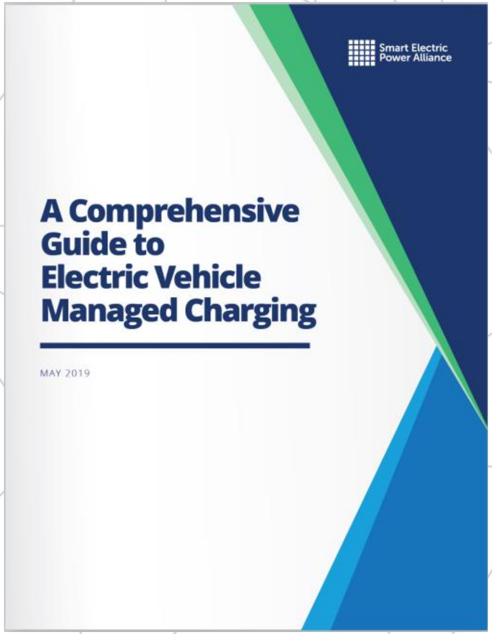
Leveraging EVs as a Grid Asset: Where We Are and Where We Need to Go

2019 EV-Utility Industry Nexus: Charging Forward

Erika Myers
Principal, Transportation Electrification

June 27, 2019



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About SEPA - Four Key Pathways

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Utility Business Models

Utilities need sustainable business models that facilitate and support a carbon-free energy future.

Regulatory Innovation

State regulatory processes must be flexible and agile, enabling the timely and effective deployment of new technologies, partnerships and business models.

Grid Integration

Clean energy must be easily integrated and result in maintained or improved levels of affordability, safety, security, reliability, resiliency and customer satisfaction.

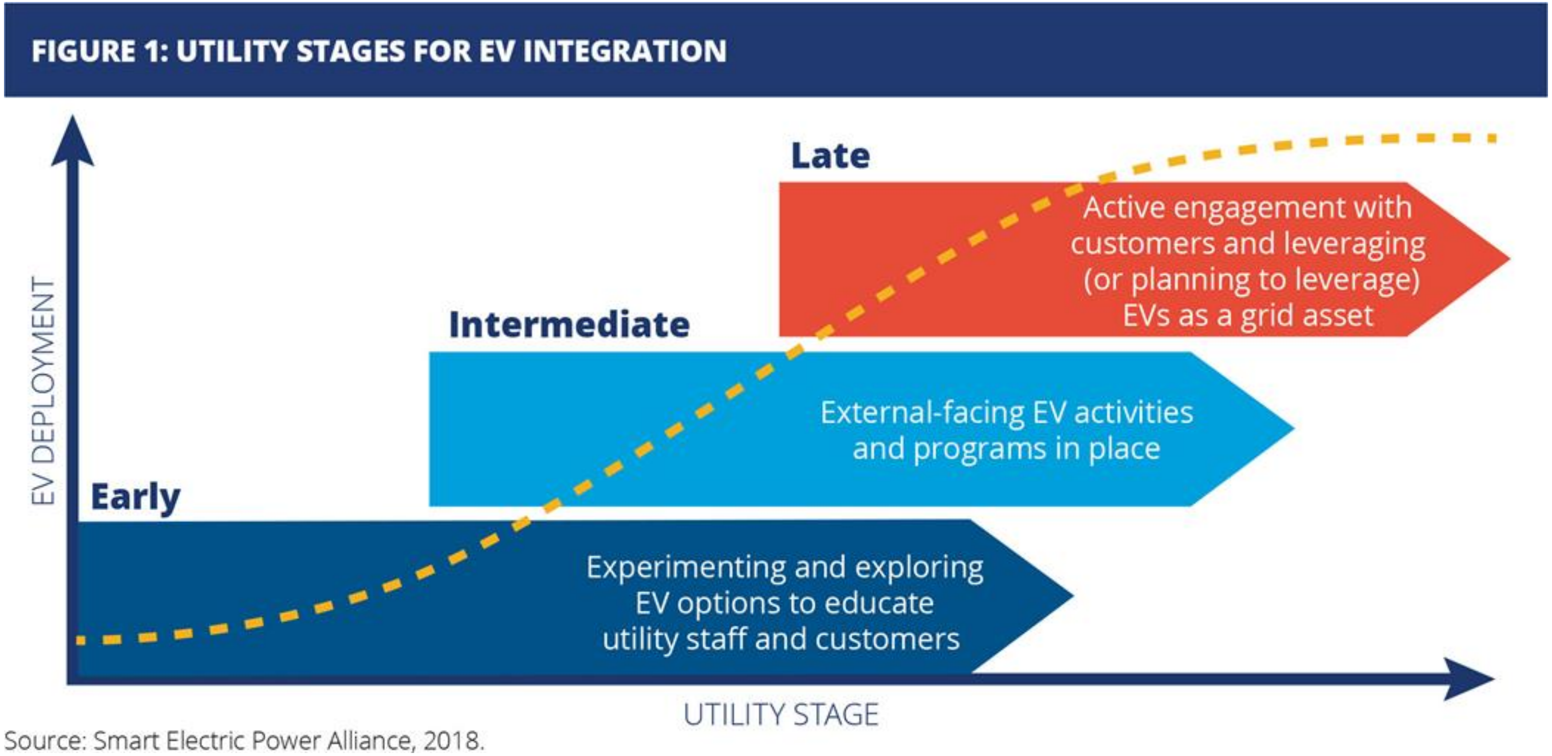
Transportation Electrification

The nation's fleet of light, medium and heavy-duty vehicles should be powered by carbon-free electricity.

Transportation Electrification 2019-2020 Priority Topic Areas

1) Utility Rates, Tariffs, and Incentives
2) Managed Charging
3) Distribution Planning for EVs
4) Storage Opportunities for EVs
5) Utility EV Customer Engagement

Stages of Deployment: Walk - Jog - Run



Utility Activity by Stage

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Source: Smart Electric Power Alliance, 2018.

