Annexure

Annexure 1: FAME Scheme

The table summarizes the various incentives given under the scheme.

Table 37: Incentives under FAME scheme

Component under FAME Scheme	FY 2015-16 (Rs Crore)	FY 2016-17 (Rs Crore)
Technology Platform (including testing infrastructure)	70	120
Demand Incentives	155	340
Charging Infrastructure	10	20
Pilot Projects	20	50
IEC / Operations (Public awareness and information dissemination)	5	5
Total	260	535

Source: FAME

Phase I of the scheme was extended till March, 2018.
With the success of phase I of the scheme, phase II of the scheme has been launched in March 2019 with an outlay of INR 9,630 Crore till 2021-2022 for demand incentives to support one million 2W-EV, half a million 3W-EV, 35,000 4W-EV, 20,000 4W-HEV, and 7090 e-buses.

Table 38: Incentive budget under FAME scheme

(All Figures in Rs Crore)

Component	2019-20	2020-21	2021-22	Total Fund
Demand Incentives	822	4587	3187	8596
Charging Infrastructure	300	400	300	1000
Administrative Expenditure	12	13	13	38
Total for FAME-II	1134	5000	3500	9634
Committed from Phase-I	366	0	0	366
Total	1500	5000	3500	10000

Source: FAME

As of June 2019, the total numbers of EVs sold under the scheme was 2,79,371 with over Rs 343 Crore disbursed as incentives under FAME[26]. A total of 29 Original Equipment Manufacturers (OEMs) are registered under FAME scheme and offer over 120 different models of vehicles. DHI has also sanctioned 455 electric buses for 9 cities in a pilot scheme launched in October 2017[27].

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[26] *https://fame-india.gov.in/*

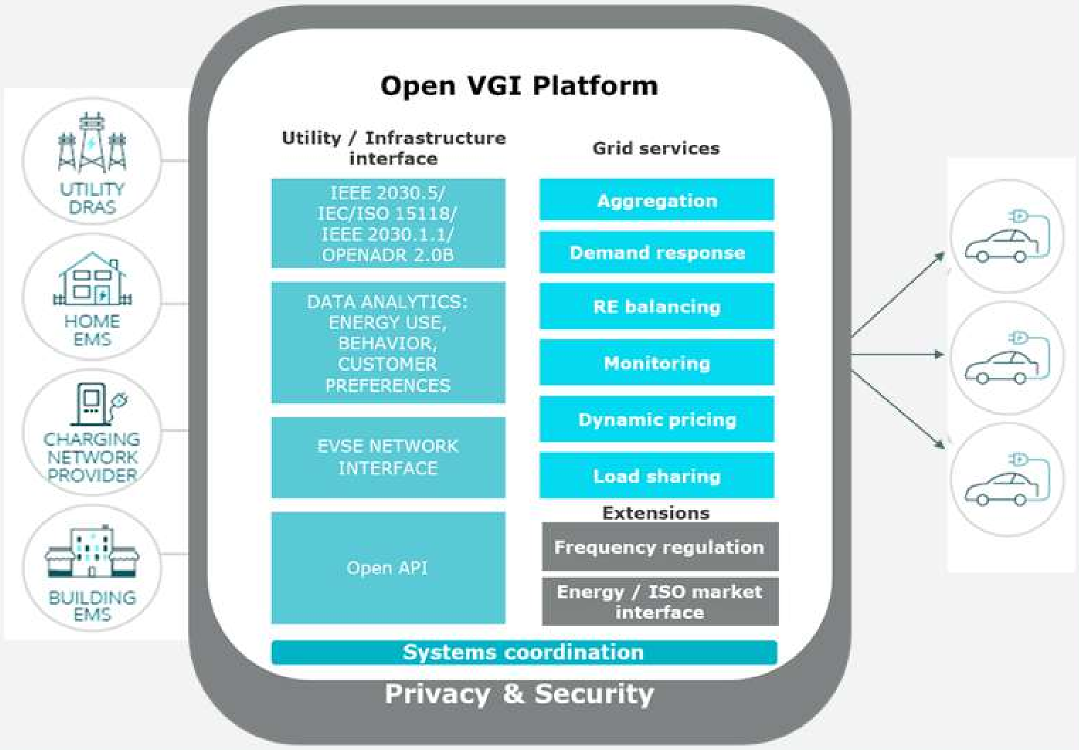
[27] *http://pib.nic.in/newsite/PrintRelease.aspx?relid=186277*

