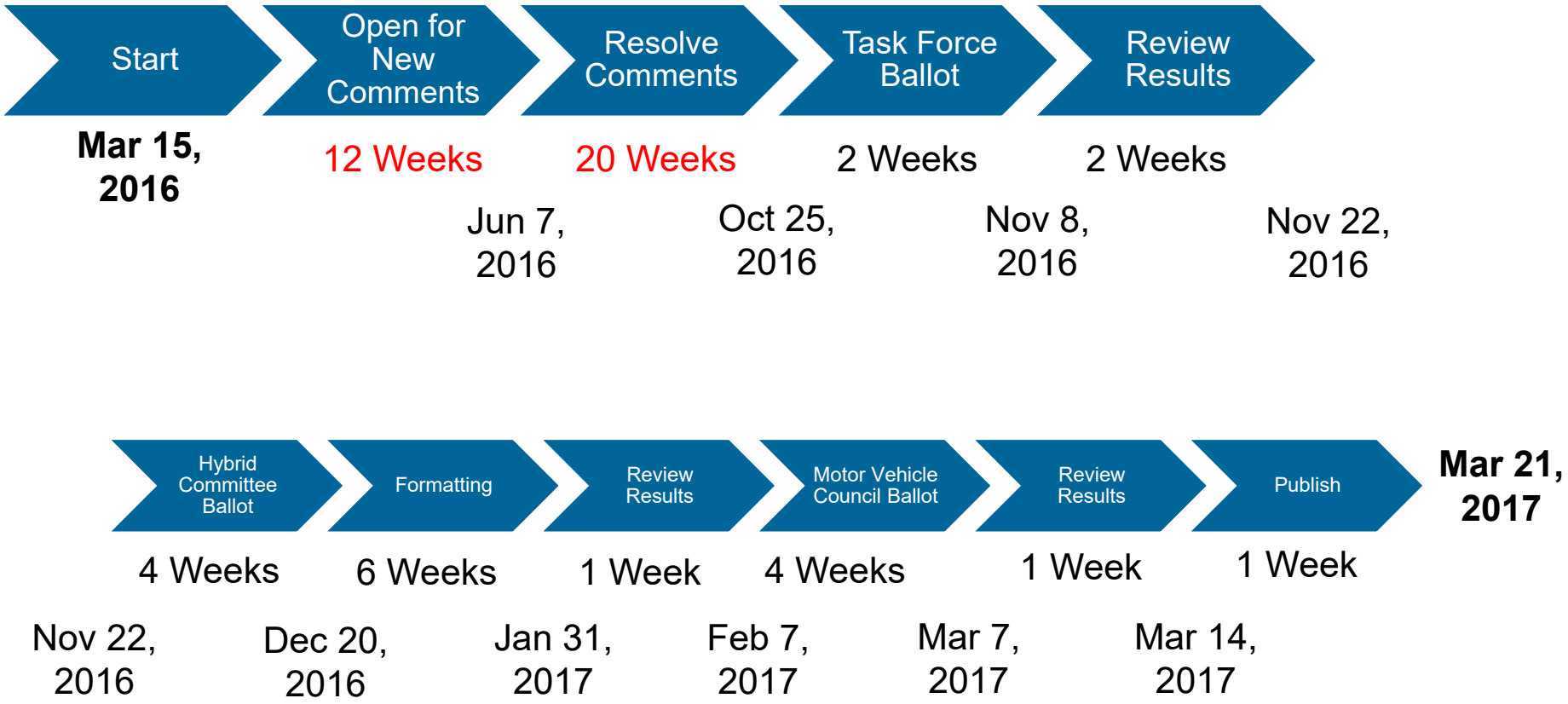
IWC Meeting – Seattle, WA
June 8, 2016

Contents

- Timeline
- Comment categories
- Work plan
- Reminder about connector rating discussion

Version 7 - J1772™ Rough Timeline

Version 6 – Published in February 2016



Comment Period Closes TODAY - June 7, 2016

EPRI ELECTRIC POWER RESEARCH INSTITUTE

~ 40 Comment Have been Submitted

- Coupler
  - Mechanical (dimensional issues)
  - Testing Protocol
  - Capacity (Voltage and Current)
- Charge Session Sequence
- Pilot Wire and Proximity Wire Issues (voltage, tolerance, PWM)
- Editorial Comments (word usage)

- Harmonization –
  - IEC/ISO: sequence, pilot, prox, editorial, control, etc
  - Connector issues

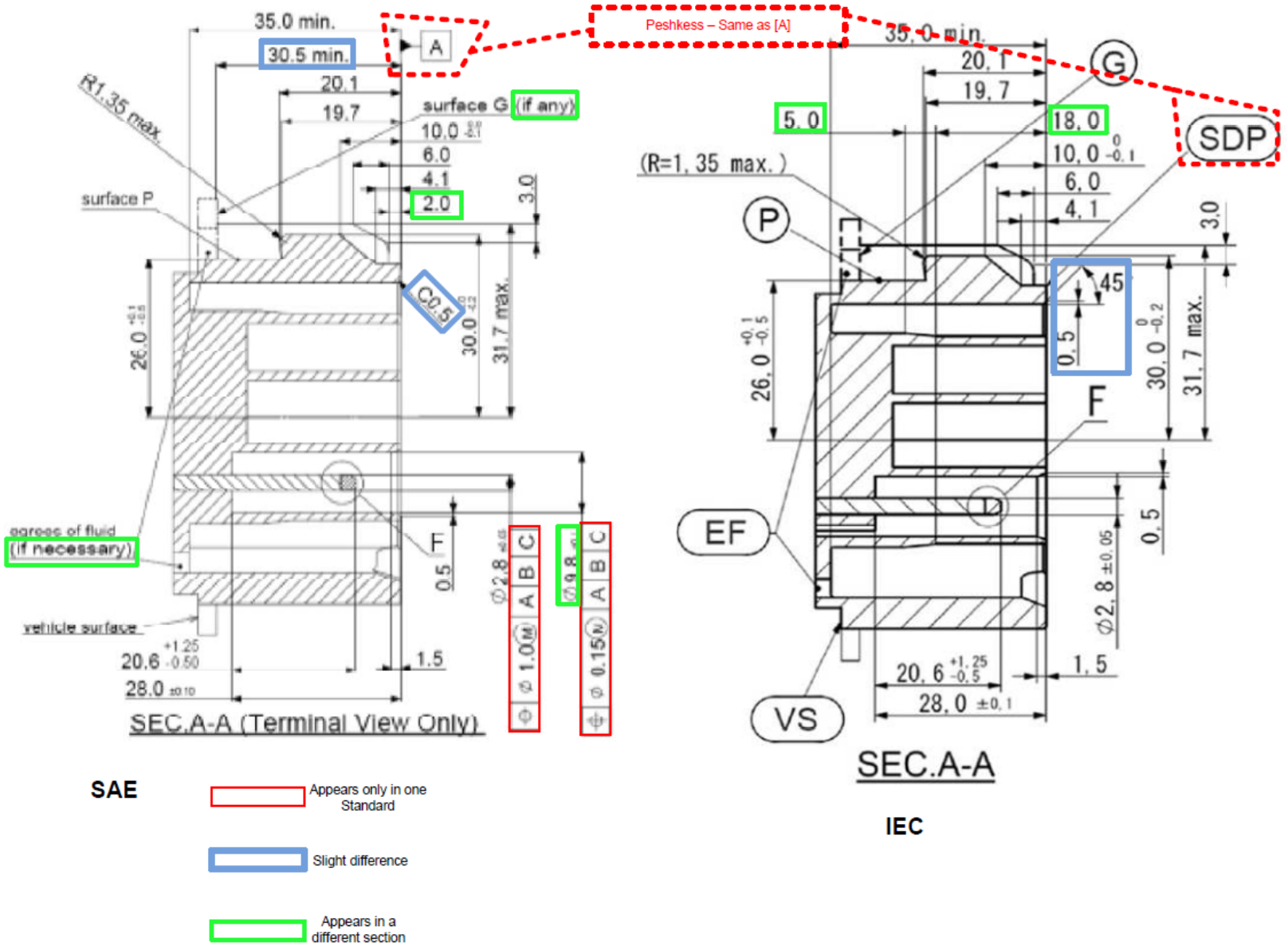
~ 40 Comment Have been Submitted

- Coupler
  - Mechanical (dimensional issues)
  - Testing Protocol
  - Capacity (Voltage and Current)
- Charge Session Sequence
- Pilot Wire and Proximity Wire Issues (voltage, tolerance, PWM)
- Editorial Comments (word usage)