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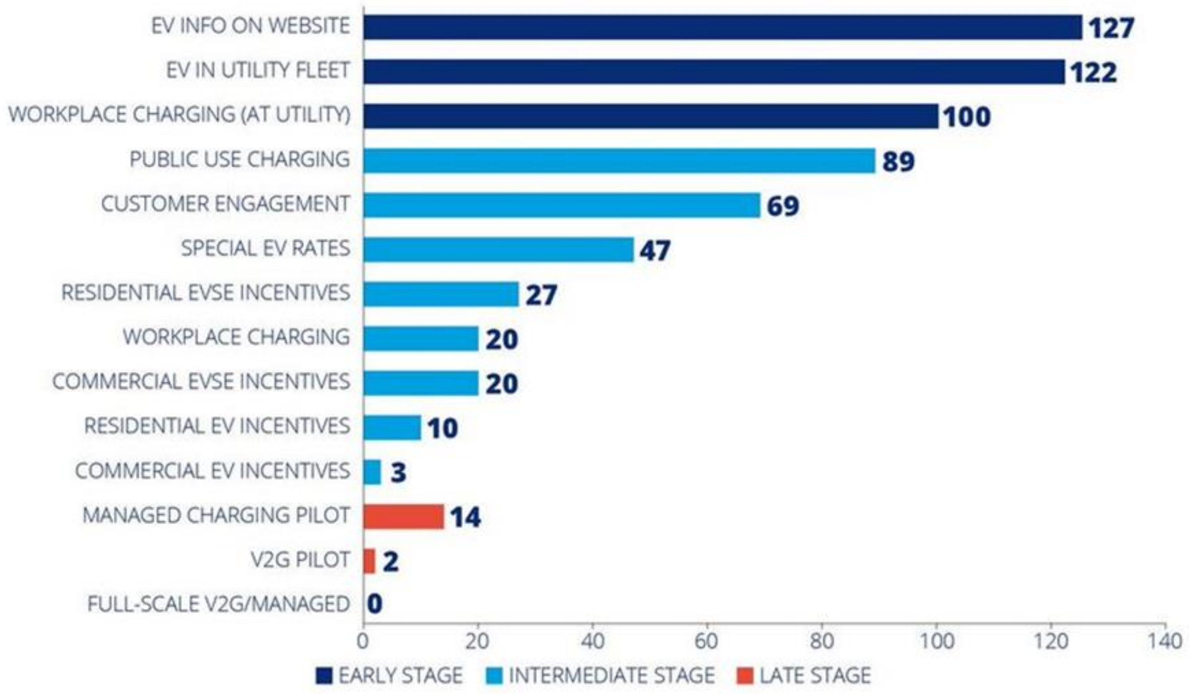
Utility Activity by Stage (Cont'd)

FIGURE 5: UTILITY EV ACTIVITIES AND PROGRAMS BY TYPE AND STAGE



Source: Smart Electric Power Alliance, 2018; N=486.

Forms of Managed Charging

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Passive managed charging relies on customer behavior to affect charging patterns.

Active managed charging relies on communication (i.e., “dispatch”) signals originating from a utility or aggregator to be sent to a vehicle or charger to control charging in a predetermined specific way.

Passive	Active
EV time-varying rates, including time-of-use rates and hourly dynamic rates	Direct load control via the charging device
Communication to customer to voluntarily reduce charging load (e.g., behavioral demand response event)	Direct load control via automaker telematics
Incentive programs rewarding off-peak charging	Direct load control via a smart circuit breaker or panel

Why Managed Charging is Important

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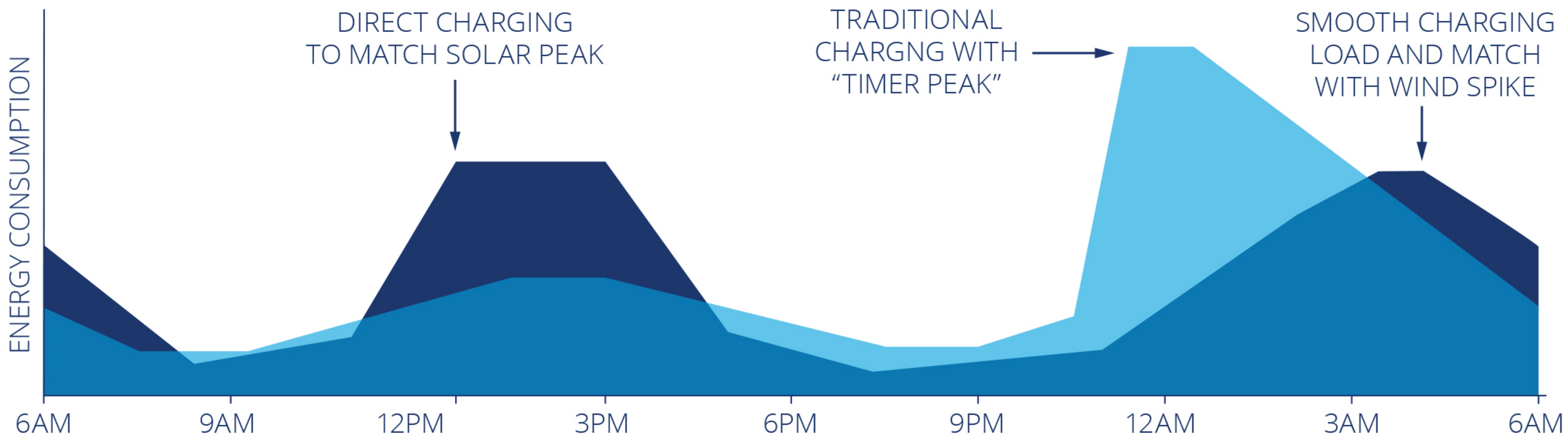
FIGURE 1: OPPORTUNITIES FOR EV MANAGED CHARGING TO MEET GRID NEEDS (ILLUSTRATIVE)



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

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

How does it work?

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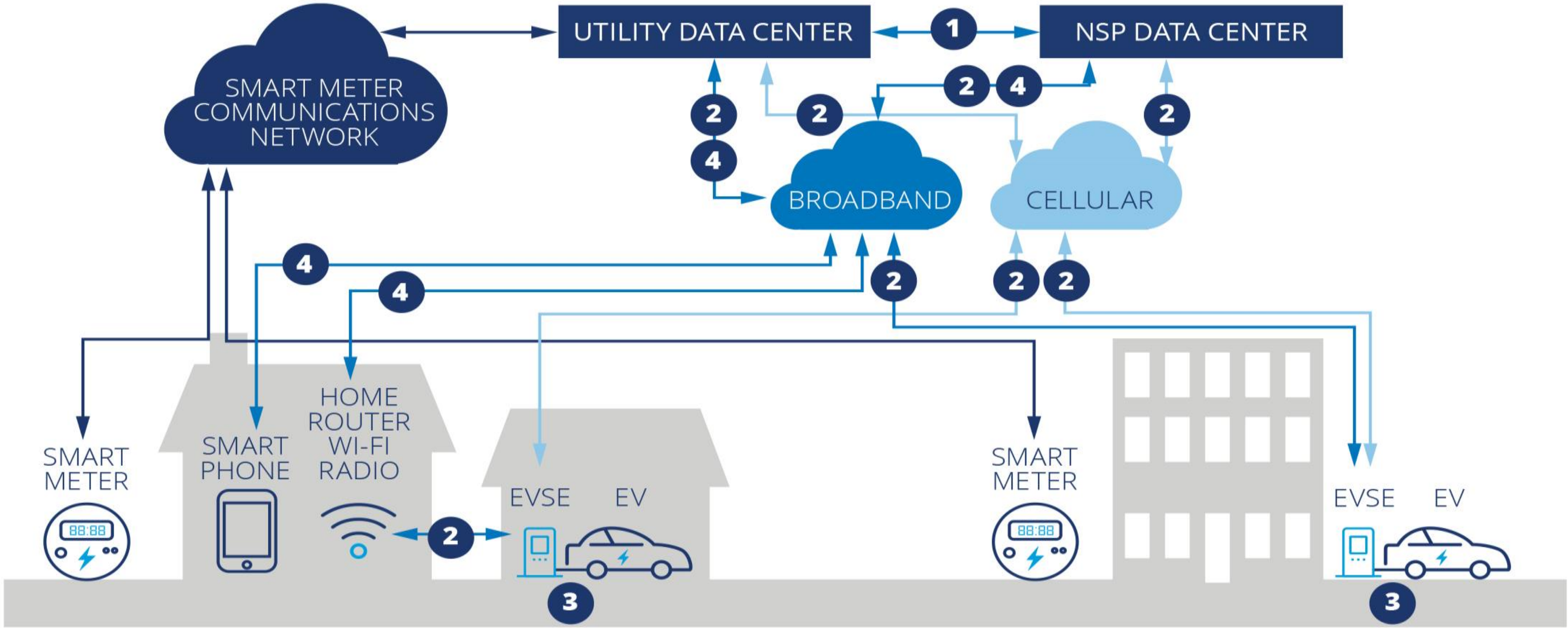
FIGURE 11: USE OF OPEN PROTOCOLS IN MANAGED EV CHARGING