Annexure 2: CPUC VGI – Communication standards and functionalities

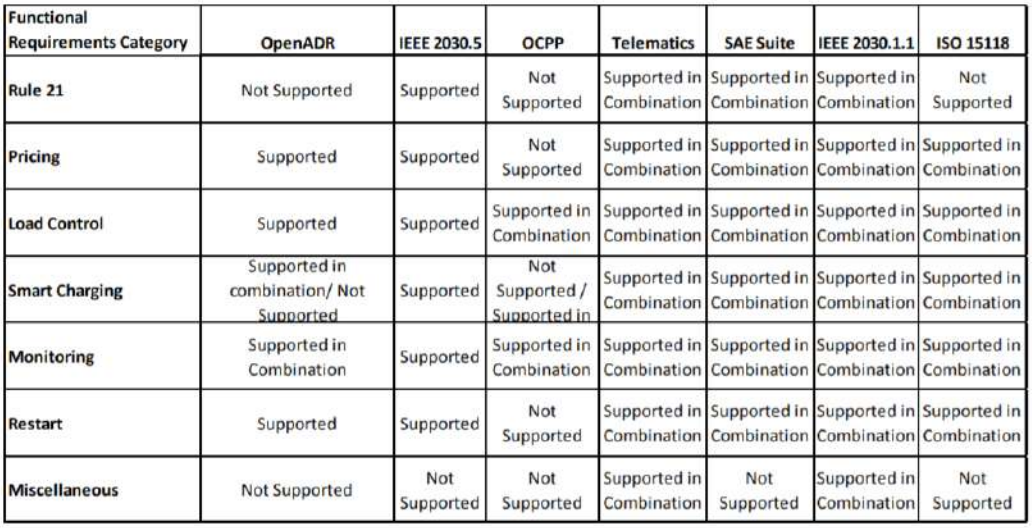
OPEN VEHICLE-GRID INTEGRATION PLATFORM (OVGIP)

The Electric Power Research Institute (EPRI) has been coordinating work on an Open Vehicle-Grid Integration Platform (OVGIP)93—a software application that connects EVSE and EVs to various nodes to allow utilities to more proactively manage charging activity that could help with a variety of grid services as shown below. In this approach, the utility communicates with the OEM's data center via the OVGIP, which then uses the vehicle telematics to control charging in the vehicle. The key benefit of the OVGIP is that it allows for utility-side uniformity while also supporting
OEM and EV Infrastructure flexibility.

This approach allows the use of existing on-vehicle communications protocols (i.e., IEEE 2030.5, ISO/IEC 15118, and telematics) with utility standard interface protocols (i.e., OpenADR 2.0b, IEEE 2030.5) and EV charging device application program interfaces (i.e., ISO/ IEC 15118, OCPP, and industry applied standard and proprietary APIs) through a common platform. These will ultimately allow utilities to provide: "time-of-use (TOU) pricing, peak load reduction, demand charge mitigation, load balancing for intermittent solar/wind generation, Real Time Pricing (RTP), aggregated Demand Response (DR), and scheduling dispatch for ancillary services," to EVSE or EVs across manufacturers.