These are likely to be challenging discussions

- Harmonization –
  - IEC/ISO: sequence, pilot, prox, editorial, control, etc
  - Connector issues

Sample - SAE versus IEC Connector Drawings



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Next Steps

- Most existing comments have been updated or withdrawn
- Receiving new comments from Task Force members
  - TODAY - June 7, 2016 comment deadline
  - Several new comments received this week that haven't been posted
- Meetings specific to category topics
- About 90% of comments have had at least a first pass discussion

- Next meeting is June 14, 2016 (webex only) and will focus on General Comments
- Will be coordinating a face-to-face meeting for connector dimensional issues – likely at SAE Headquarters in Detroit (will have a phone conference to set this up)

SAE J1772 Combo Connector System (Light Duty Vehicle Charging DC Connector)

- Auto OEMs interested in moving to higher power levels for charging
- SAE is working to raise the voltage and current limit of the SAE Combo Connector
  - Current limit from 200A to 350A
  - Voltage limit from 500Vdc to 1000Vdc

= 350kW Max Power

Together…Shaping the Future of Electricity

IEC STANDARDS FOR EV CHARGING

EPRI IWC

June 8, 2016

Gregory C. Nieminski, LLC
silvergregn@verizon.net

IEC Project Stages and Timetable for Standards Development

Project Stage	Associated Document Name	Abbreviation	Minimum Timeline (for comment and/or voting)
Proposal stage	New Work Item Proposal	NWIP	3 months for voting
Preparatory stage	Working draft	WD	12 months recommended
Committee stage	Committee draft	CD	2-4 months for comment
Enquiry stage	Enquiry draft	IEC/CDV ISO/DIS	5 months for translation (2), comment and voting (3)
Approval stage	Final Draft International Standard	FDIS	2 months for voting
Publication stage	International Standard	IEC or ISO/IEC	1.5 -2 months

IEC TC69 Charging Station (EVSE) Standards

Projects: Key: In Publications Published New Status Change Delay * MT5 meeting June 2016

IEC	Edition	Stage						
		NWIP	Working Draft	CD	Next CD (CD#)	CDV	FDIS	Publication
61851-1	3						2016-04	2016-07
61851-21-1	1		2012-07	→	→	→	2016-02	2016-09
61851-21-2	1		2012-07	→	(3rd) 2015-11	→	→	2017-03
61851-22	1	To be withdrawn – Consolidated into 61851-1						
61851-23, 61851-24	2	MT5	(3rd) 2016-01	2016-07*		2017-03	2017-12	2018-04
61851-3-1, -2	1	2013-01	→	→	(3nd) 2016-6	Scope change		TS 2016-10
61851-3-3, -4, -5, -6, -7	1	2013-01		2016-02	(3nd) 2016-6			TS 2016-10

IEC 61851-1, 3rd Edition

Edited draft for FDIS sent to IEC mid-April

FDIS in preparation, final vote on FDIS pending (two month vote).

Issues:

- Cord and plug connected wall box requirements – Maintained in Standard.
- EV Cord Sets (Cord & plug, in-line PPS & CP box, EV connector) now covered by IEC 62752.
- CCID/GM vs. RCD (IEC 62752 published March 2016).
- Change to higher ambient temperature (+35 °C vs. 25 °C)
  - Introduce North America deviation in FDIS.

IEC 61851-23 & 61851-24, 2rd Edition

3nd Working Draft, comments submitted April, 2016

Meeting to review comments: June, 2016,
Toronto, Canada

Issues & New Items:

- Organization of Standard to follow 61851-1
- Overcurrent & Short Circuit protection
- Bi-directional power flow – now included
- Automated connection system for DC Charging, new work project accepted New PT 61851-23-1 – Netherlands
- Isolation monitoring for multi-outlet DC chargers
- Conversion Box (connects EV connectors and inlets from different systems) No further information.

IEC 61851-3 series, 1st Edition

Covers:

- 61851-3 (series): Electric Vehicles conductive power supply system
- Part 3-1: General Requirements for Light Electric Vehicles, AC and DC conductive power supply systems
- Part 3-2: Requirements for Light Electric Vehicles, DC off-board conductive power supply systems
- Part 3-3: Requirements for Light Electric Vehicles, battery swap systems
- Part 3-4: Requirements for Light Electric Vehicles, communications
- Part 3-5: Requirements for Light Electric Vehicles, communication - Pre-defined communication parameters
- Part 3-6, Requirements for Light Electric Vehicles, communication - Voltage converter unit
- Part 3-7, Requirements for Light Electric Vehicles, communication - Battery system

IEC 61851-3 series, 1st Edition

Issues:

- Scopes overlap other parts of 61851.
- Voltage and current ranges for DC charging overlap Part 23
- AC output ratings not used (now includes 480VAC, 3Ø)
- Differences in construction not defined to distinguish from Part 1 or Part 23.
- May be of double/reinforced insulated construction
- Output may be at Safety Low Voltage level (≤ 60VDC)

Proposal made May 30, 2016 to modify Scope to include AC output for specific construction types, limited DC (voltage) outputs, etc., under review.

CD's to follow.

IEC 61851-3 series, 1st Edition

Other issues:

- Proposals limited to one construction, other options not permitted by convenor
  (Reason: EN wants one solution but this is Int'l Standard)
- Parts 3-5, 3-6 and 3-7 not authorized by original work proposal.

IEC TC69 to resolve these questions/issues.

IEC 61980 series Wireless Charging

IEC	Edition	Stage						
		NWIP	Working Draft	CD	NEXT CD (CD#)	CDV	FDIS	Publication
61980-1	1	Published 2015-08						
61980-2	1	2012-12	2013-08	2015-08		2016-04		2017-01
61980-3	1	2012-12	2013-08	2015-08		2016-04		2017-03

- 61980-1: Electric vehicle wireless power transfer systems (WPT) - Part 1: General requirements
- 61980-2: Electric vehicle wireless power transfer (WPT) systems - Part 2 specific requirements for communication between electric road vehicle (EV) and infrastructure with respect to wireless power transfer (WPT) systems
- 61980-3: Electric vehicle wireless power transfer (WPT) systems - Part 3 specific requirements for the magnetic field power transfer systems.

ISO 15118 series - Vehicle To Grid Communications Interface

ISO	Edition	Stage						
		NWIP	Working Draft	CD	NEXT CD (CD#)	CDV	FDIS	Publication
15118-1	1	Published 2013-04						
15118-2	1	Published 2013-03						
15118-3	1	Published 2015-05						
15118-4	1			(3nd) 2016-01				
15118-5	1				(2nd) 2015-03	2016-06		2017-10
15118-6	1				(2nd) 2015-09		2016-05	2016-10
15118-7	1				(2nd) 2016-01			
15118-8	1				(2nd) 2015-09	2016-04		2017-07

ISO 15118 series

- **ISO 15118-1: Road vehicles - Vehicle to grid communication interface - Part 1: General information and use-case definition**
- **ISO 15118-2: Road vehicles – Vehicle to Grid communication Interface - Part 2: Technical protocol description and Open Systems Interconnections (OSI) layer requirements**
- **ISO 15118-3: Road Vehicles - Vehicle to grid communication interface - Part 3: Physical layer and Data Link layer requirements**
- **ISO 15118-4 Ed.1: Road vehicles — Vehicle to grid communication interface — Part 4: Network and application protocol conformance test**
- **ISO 15118-5 Ed.1: Road vehicles - Vehicle to grid communication interface - Part 5: Physical and data link layer conformance test**
- **ISO 15118-6 Ed. 1.0: Road vehicles - Vehicle to grid communication interface - Part 6: General information and use-case definition for wireless communication**
- **ISO 15118-7 Ed. 1.0: Road vehicles - Vehicle to grid communication interface - Part 7: Network and application protocol requirements for wireless communication**
- **ISO 15118-8 Ed. 1.0: Road vehicles - Vehicle to grid communication interface - Part 8: Physical layer and data link layer requirements for wireless communication**

IEC SC23H Standards EV Couplers

IEC	Edition	Stage						
		NWIP	Working Draft	CD	NEXT CD (CD#)	CDV	FDIS	Publication
62196-1, 62196-3 Amendment	3	RR 2016-05						2018
62196-2	2	Published 2016-02						
62196-4	1	2013-07	2014-07	2015-03	(2nd) 2016-6			2015-09

New Items

- Proposed New Tests to address EV Coupler Overheating Issues (Thermal Cycling, Humidity/Mixed Gas Exposure, Misalignment, Termination & Contact Stability, No Load Endurance with Salt/Sand Exposure)
- Increased DC ratings (1000 VDC, 350 A)
- Cooled DC High Power Charging System, 350kW Proposal by Germany

IEC 62196 series

Part 2 - AC Couplers

Configuration Types 1, 2 or 3 are rated as follows:

Type 1: 250 V, 32 A single phase;

Type 2: 250 V, 32 A or 63 A or 70 A single phase,
380-480 V, 32 A or 63 A, three-phase.