1 OPENADR AND OCPI 2 OCPP AND OPENADR 3 SAE J1772 (PLUG), ISO/IEC 15118 (EV TO EVSE) 4 INTERNET PROTOCOL

Source: Siemens, EV Technical Workshop, NY Public Service Commission, July 2018.

1) Transport Layer Protocols

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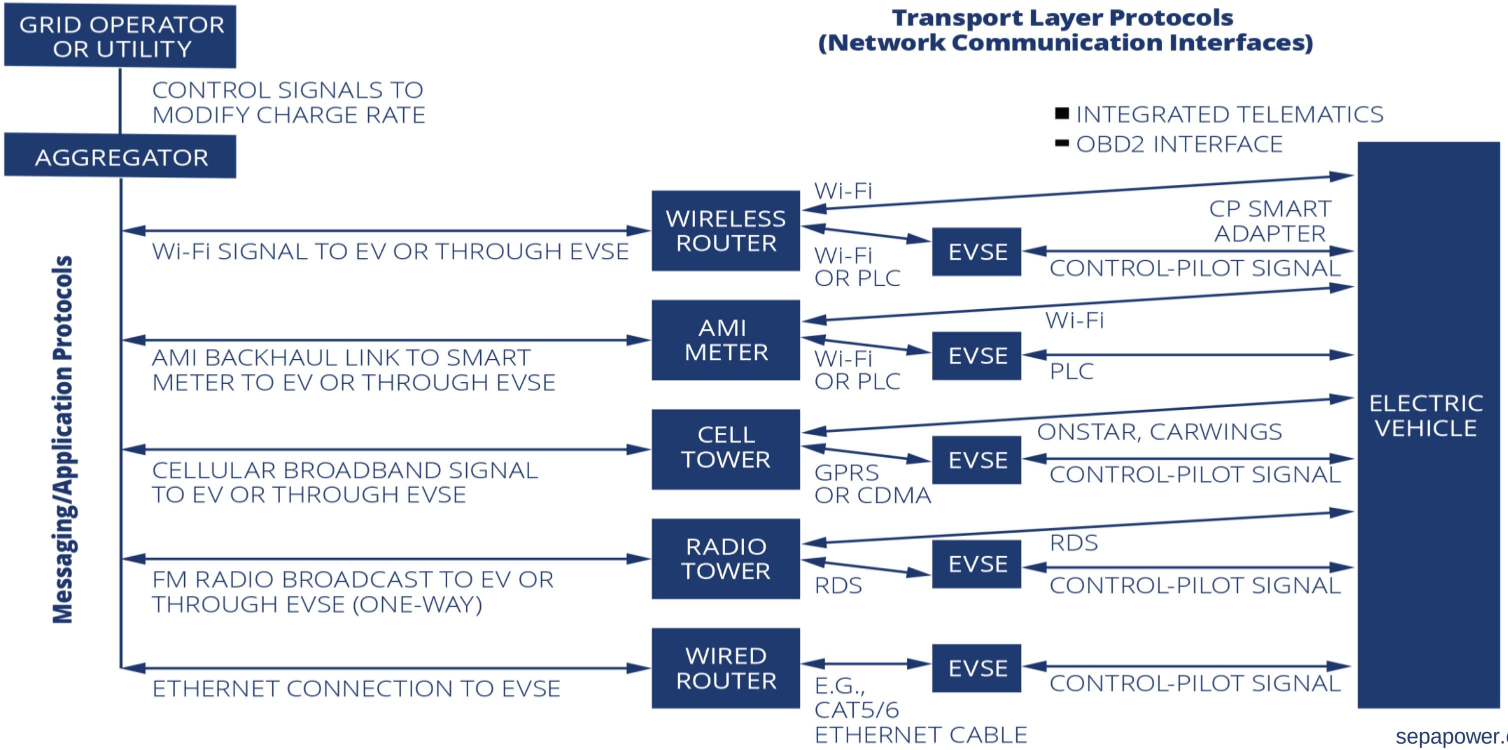
FIGURE 12: MANAGED CHARGING NETWORK COMMUNICATION INTERFACE OPTIONS



Source: Dr. David P. Tuttle, 2019[66] with edits by Smart Electric Power Alliance, 2019