Annexure 3: CPUC VGI – Communication standards and functionalities

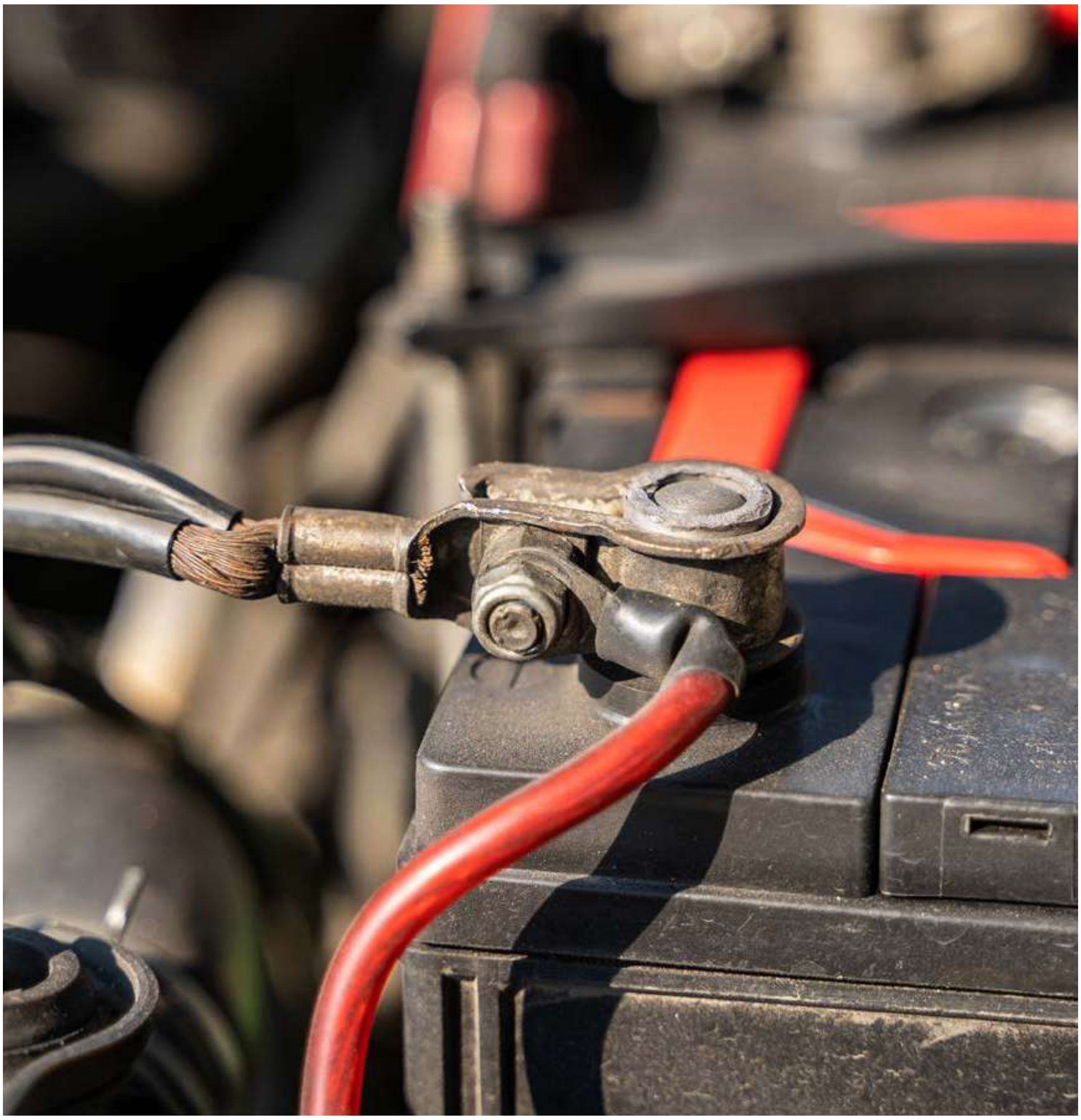


Functional Requirements Category	OpenADR	IEEE 2030.5	OCPP	Telematics	SAE Suite	IEEE 2030.1.1	ISO 15118
Rule 21	Not Supported	Supported	Not Supported	Supported in Combination	Supported in Combination	Supported in Combination	Not Supported
Pricing	Supported	Supported	Not Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Load Control	Supported	Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Smart Charging	Supported in combination/ Not Supported	Supported	Not Supported / Supported in	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Monitoring	Supported in Combination	Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Restart	Supported	Supported	Not Supported	Supported in Combination	Supported in Combination	Supported in Combination	Supported in Combination
Miscellaneous	Not Supported	Not Supported	Not Supported	Supported in Combination	Not Supported	Supported in Combination	Not Supported