Type 3: 250 V, 16 A or 32 A, single phase,
380-480 V, 32 A or 63 A three-phase.

IEC 62196 series

Part 3 Combo AC/DC Couplers

Configuration	Dimensions described in	Max. Rated Voltage V d.c.	Max. Rated Current A	Shall only be used with d.c. charging station according to
AA Chademo	Standard Sheets 3-I	600	200	IEC 61851-23, Annex AA
BB Chinese	Standard Sheets 3-II	750	250	IEC 61851-23, Annex BB
CC J1772 Type 1	Standard Sheets 3-V	600 AC/DC	80	IEC 61851-23, Annex CC
DD IEC Type 2	Standard Sheets 3-VI	480 AC/DC	80	IEC 61851-23, Annex CC
EE J1772Type 1 + DC	Standard Sheets 3-III	~~600~~ 1000	~~200~~ 350	IEC 61851-23, Annex CC
FF IEC Type 2 + DC	Standard Sheets 3-IV	1 000	~~200~~ 350	IEC 61851-23, Annex CC

IEC SC23H (Non-Road) Standards (Shore to Ship Connectors)

IEC	Edition	Stage						
		NWIP	Working Draft	CD	NEXT CD (CD#)	CDV	FDIS	Publication
60309-5	1	2014-08	→			2016-04		2017-03

IEC 60309-5 (new Standard number to be assigned) Plugs, socket-outlets and couplers for industrial purposes - Part 5: Dimensional compatibility and interchangeability requirements for plugs, socket-outlets, ship connectors and ship inlets for low-voltage shore connection systems (LVSC) – 690VAC, 350 A, 3Ø

SAE PEV Communication & Interoperability Task Force Status

IWC Meeting

June 8, 2016

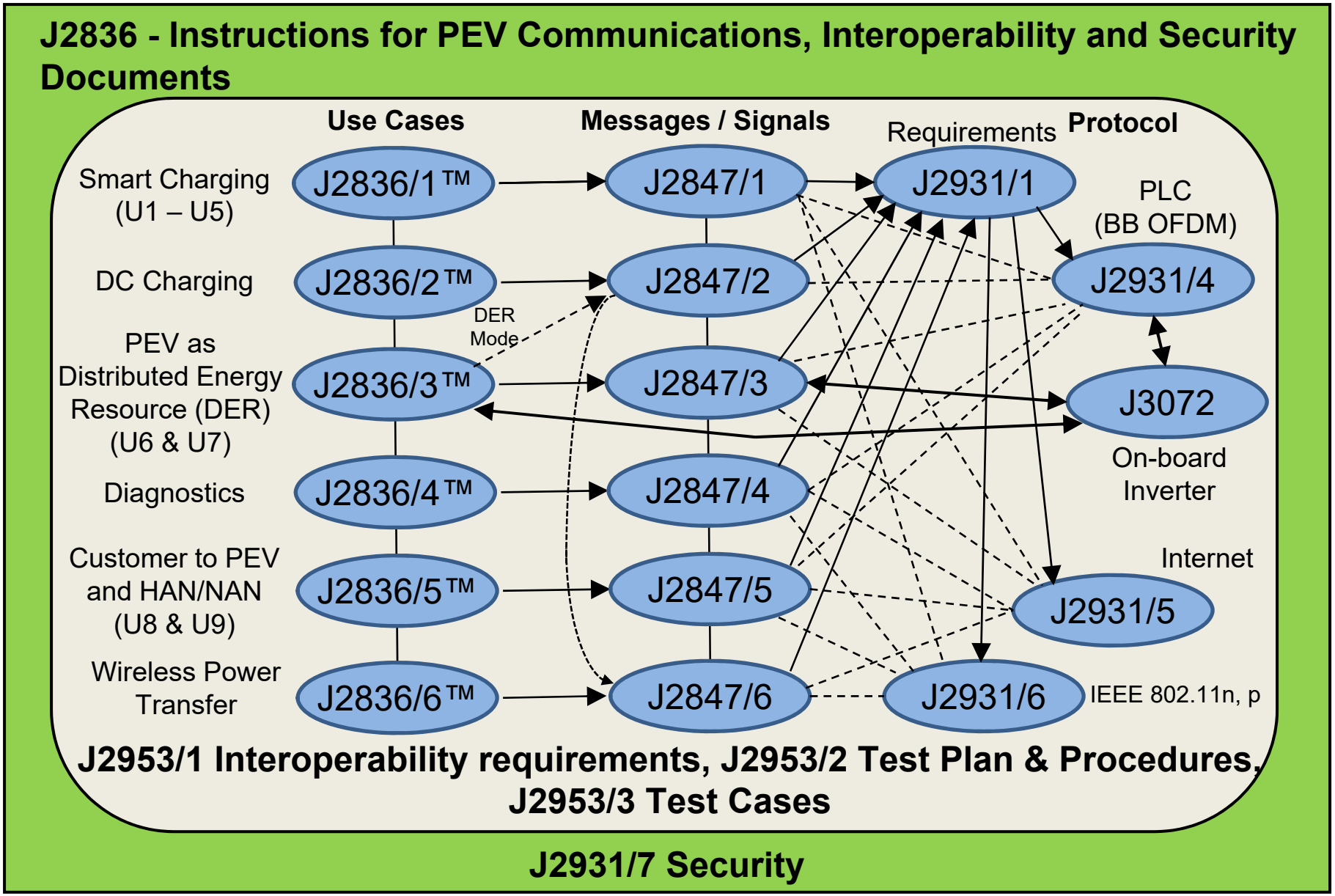
Seattle Light, Seattle, Washington

Background

SAE Communication Background
Major Documents and Functions

1. J2836™ - Instructions and Use Cases (establishes requirements)
   - ❖ Technical Information Report (TIR)
2. J2847 – Messages, diagrams, etc. (derived from the use case requirements)
   - ❖ -2 is a Standard, others are Recommended Practice (RP)
3. J2931 – Communication Requirements & Protocol
   - ❖ TIR
4. J2953 – Interoperability
   - ❖ RP
5. J3072 – Interconnection Requirements for Onboard, Utility-Interactive, Inverter Systems
   - ❖ Standard

SAE Document Interaction



ISO 15118

-6, -7 & -8 now moved to -1, -2, -3 ED 2

EPRI IWC November 2015

IEC TC69 Road Vehicles – Vehicle To Grid Communications Interface Standards

ISO 15118-1: Road vehicles - Vehicle to grid communication interface - Part 1: General information and use-case definition

ISO 15118-2: Road vehicles – Vehicle to Grid communication Interface - Part 2: Technical protocol description and Open Systems Interconnections (OSI) layer requirements

ISO 15118-3: Road Vehicles - Vehicle to grid communication interface - Part 3: Physical layer and Data Link layer requirements

ISO 15118-4 Ed.1: Road vehicles — Vehicle to grid communication interface — Part 4: Network and application protocol conformance test

ISO 15118-5 Ed.1: Road vehicles - Vehicle to grid ccommunication interface - Part 5: Physical and data link layer conformance test

ISO 15118-6 Ed. 1.0: Road vehicles - Vehicle to grid communication interface - Part 6: General information and use-case definition for wireless communication

ISO 15118-7 Ed. 1.0: Road vehicles - Vehicle to grid communication interface - Part 7: Network and application protocol requirements for wireless communication

ISO 15118-8 Ed. 1.0: Road vehicles - Vehicle to grid communication interface - Part 8: Physical layer and data link layer requirements for wireless communication

Current Status

Activate SAE Documents

1. **J2836™ – V1 - Instructions for PEV Communications, Interoperability and Security Documents**
2. J2836/3™ - V2 - Use Cases for the PEV Communicating as a Distributed Energy Resource (DER)
3. **J2836/4™ - V1 – Diagnostics**
4. **J2836/5™ - V2 – Customer to PEV Use Cases**
5. J2847/2 – V4 - DC Charging messages/signals
6. J2931/1 – V4 – Communication Requirements
7. J2931/7 – V1 - Security
8. J2953/1 – V2 - Interoperability requirements
9. J2953/2 – V2 – Interoperability Plan and Report
10. J2953/3 – V1 – Interoperability Test Cases

Up next

1. J2847/5 – V1 – Customer to PEV messages/signals
2. J2931/5 – V1 – Customer to PEV Protocol

J2836™ – V1
Instructions for PEV Communications, Interoperability and Security Documents

Scope:
This SAE Information Report J2836™ establishes the instructions for the documents required for the variety of potential functions for PEV communications, energy transfer options, interoperability and security. This includes the history, current status and future plans for migrating thru these documents created in the Hybrid Communication and Interoperability Task Force, based on functional objective (e.g. (1) if I want to do V2G with an off-board inverter, what documents and items within them do I need, (2) What do we intend for V3 of J2953, …).