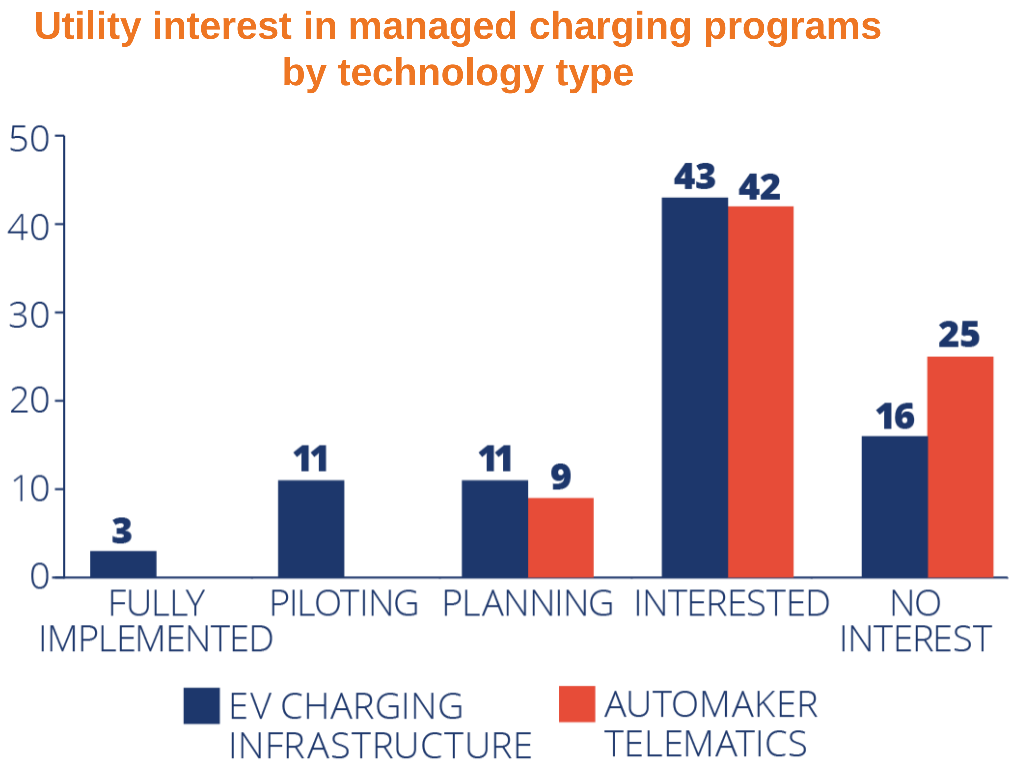
2) Messaging Protocols

TABLE 7: RECOMMENDED PROTOCOLS TO ENABLE VEHICLE GRID INTEGRATION

DOMAIN OF COMMUNICATION	RECOMMENDED PROTOCOLS CURRENTLY AVAILABLE
PFE to EVSE	One or a combination of the following: 1. OpenADR 2.0b 2. IEEE 2030.5 3. OCPP 1.6 4. IEC 63110
EVSE to EV	One or a combination of the following: 1. ISO/IEC 15118 v1 2. IEEE 2030.5
Vehicle OEM to EV	Telematics (using proprietary protocols or IEEE 2030.5)

Source: California Vehicle Grid Integration Communications Protocols Working Group, 2017, with edits by SEPA.[71]

Utility Interest in Managed Charging



Source: Smart Electric Power Alliance, 2019. n=84

Managed Charging Projects To Date

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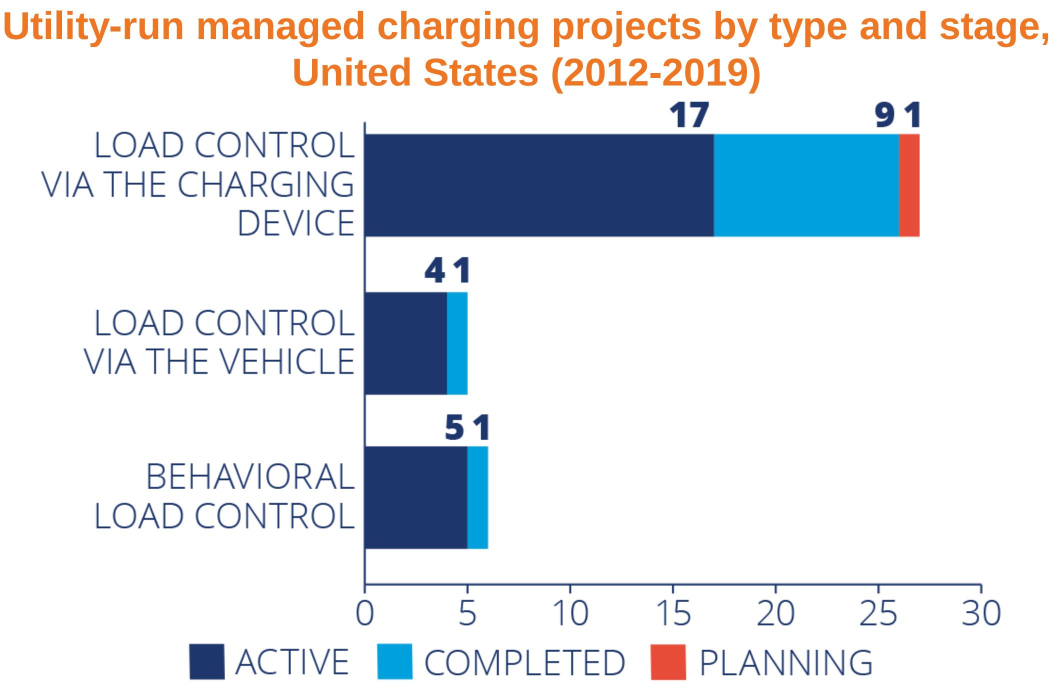

Source: Smart Electric Power Alliance, 2019. See Appendix A for details.
n=38

Managed Charging Application Types

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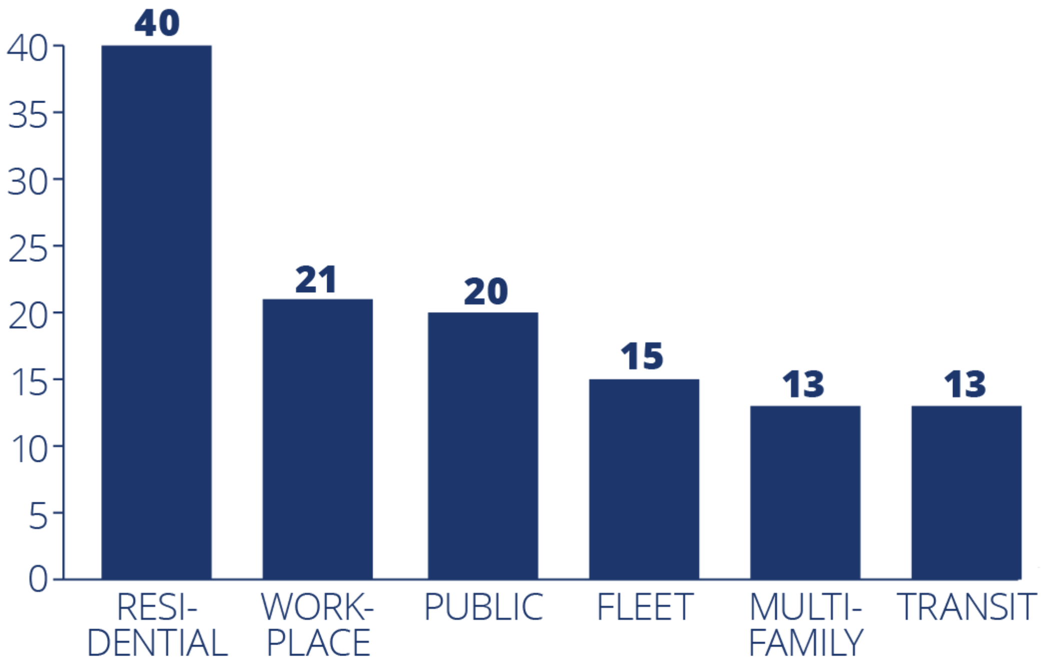
Application types targeted for a managed charging program



Source: Smart Electric Power Alliance, 2019. n=49.
Note: Utilities selected all that applied.