Rational:
Plug-in Electric Vehicles have a multitude of options regarding charging and discharging functions and six categories have been established to clearly identify Use Cases, Messages/Signals, Protocol, then include Diagnostics, Interoperability and Security. The overall functions are explained and then scenarios are included to clearly guide towards all of the specific documents and sections within these are required and optional for the variety of options available.

DC Charging

J2847/2 - V3 – DC charging messages and signals

Published 4-09-15,

V4 reopened:

1. **Address the 234 variations and additions to message & signals in 15118-2 vs. DIN/J2847/2 for DC charging, then 15118-7 vs. J2847/6 for Wireless Power Transfer (WPT)**
2. **Add references to Wireless Power Transfer (J2847/6)**
3. **Add Distributed Energy Resources (DER) messages/signals**
4. **Establish and include restarts/retries**
5. **Schema updates**
   - DIN 2.0 (DIN and J2847/2 V3)
   - ISO 3.0 (15118 Ed 2)
     - ISO 1.0 & 2.0
   - SAE 4.0 (harmonized for DC and WPT, plus DER)
     - J2847/6 1.0

DC Charging (DIN/J2847/2)	
Association	
M	SLAC
M	Service Discovery Protocol
Initialization	
M	SupportedAppProtocol
M	SessionSetup
M	ServiceDiscovery
N/U	ServicePaymentSelection
N/U	Contract Authentication
M	ChargeParameterDiscovery
Isolation Monitoring & PreCharge	
	CableCheck
	Pre-Charge
M	PowerDelivery
Energy Transfer	
	CurrentDemand
Welding Check & Termination	
	WeldingDetection
M	SessionStop

15118-2 Ed 2 (AC)	
Association	
M	SLAC
M	Service Discovery Protocol
Initialization	
M	SupportedAppProtocol
M	SessionSetup
M	ServiceDiscovery
O	ServiceDetail
M	PaymentServiceSelection
O	CertificateUpdate
O	CertificateInstallation
M	PaymentDetails (PnC)
M	Authorization
M	ChargeParameterDiscovery
Energy Transfer	
M	ChargingStatus
M	MeteringReceipt (PnC)
M	SessionStop

15118-2 Ed 2 (DC)	
Association	
M	SLAC
M	Service Discovery Protocol
Initialization	
M	SupportedAppProtocol
M	SessionSetup
M	ServiceDiscovery
O	ServiceDetail
M	PaymentServiceSelection
O	CertificateUpdate
O	CertificateInstallation
M	PaymentDetails (PnC)
M	Authorization
M	ChargeParameterDiscovery
Isolation Monitoring & PreCharg	
	CableCheck
	PreCharge
M	PowerDelivery
Energy Transfer	
	CurrentDemand
M	MeteringReceipt (PnC)
Welding Check & Termination	
M	WeldingDetection
M	SessionStop

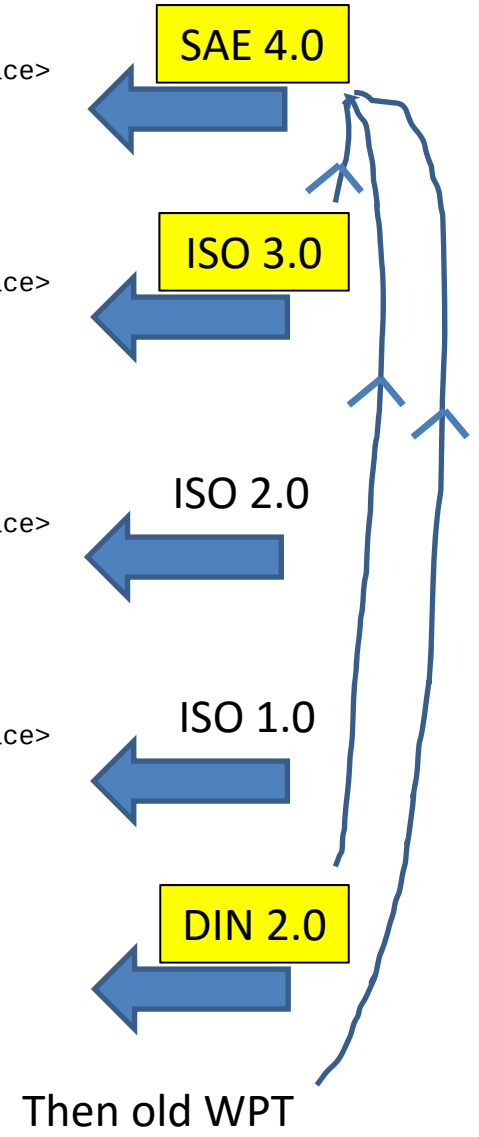
Yellow is "common"

V2G Message Example 1 – supportedAppProtocolReq: Protocol Prioritization

```
<?xml version="1.0" encoding="UTF-8"?>
<ns0:supportedAppProtocolReq xmlns:ns0="urn:iso:15118:2:2010:AppProtocol"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
    <AppProtocol>
              <ProtocolNamespace>urn:sae:j2847-2:2017:MsgDef</ProtocolNamespace>
              <VersionNumberMajor>4</VersionNumberMajor>
              <VersionNumberMinor>0</VersionNumberMinor>
              <SchemaID>10</SchemaID>
              <Priority>1</Priority>
         </AppProtocol>
    <AppProtocol>
              <ProtocolNamespace>urn:iso:15118:2:2015:MsgDef</ProtocolNamespace>
              <VersionNumberMajor>3</VersionNumberMajor>
              <VersionNumberMinor>0</VersionNumberMinor>
              <SchemaID>20</SchemaID>
              <Priority>2</Priority>
         </AppProtocol>

         <AppProtocol>
              <ProtocolNamespace>urn:iso:15118:2:2013:MsgDef</ProtocolNamespace>
              <VersionNumberMajor>2</VersionNumberMajor>
              <VersionNumberMinor>0</VersionNumberMinor>
              <SchemaID>30</SchemaID>
              <Priority>3</Priority>
         </AppProtocol>
         <AppProtocol>
              <ProtocolNamespace>urn:iso:15118:2:2010:MsgDef</ProtocolNamespace>
              <VersionNumberMajor>1</VersionNumberMajor>
              <VersionNumberMinor>0</VersionNumberMinor>
              <SchemaID>40</SchemaID>
              <Priority>4</Priority>
   </AppProtocol>
     <AppProtocol>
        <ProtocolNamespace>urn:din:70121:2012:MsgDef</ProtocolNamespace>
        <VersionNumberMajor>2</VersionNumberMajor>
        <VersionNumberMinor>0</VersionNumberMinor>
        <SchemaID>50</SchemaID>
        <Priority>5</Priority>
     </AppProtocol>

</ns0:supportedAppProtocolReq>
```



Distributed Energy Resource (DER) Standards

(V2L & V2G) Hank McGlynn

J2836/3™ V2 - Use Cases for PEV as a DER

- Restructuring to more clearly separate requirements for PEV and EVSE inverters
- **PEV Onboard Inverter – PEV is the DER**
  - "Roaming Inverter" unprecedented for utility approval of DER interconnection
    - Explain role of J3072 for PEV and EVSE certification
  - Use Cases U6 & U7 fully apply to onboard inverter – Still OK – meets IEC 61850
  - DER control entity engages directly with smart inverter functions onboard PEV via SEP2 Bridge (J2847/3) , OEM Telematics, or IEC/ISO 15118 DER version
- **EVSE Offboard Inverter – EVSE is the DER**
  - Establish requirements for DC DER mode for use with EVSE inverter – J2847/2 V4
  - EVSE follows existing utility process for interconnection approval
    - Stationary ESS with interchangeable battery pack
    - EVSE listed by NRTL to UL 1741 (UL 9741)
  - SAE scope regarding EVSE beyond interoperability with PEV?
    - Inverter functions established by state/utility (CA Rule 21) to IEC 61850
    - EVSE follows building communication protocol or other external
    - For use with SEP2, J2836/3 & J2847/3 could be useful to EVSE OEM

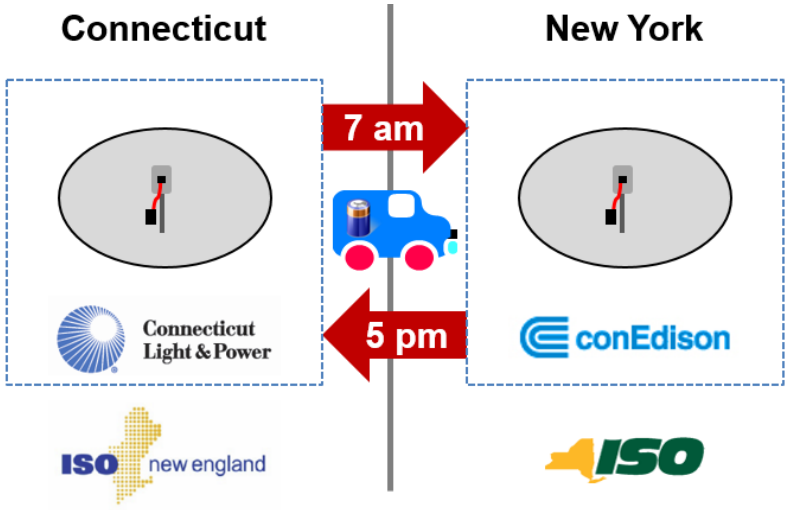
J2847/2 V4 - Communication Between Plug-In Vehicles and Off-Board DC Chargers

- V4 reopened – Add a DER mode with new messages, as needed.

J3072 Interconnection Requirements for Onboard, Utility-Interactive, Inverter Systems

- V1 published – reopen to harmonize with UL XXXX and any interconnection concerns

The Roaming Inverter



When PEV connects to EVSE

1. EVSE provides site settings to PEV
2. EVSE confirms PEV settings
3. EVSE verifies PEV J3072 certification
4. EVSE authorizes PEV to discharge

Equipment Listings & Certifications

PEV's "Inverter System Model" (ISM) certified by Vehicle Manufacturer to SAE J3072

EVSE Model listed by NRTL to UL XXXX (which calls out J3072 4.5 & 4.6)

Installation Approval by Code Authority

EVSE installation to NEC 625.48 (2017)

PEV equipment is out of scope of NEC

Utility DER Interconnection approval

DER Application uses EVSE Model
Utility role for approval of PEV ISMs?
Authorization to Discharge Method?
- Only by onboard J3072 software tag?
- By EVSE search of ISM database?

15118-2 Ed 2 (DC)	
Association	
M	SLAC
M	Service Discovery Protocol
Initialization	
M	SupportedAppProtocol
M	SessionSetup
M	ServiceDiscovery
O	ServiceDetail
M	PaymentServiceSelection
O	CertificateUpdate
O	CertificateInstallation
M	PaymentDetails (PnC)
M	Authorization
M	ChargeParameterDiscovery
Isolation Monitoring & PreCharge	
	CableCheck
	PreCharge
M	PowerDelivery
Energy Transfer	
	CurrentDemand
M	MeteringReceipt (PnC)
Welding Check & Termination	
M	WeldingDetection
M	SessionStop

15118-2 Ed 2 (AC DER)	
Association	
M	SLAC
M	Service Discovery Protocol
Initialization	
M	SupportedAppProtocol
M	SessionSetup
M	ServiceDiscovery
O	ServiceDetail
M	PaymentServiceSelection
O	CertificateUpdate
O	CertificateInstallation
M	PaymentDetails (PnC)
M	Authorization
M	ChargeParameterDiscovery
Isolation Monitoring & PreCharge	
M	PowerDelivery
Energy Transfer	
O	ChargingStatus
M	MeteringReceipt (PnC)
Welding Check & Termination	
M	SessionStop

15118-2 Ed 2 (DC DER)	
Association	
M	SLAC
M	Service Discovery Protocol
Initialization	
M	SupportedAppProtocol
M	SessionSetup
M	ServiceDiscovery
O	ServiceDetail
M	PaymentServiceSelection
O	CertificateUpdate
O	CertificateInstallation
M	PaymentDetails (PnC)
M	Authorization
M	ChargeParameterDiscovery
Isolation Monitoring & PreCharge	
	CableCheck
	PreCharge
M	PowerDelivery
Energy Transfer	
	CurrentDemand
	DischargeSupply
M	MeteringReceipt (PnC)
Welding Check & Termination	
M	WeldingDetection
M	SessionStop

15118-2 Ed 2 (ACD)	
Association	
M	SLAC
M	Service Discovery Protocol
Initialization	
M	SupportedAppProtocol
M	SessionSetup
M	ServiceDiscovery
O	ServiceDetail
M	PaymentServiceSelection
	SystemStatus
O	CertificateUpdate
O	CertificateInstallation
M	PaymentDetails (PnC)
M	Authorization
M	ChargeParameterDiscovery
Isolation Monitoring & PreCharge	
	CableCheck
	PreCharge
M	PowerDelivery
Energy Transfer	
	CurrentDemand
Welding Check & Termination	
M	SessionStop

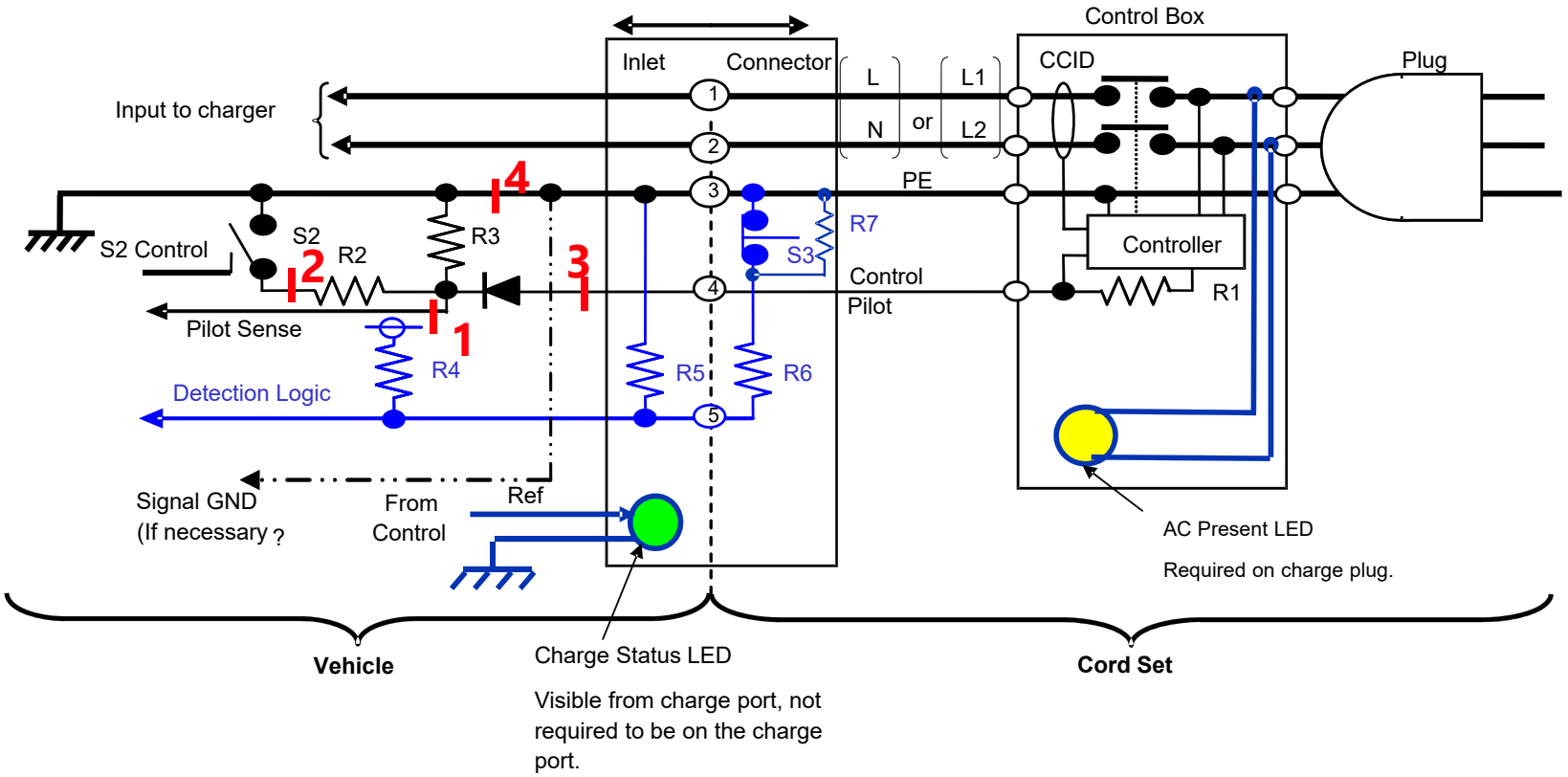
J2836/4™ - V1

Use Cases for Diagnostic Communication for Plug-in Electric Vehicles - (Rich)