How Utilities are Using Managed Charging

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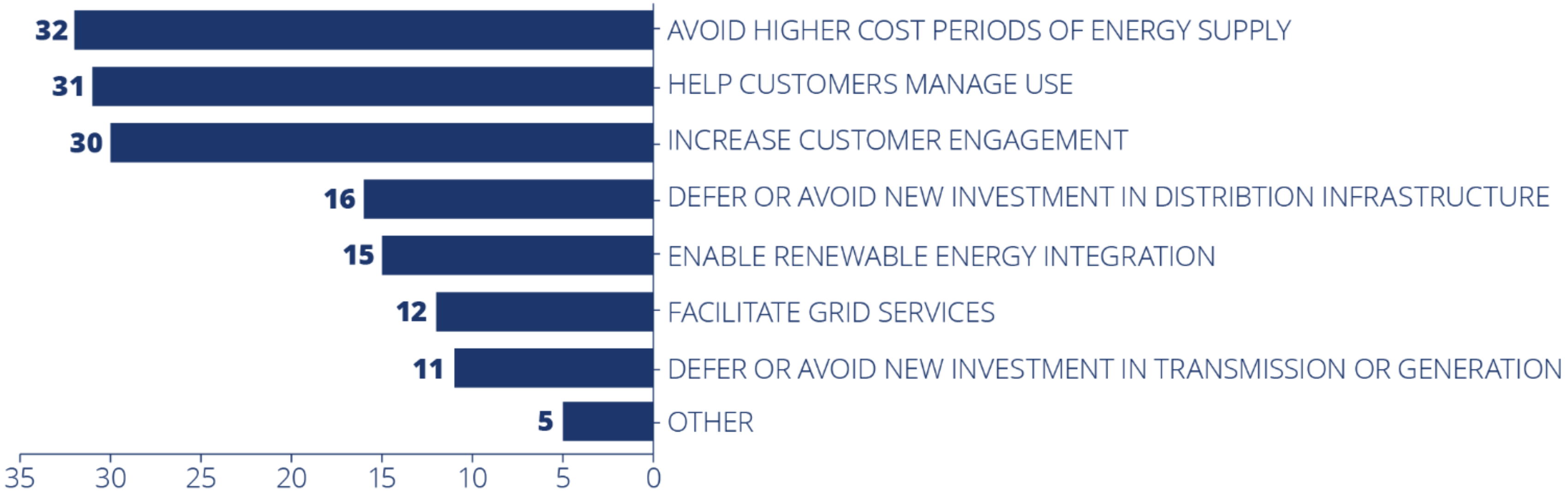
How are utilities using or planning to use managed charging programs?



Source: Smart Electric Power Alliance, 2019. N=48. Note: Utilities selected all that applied.

Barriers to Implementation

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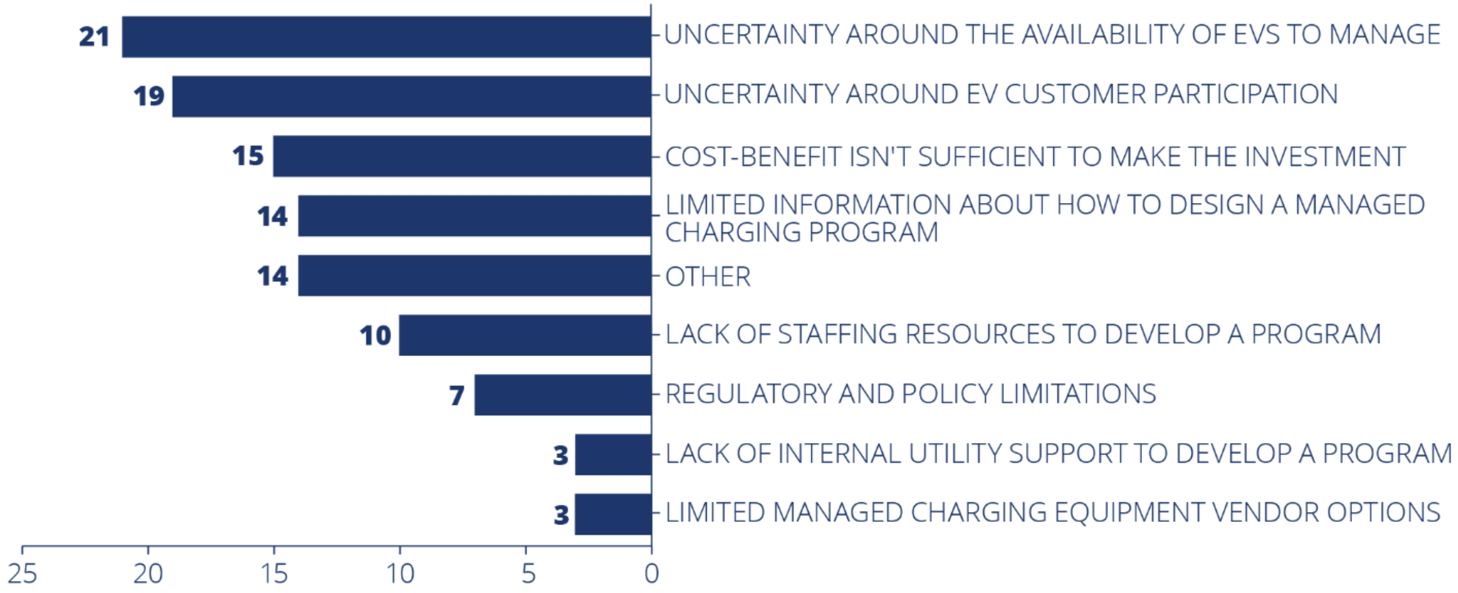
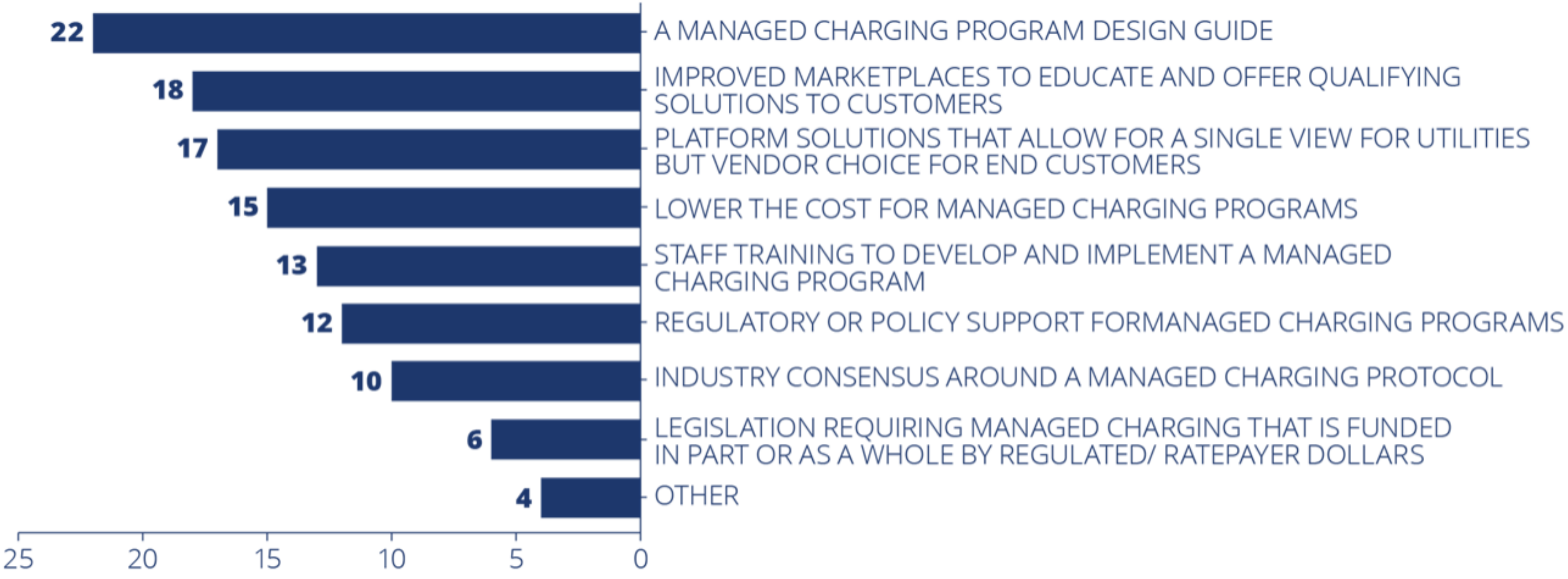
Barriers to implementing a Managed Charging Program