1. Control Pilot

- Four detectable or undetectable states
  - Open, short low, short high

Potential fault locations



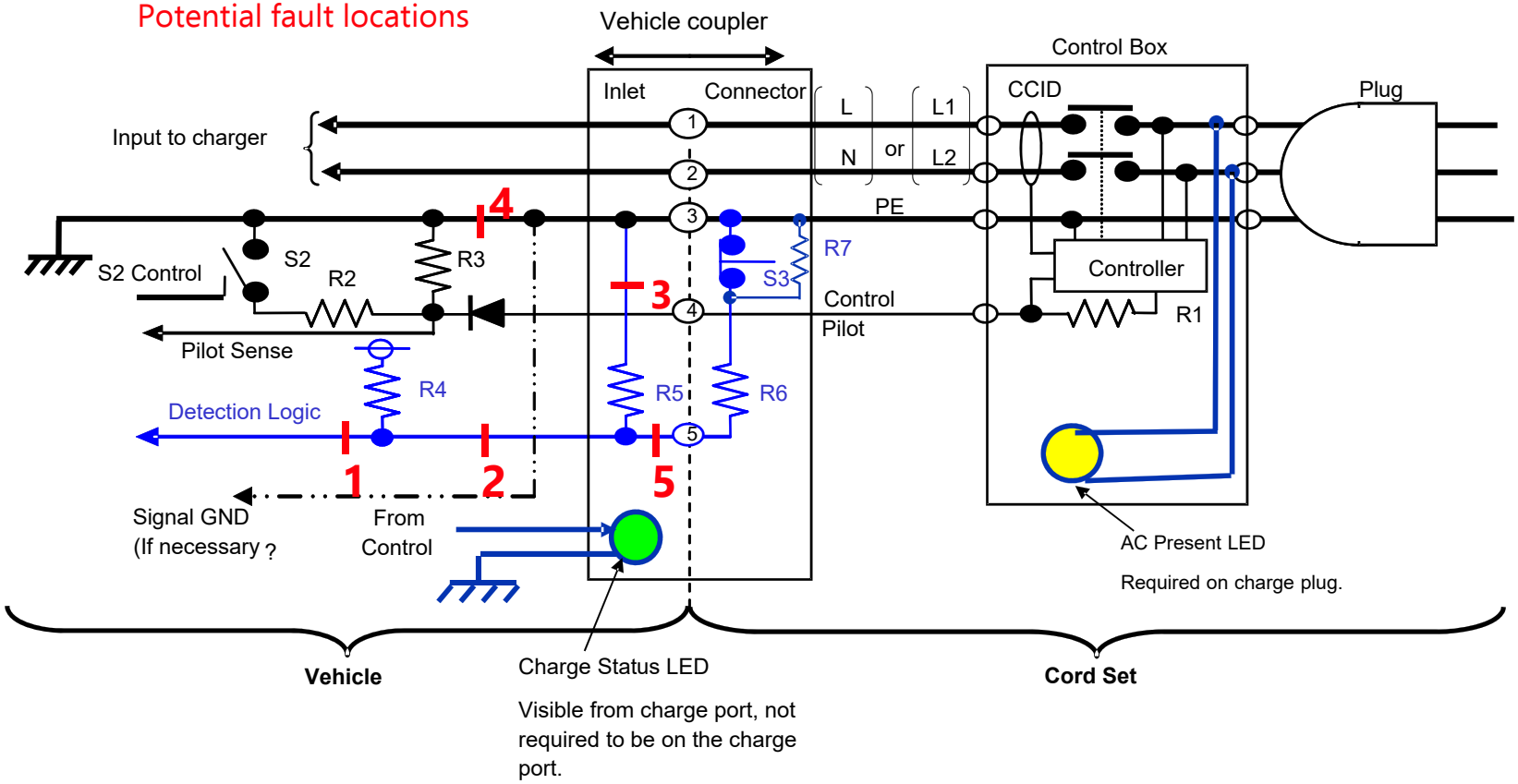
Open (shown), also include short low, short high for each J1772™ state

	Pilot Sense - Fault = Open Circuit (OC)			
Mode	Fault Location			
	P1	P2	P3	P4
State A (connected & transition to State B) (Power Mode=RUN)	Indeterminate (Vehicle does not wake up)	Not required	Indeterminate (Vehicle does not wake up). Same as not connected.	Indeterminate (Vehicle does not wake up). Same as not connected.
State B (Connected) (Power Mode=OFF)	Pilot PWM drops to zero, vehicle powers down & sets DTC.	When vehicle closes S2, it detects no voltage change (9V to 6 or 3V) & sets DTC.	Pilot PWM drops to zero, reverts back to State A. Sets DTC.	Pilot PWM drops to zero, reverts back to State A. Sets DTC.
State C (Charging) (Power Mode=OFF)	Pilot PWM drops to zero, opens S2, reverts back to State B. Sets DTC.	Vehicle detects voltage change back to 9V & sets DTC.	Pilot PWM drops to zero, vehicle powers down & sets DTC.	Pilot PWM drops to zero, vehicle powers down & sets DTC.

J2836/4™ - V1

Use Cases for Diagnostic Communication for Plug-in Electric Vehicles - (Rich)

1. Prox
   - Five detectable or undetectable states
     - Open, short low, short high



Open (shown), also include short low, short high for each J1772™ state

	Detection - Fault = Open Circuit (OC)				
Mode	Fault Location				
	D1	D2	D3	D4	D5
State A (Not connected) (Power Mode=RUN)	Prox Detection voltage = 0V, should be 4.5V Out-of-Range-Low	Prox Detection voltage = 5V, should be 4.5V Out-of-Range-High	Prox Detection voltage = 5V, should be 4.5V Out-of-Range-High	Prox Detection voltage = 0V, should be 4.5V Out-of-Range-Low	No impact (not connected)
State B (Connected) (Power Mode=OFF)	Prox Detection voltage = 0V, should be 1.5V Out-of-Range-Low	Prox Detection voltage = 5V, should be 1.5V Out-of-Range-High	Prox Detection voltage = 2.963 vs 2.763V (7.2% Δ) with S3 open & 1.562 vs. 1.505V (3.78% Δ) with S3 closed.	Prox Detection voltage = 0V, should be 1.5V Out-of-Range-Low	Prox Detection voltage = 4.5V, should be 1.5V. Does not detect cord, fault could be on either side of coupler
State C (Charging) (Power Mode=OFF)	Prox Detection voltage = 0V, should be 1.5V Out-of-Range-Low	Prox Detection voltage = 5V, should be 1.5V Out-of-Range-High	Prox Detection voltage = 2.963 vs 2.763V (7.2% Δ) with S3 open & 1.562 vs. 1.505V (3.78% Δ) with S3 closed.	Prox Detection voltage = 0V, should be 1.5V Out-of-Range-Low	Prox Detection voltage = 4.5V, should be 1.5V. Does not detect cord, fault could be on either side of coupler

J2836/4

- What else (V2)?
  - Common indicators and controls
    - EVSE and PEV
  - Diagnostics for charging
    - AC
    - Then DC
    - Then DER
    - Then WPR
    - …

Customer to PEV Communications
George Bellino/Scott Turik

- J2836/5™ V1 - Use Cases
  - Published 5-7-15.
    - Use Case U8 “Customer Convenience”
      - A - Customer Remote Start /Stop
      - B - Cabin Conditioning
      - C - Charge Status Information
      - D - Setting Customer Preferences
      - E - Locate and Reserve EVSE
      - F - Energy Usage History
    - Use Case U9 “Conflict and Resolution”
  - **V2 - Use Case U10 “Payment”**
- J2847/5 (V1) is next for messages and signals.
- J2931/5 (V1) for protocol.
  - Wireless options

J2836/6™ - Wireless Charging Use Cases

- V1 Published 5-3-13.
- V2 15118 ED 2 additions

J2847/6 V1 - Wireless charging messages

- V1 published 8-5-15.
- V2 planned for some unresolved comments and further harmonization with ISO 15118-1, 2 & 3 (ED 2).

J2931/6 - Wireless charging protocol

- V1 published 8-27-15
- V2 any variations to 15118-3 ED 2

Wireless					
15118-2 Ed 2 (WPT)		WPT (J2847/6)		WPT (ISO 15118-7)	
Association					
Initialization		Initialization		Communication Setup	
M	SupportedAppProtocol	M	SupportedAppProtocol	M	SupportedAppProtocol
M	SessionSetup	M	SessionSetup	M	SessionSetup
			Identification, Authentication and Authorization		
M	ServiceDiscovery	M	Service Discovery	M	Service Discovery
M	ServiceDetail			M	ServiceDetail
M	PaymentServiceSelection	M	ServicePaymentSelection	M	ServicePaymentSelection
O	CertificateUpdate				
O	CertificateInstallation				
M	PaymentDetails (PnC)				
M	FinePositioning			M	FinePositioning
		M	Start Alignment		
		M	EndAlignment		
				M	AlignmentCheck
		M	Start AlignmentCheck		
		M	EndAlignmentCheck		
		M	AlignmentComplete		
M	Pairing	M	Pairing	M	Pairing
		M	Heartbeat		
M	Authorization	M	Contract Authentication	M	Authorization
			Target Setting and Charge Scheduling		
M	ChargeParameterDiscovery	M	ChargeParameterDiscovery	M	ChargeParameterDiscovery
Isolation Monitoring & PreCharge		PreCharge			
O	PreCharge		WPPreCharge		
M	PowerDelivery	M	PowerDelivery	M	PowerDelivery
Energy Transfer		Charging		Charge Control and Re-Scheduling	
	PowerDemand				
	MeteringReceipt				
Welding Check & Termination		Finalize		End of charging process	
			PowerDelivery		PowerDeliv ery
M	SessionStop	M	SessionStop	M	SessionStop

Security
Gordon Lum

- J2931/1 – Protocol Requirements
  - V3 published for DC Charging
  - V4 reopened to include security updates (high level)
- J2931/7 – Security
  - V1 restarted and correlating with SGIP comments on J2931/1.
  - Meetings restarted in July.

J2953/1, /2 & /3 – Interoperability
Ted Bohn

- J2953/1 (requirements).
  - V1 testing at Intertek (control pilot and prox) is complete and waiting for final report.
  - V2 is DC communications plus J1772 V6 changes
- J2953/2 (plan & procedure)
  - V1 & 2 - Tracking J2953/1 effort.
- J2953/3 (Test Cases)
  - 45 AC test cases (Pirooz Javanbakht is reviewing and summarizing what to add to J1772, V7?)
  - 95 DC test cases – more to come by year end
  - Golden Test Device (GTD) not available until end of 2016

Summary/Backup

Use Case Document Status - TIR

J2836™ - Instructions for PEV Communications, Interoperability and Security Documents
- V1 Published 4-8-10

J2836/1™ - Utility Use Cases
- V1 Published 4-8-10

J2836/2™ - DC Charging Use Cases
- V1 Published 9-15-11

J2836/3™ - PEV as a Distributed Energy Resource (DER) Use Cases
- V1 Published 1-3-13
- V2 being revised to add requirements for DC RPF for J2847/2 & role of J3072

J2836/4™ - Diagnostics Use Cases
- V1 Started for failures on control pilot and prox, but waiting for J2953/1 & /2 (Interoperability) for more data

J2836/5™ - Customer to PEV Use Cases
- V1 published 5-7-15
- V2 reopened for U10 (Payment)

J2836/6™ - Wireless Charging Use Cases
- V1 Published 5-3-13.
- V2 Planned for updates from 15118-1 ED 2
- V3 Potentially for dynamic

Signal/Message Document Status – RP/Standard

J2847/1 - Utility signals/messages
- V1 Published 6-16-10, V2 5-9-11, V3 11-9-11, V4 11-5-13

J2847/2 - DC Charging (Standard)
- V1 Published 10-21-11,
- V2 – 8-20-12 to align with J1772 V5 (DC charging).
- V3 Published 4-9-15 to align with DIN SPEC 70121 V6a
- V4 restarted (June, 2015) to cover
  - EVSE inverter with DC RPF (J2836/3 V2)
  - Include ISO/IEC 15118-2 & -3 ED 2 updates (variations to DIN SPEC 70121)
  - Include Wireless Charging updates

J2847/3 - PEV as a Distributed Energy Resource (DER)
- V1 Published 12-10-13

J2847/4 - Diagnostics
- Started but waiting for J2836/4™ & J2953/1 & /2 (Interoperability)

J2847/5 - Customer to PEV
- Meetings to start soon since J2836/5™ Use Cases are complete.

J2847/6 - Wireless Charging
- V1 published 8-5-15
- V2 planned for unresolved issues from V1 and updates from ISO 15118-2 (ED 2).
- V3 potentially for dynamic

Requirements and Protocol Documents - TIR

J2931/1 – Requirements
- V1 Published 1-24-12, V2 Published 9-7-12
- V3 Published 1-5-15 for DC Charging
- V4 Reopened for Security additions

J2931/4 – PowerLine Carrier (PLC) – wired communication protocol
- V1 Published 7-26-12, V2 Published 11-14-13
- V3 Published 10-22-15 for DC Charging

J2931/5 – Telematics – wireless communication protocol
- Waiting for J2847/5

J2931/6 – Wireless Charging Communication (IEEE 802.11n – Static, 802.11p for dynamic) wireless charging protocol
- V1 Published 8-27-15
- V2 Will reopen for updates to 15118-3 ED 2
- V3 Will reopen for dynamic

J2931/7 - Security
- Restarted to align with J2931/1

Interoperability Documents - RP

J2953/1 – Requirements

- V1 Published 10-7-13.
  - V1 started testing for the analogue communications (J1772™ control pilot and prox).
- V2 is addressing digital communication for DC charging
- V3 planned to include WPT

J2953/2 – Test plan

- V1 Published 1-22-14
- V2 Adding V1 updates and DC Charging
- V3 planned to include WPT

J2953/3 – Test Cases

- V1 started to capture AC and DC test cases

On-board Inverter - Standard

J3072 – Interconnection Requirements for Onboard, Utility-Interactive, Inverter Systems

- V1 published 4-9-15.

The End

Questions?

SAE J3068 Update

EV Power Transfer using Three-phase Capable Coupler

EPRI IWC

Rodney McGee

Tuesday, June 8, 2016

Scope of J3068

- The SAE has authorized a document for three-phase AC charging for electric vehicles
- Scope

  This document covers the general physical, electrical, functional, testing, and performance requirements for conductive power transfer to an electric vehicle using a coupler capable of, but not limited to, transferring three-phase AC power. It defines a conductive power transfer method including the digital communication system. It also covers the functional and dimensional requirements for the vehicle inlet, supply equipment outlet, and mating housings and contacts.
- **Targeted towards charging at commercial and industrial locations or other places where three-phase power is available and preferred.**

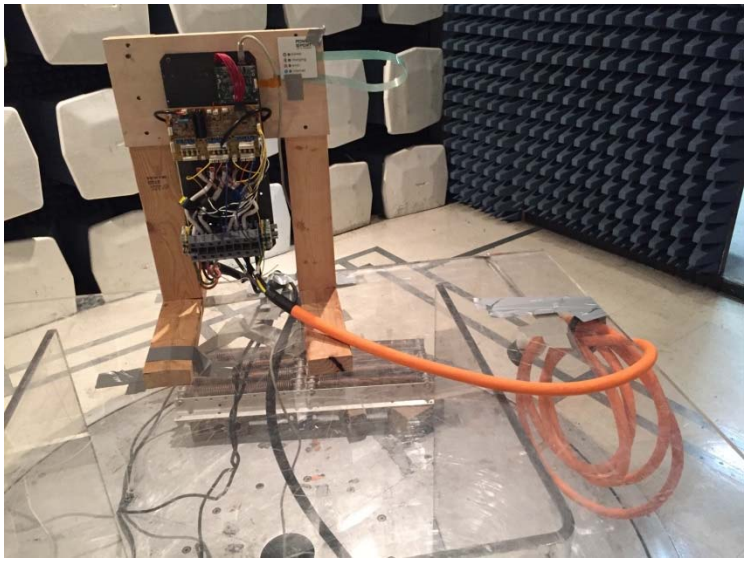
J3068

- EVSE
  - Evaluated to UL-2594, UL-2231
- Cordset / Coupler
  - Directly refers to IEC mechanical drawings
    - 62196-2 Sheets 2-IIf and 2-IIe
  - Evaluated to UL-2251
- Power levels and voltage
  - Voltages
    - USA 208/120Y & 480/277Y VAC
    - Canada 208/120Y & 600/347Y VAC
  - Power example
    - 16A 480VAC 3ø = 11kW
    - 80A 480VAC 3ø = 65kW
    - 160A 480VAC 3ø = 133kW