Source: Smart Electric Power Alliance, 2019. N=45. Note: Utilities selected all that applied.

Activities that would support Utilities

Industry activities that would help utilities implement a Managed Charging Program



Source: Smart Electric Power Alliance, 2019. N=49. Note: Utilities selected top three options.

State of the Industry

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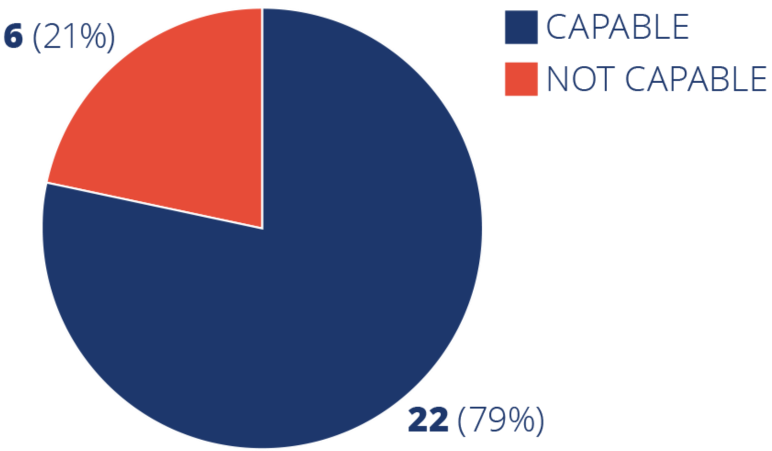
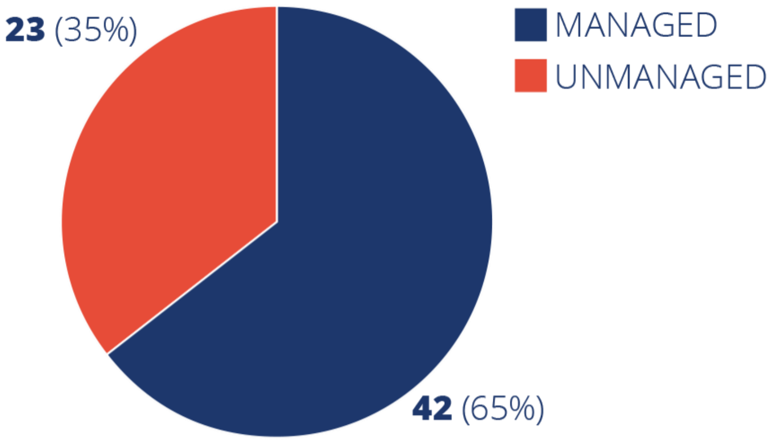
Percentage of Network Service Providers with Managed Charging Capabilities, U.S., 2019



Source: Smart Electric Power Alliance, 2019.

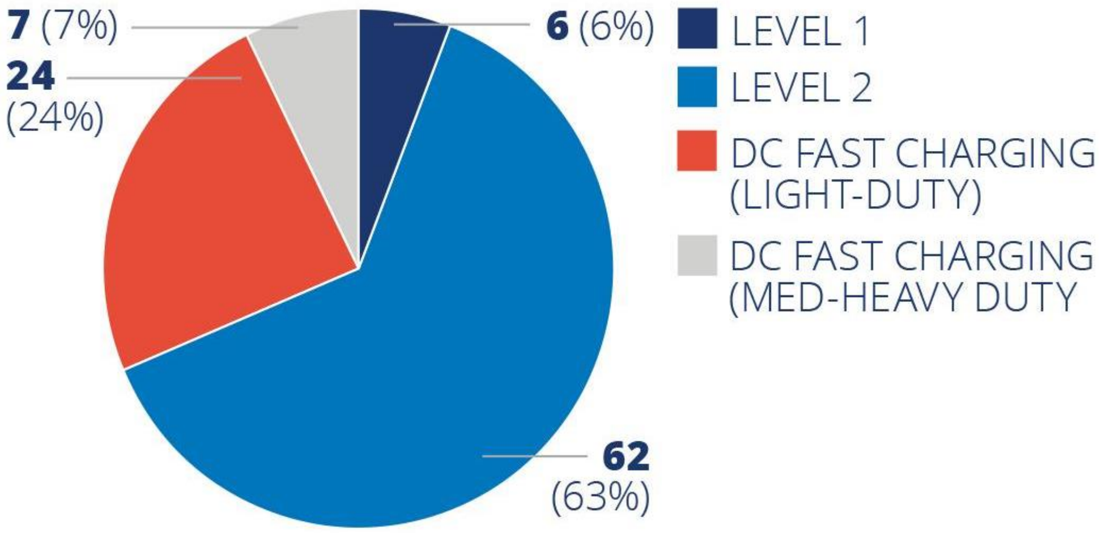
Percentage of EVSE Manufacturers with Managed Charging Capabilities, U.S., 2019



Source: Smart Electric Power Alliance, 2019.