J3068 Draft Document Posted

- May 11 Draft posted in SAE TEVHYB13 J3068 “Work Area”
- 51 pages
- Includes:
- Basic electrical requirements
- Mechanical references
- Messaging
- Good progress since last IWC

J3068 at NREL



- Testing at NREL for J3068
- Energy Systems Integration Facility (ESIF) at the U.S. Department of Energy's National Renewable Energy Laboratory in Golden, CO
- Transpower school bus
- Type-2 three-phase AC inlet
- Integrated motor inverter/charger (EPC Power)
- Charges and discharges into grid up to 70kW
- Test with AC EVSE shown on right (shown case-less during EMI testing)

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

J3068 – Inlet and Connector

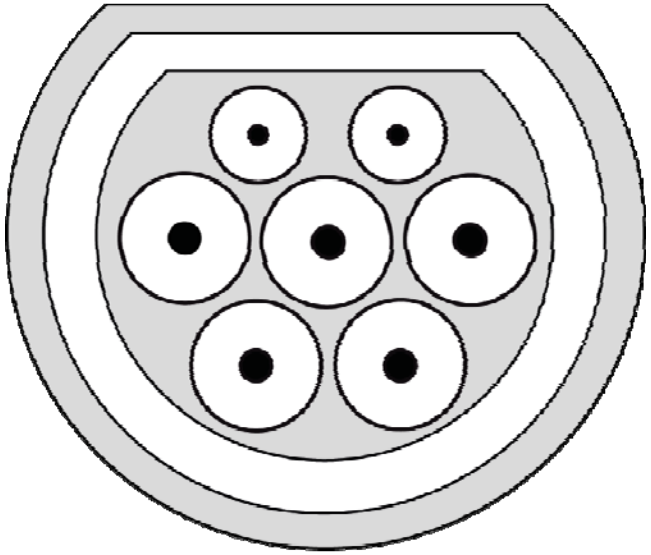


Illustration of Vehicle Inlet
For mechanical specs see IEC 62196-2 Sheet 2-IIf

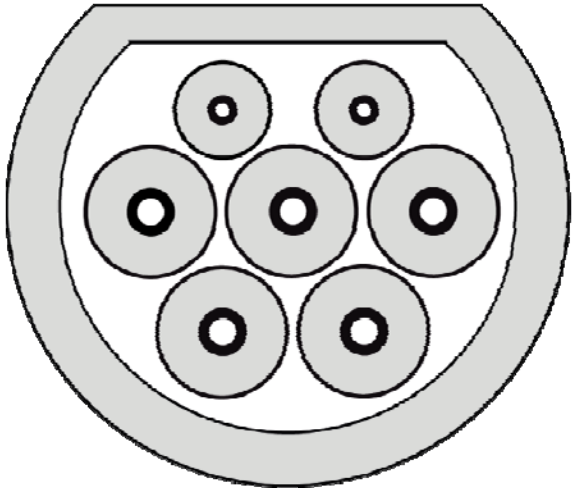


Illustration of Vehicle Connector
For mechanical specs see IEC 62196-2 Sheet 2-IIe

J3068 Electrical Specifications

Note: J3068 electrical specifications are for MX,CA,US and are beyond what is currently defined in the IEC 62196 series

- Current not exceeding 160 A AC three-phase
- Nominal voltages up to 600 V AC three-phase
- Must comply with UL 2251

For illustration purpose only (not drawn to scale) –
licenses are Public Domain (source Michelle Pettinella)

J3068 – Combo Inlet and Connector

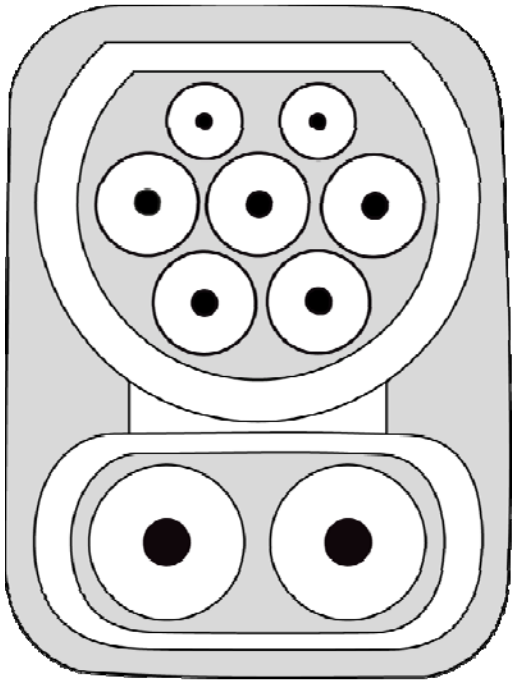


Illustration of Vehicle Inlet
For mechanical specs see IEC 62196-3 Sheet 3-IVa

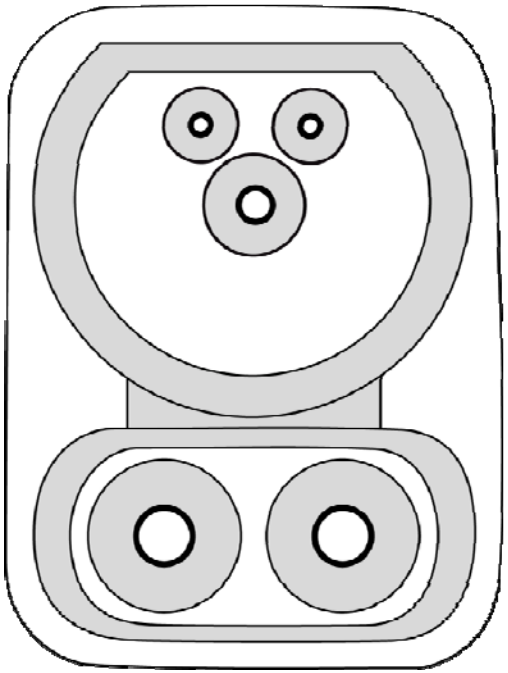
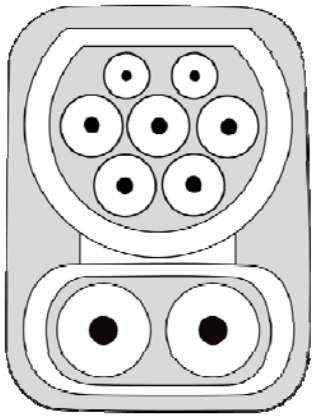


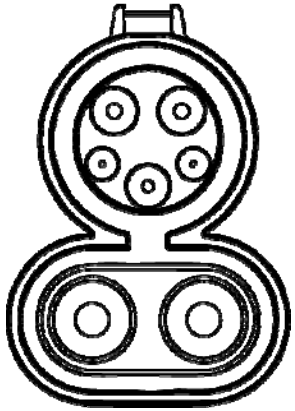
Illustration of Vehicle Connector
For mechanical specs see IEC 62196-3 Sheet 3-IVc

J3068 – Combo Inlet



IEC 62196-3 Sheet 3-IVa
”Type 2 Combo”

- ✓ Three-phase AC (6mm pins)
- ✓ Single-phase also allowed (including 277 VAC)
- ✓ Can DC charge using SAE CCS communication standards
- X Uncommon for North American passenger cars



J1772 CCS / ”Type 1 Combo”

- ✓ Single-phase AC (3.6mm pins)
- ✓ DC charge using SAE CCS communication standards
- ✓ Used on several North American passenger cars with infrastructure installed in many locations
- X Limited AC power; no three-phase; no mandatory AC lock

The End

Questions?