State of the Industry (Cont'd)

Number of Managed Charging Capable EVSE by Level, U.S., 2019



Source: Smart Electric Power Alliance, 2019. Note: Some manufacturers offer multiple configurations of chargers in a series type. Only one base configuration in a series was included in the tally.

NSP & EVSE Messaging Protocols

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TABLE 10: NUMBER OF MANAGED CHARGING-CAPABLE NETWORK SERVICE PROVIDERS BY MESSAGING PROTOCOL TYPE, U.S., 2019

OSCP/ OCPP	OPENADR 2.0	ISO/IEC 15118	API	IEEE 2030.5
14	11	10	6	2

Source: Smart Electric Power Alliance, 2019. Note: Many Network Service Providers use more than one messaging protocol.

TABLE 11: NUMBER OF MANAGED CHARGING-CAPABLE EVSE MANUFACTURERS BY MESSAGING PROTOCOL TYPE, 2019

OSCP/ OCPP	OPENADR	ISO/IEC 15118	IEEE 2030.5	API	PROPRIETARY
29	8	8	4	2	7

Source: Smart Electric Power Alliance, 2019. Note: Many EVSE include more than one messaging protocol.

Auto OEM Messaging Protocols

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TABLE 12: PROTOCOLS INCLUDED IN AUTOMAKERS' 10-YEAR TIME HORIZON, 2017			
AUTOMAKER	**AC CONDUCTIVE**	**DC CONDUCTIVE**	**WIRELESS INDUCTIVE**
BMW	ISO 15118 (HomePlug Green PHY)	ISO 15118 (HomePlug Green PHY)	ISO 15118
Fiat Chrysler	IEEE 2030.5	ISO 15118 (HomePlug Green PHY)	WiFi, ISO 15118 v2
Ford	Telematics & ISO 15118 (future)	ISO 15118 (HomePlug Green PHY)	ISO 15118 v2
GM	No High Level Communication	DIN Spec, no timeframe for ISO/IEC	WiFi and Telematics
Honda	TBD High Level Communication, Vehicle to Grid	DIN Spec / ISO 15118, Vehicle to Grid	Premium product
Lucid	ISO 15118 (HomePlug Green PHY)	ISO 15118 (HomePlug Green PHY)	
Mercedes Benz	ISO 15118 (HomePlug Green PHY)	ISO 15118 (HomePlug Green PHY)	J2954 / ISO 15118
Nissan	Telematics	CHAdeMO	In development
Porsce/Audi/ Volkswagen	ISO 15118 (HomePlug Green PHY)	ISO 15118 (HomePlug Green PHY)	ISO 15118 (In development—2018)

Source: Vehicle-Grid Integration Communications Protocol Working Group, Final Staff Report, 2017.[91]

Other Technology Options

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- **Distributed Energy Resource Management Systems (DERMS)**
- **AMI –** Power Line Carrier (e.g., Zigbee, GreenPHY) load disaggregation (Sagewell)
- **Meter collars** – (e.g., ConnectDER)
- **On-board diagnostic interface (OBD-II)**
- **Adaptive Load Management**
- **Smart Circuit Breakers/ Smart Panels**
- **Behavioral Load Control –** e.g., gamification, text alerts

Proposed VGI Valuation Framework

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FIGURE 8: VGI VALUATION FRAMEWORK

SECTOR
EV LOADSHAPES: RESIDENTIAL, COMMERCIAL, RIDESHARE

APPLICATION
RELIABILITY AND NON-RELIABILITY SERVICES FOR: CUSTOMERS, T&D GRIDS, AND WHOLESHALE R/A

TYPE
POWER FLOW BETWEEN THE EV AND THE GRID: V1G AND V2G

APPROACH
CONTROL MECHANISMS: DIRECT (ACTIVE) OR INDIRECT (PASSIVE, MOSTLY RATES)

RESOURCE
EV-EVSE OWNERSHIP/ OPERATION: UNIFIED BY THE SAME ACTOR, OR FRAGMENTED AMONG DIFFERENT ACTORS

ALIGNMENT
IN ACTIONS AND INCENTIVES AMONG THE EV-ACTOR AND EVSE-ACTOR

TECHNOLOGY
HARDWARE & SOFTWARE: INCLUDING EV CLASS, CHARGING TYPE, AND COMMUNICATION STANDARDS/PROTOCOLS

For further information on PG&E's VGI efforts, contact Karim Farhat (karim.farhat@pge.com)

Example: PG&E EV Smart Charging Pilot

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TABLE 6: APPLICATION OF THE VGI VALUATION FRAMEWORK IN THE PG&E EV SMART CHARGING PILOT

	SECTOR	APPLICATION	TYPE	APPROACH	RESOURCE	ALIGNMENT	TECHNOLOGY
Phase 1							
Use-case 1	Residential	Wholesale, Capacity	V1G	Direct	Unified	Aligned	LDV, L2, Telematics
Use-case 2	Residential	Wholesale, Energy	V1G	Direct	Unified	Aligned	LDV, L2, Telematics
Phase 2							
Use-case 3	Residential	Wholesale, Overgeneration	V1G	Direct	Unified	Aligned	LDV, L1 & L2, Telematics
Use-case 4	Workplace	Wholesale, Overgeneration	V1G	Direct	Fragmented	Not aligned	LDV, L1 & L2, Telematics

Source: PG&E, 2019.

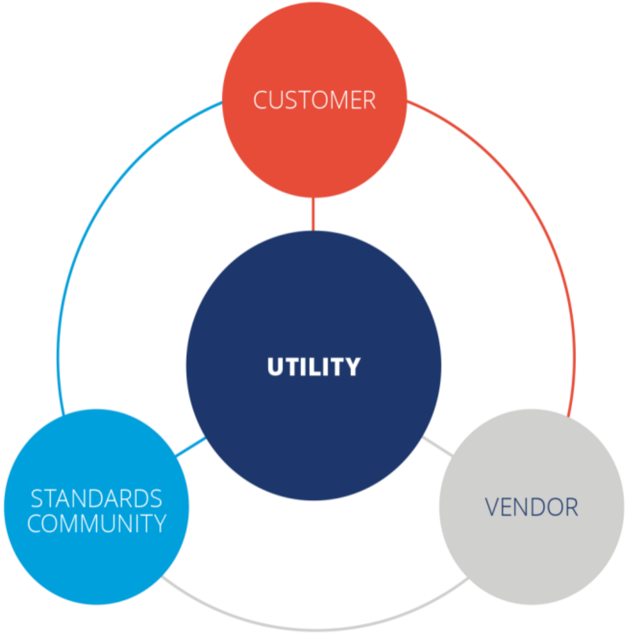
What about customers?

TABLE 4: MANAGED CHARGING CUSTOMER OPTIMIZATION PATHWAY	
Basic	Customer manual opt-in or opt-out of a managed charging event
Good	Automate user preferences during managed charging program enrollment
Better	Use standards to ensure interoperability and automated inputs across location types (e.g., where there may be more local grid constraints) to improve customer experience
Superior	Leverage intelligence throughout the network to improve predictive capabilities and maximize load forecast estimates over time and location (i.e., to minimize charging disruptions except where most needed)

Source: California Energy Commission, 2019.

Next Steps

- **Quantify the value** of managed charging
- **Define the business model** for managed charging – including costs and payback for utility and EV customer – and establish industry standards to reduce barriers, costs, and complexity
- Work with EV industry to **develop industry-wide standards for the entire ‘ecosystem’**
- Provide customers with **maximum flexibility** – including opt-out
- Gain visibility **where EV resources are located** on the distribution system, and define cost-benefit of avoided distribution upgrades
- Proactively engage customers and **provide information** on managed charging-capable charging EVSE and NSPs
- Identify **least-cost and reliable communication** solutions



Source: Smart Electric Power Alliance, 2019

Planning for the Future: Team-Building

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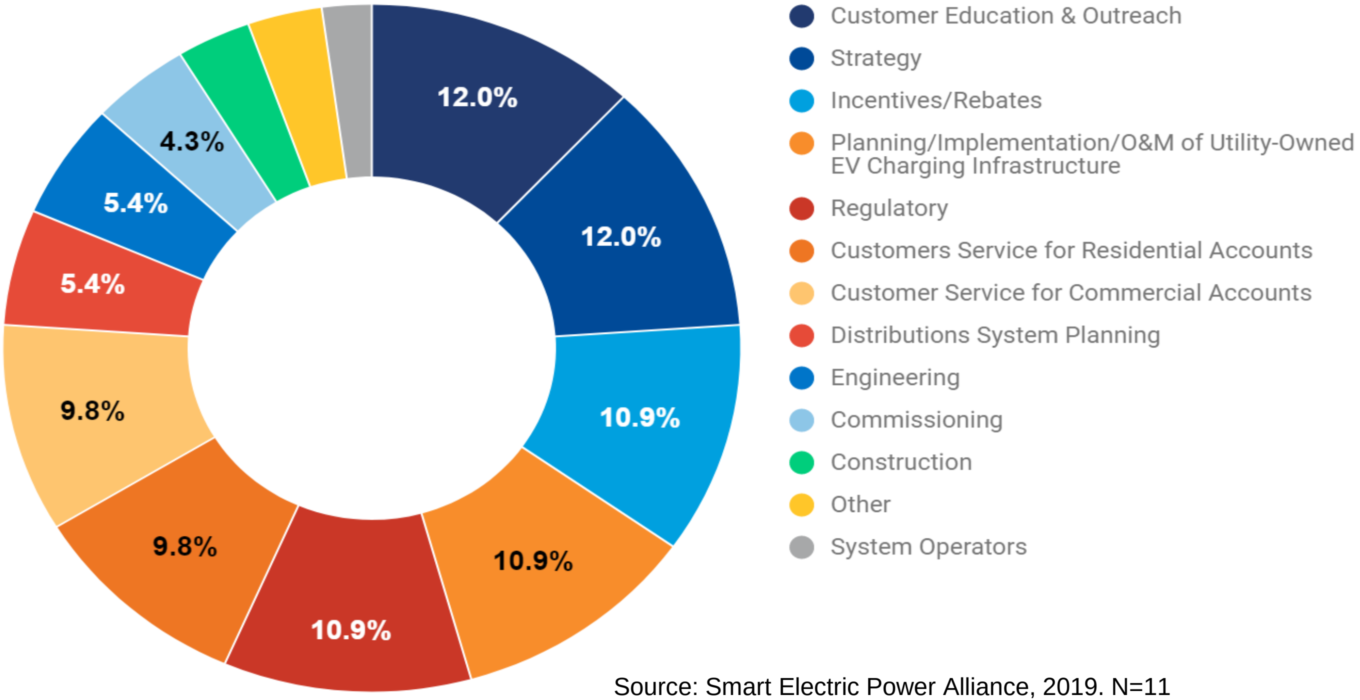
If yes, which portions of the TE process does your TE group cover?



Source: Smart Electric Power Alliance, 2019. N=11

SCE eMobility Operating Model

eMobility®

eMobility®

Strategy & Program Dev.

- Market & technology trend analysis
- TE business strategy development
- Customer insight and adoption barrier analysis
- Direct research and testing
- Program & pilots design

Business Dev. & Partnerships

- Guide external engagement strategy
- Develop materials for account manager training
- Material development for advisory services
- Education and outreach
- Partnerships

Operations

- Infrastructure deployment & management PMO
  - Ongoing coordination and management of operations (programs)
  - Reporting
  - Supplier management
- TE related rebates management

T&D TE PMO

Project management of infrastructure deployment including design and construction of TE infrastructure pilots & program

Business Customer Division

- Training of account managers
- Account management

Corporate Strategy	Marketing	Supply Chain	Gov't Affairs	Regulatory Affairs	Law	Corporate Comm.	Facilities	T&D
TE planning, high level strategy, and forecasting	Marketing materials development	Management of selection and onboarding of external suppliers	Legislative policy development Local public affairs management	Regulatory policy development Implement rate design	Represent the Company in TE policy-setting proceedings	Develop creative material Work on campaigns	SCE workplace charging	Deployment; laying infrastructure & maintenance for forecasted load growth

SEPA EV Working Group

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- Open to all SEPA members; 400 members to date
- Monthly group calls on the third Thursday from 4-5pm eastern
  - July 18 - Clean Energy Works value proposition for site-specific tariffed on-bill investments for battery electric transit buses
- Subcommittees
  - Distribution Planning for EVs
  - Managed Charging/ V2X
  - Utility Rates, Tariffs, and Incentives
- In-person Meet-ups

Upcoming EV Research & Workshops

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Reports:

- Accelerating Electric Vehicle Infrastructure: A Guide to Best Practices in Utility Planning and Deployment - August
- The Efficacy of Electric Vehicle Time-Varying Rates: Attributes that Increase Adoption - November

Workshops:

- Interactive Learning Lab: Managing Large Loads on the Grid Edge - SEPA's Grid Evolution Summit, August 1
- Fundamentals and Best Practices for EV Charging Infrastructure Rollouts - North America Smart Energy Week, September 23

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