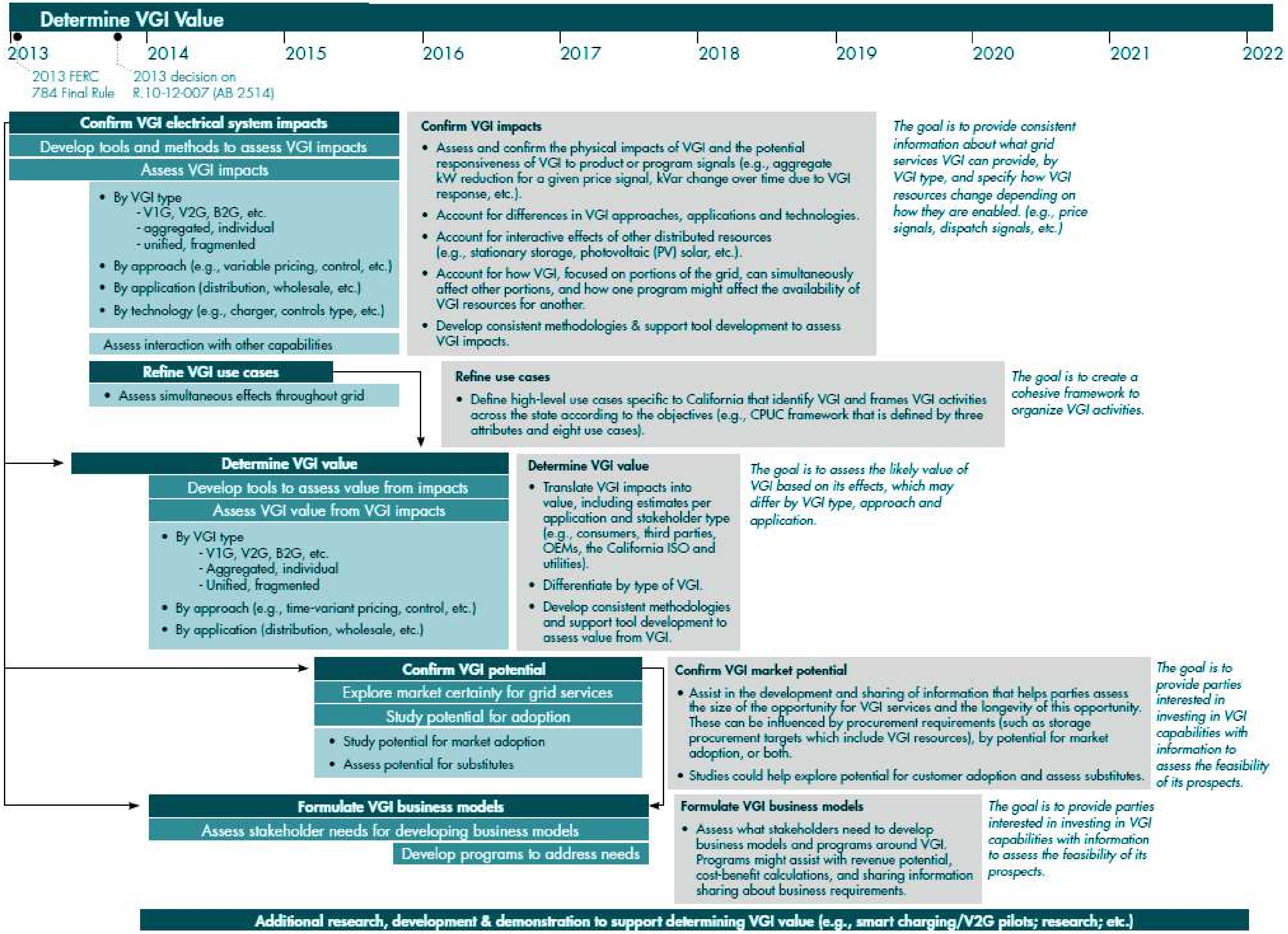
Annexure 4: Protocols provided by OEMs

Protocols included in participating automakers' 10-year time horizon, 2017 (CPUC)

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
Porsche/Audi/Volkswagen	ISO 15118 (HomePlug Green PHY)	ISO 15118 (HomePlug Green PHY)	ISO 15118 (in development - 2018)



Annexure 5: CEC VGI Roadmap, 2014



Confirm VGI impacts

- Assess and confirm the physical impacts of VGI and the potential responsiveness of VGI to product or program signals (e.g., aggregate kW reduction for a given price signal, kVar change over time due to VGI response, etc.).
- Account for differences in VGI approaches, applications and technologies.
- Account for interactive effects of other distributed resources (e.g., stationary storage, photovoltaic (PV) solar, etc.).
- Account for how VGI, focused on portions of the grid, can simultaneously affect other portions, and how one program might affect the availability of VGI resources for another.
- Develop consistent methodologies & support tool development to assess VGI impacts.

The goal is to provide consistent information about what grid services VGI can provide, by VGI type, and specify how VGI resources change depending on how they are enabled. (e.g., price signals, dispatch signals, etc.)

Refine use cases

- Define high-level use cases specific to California that identify VGI and frames VGI activities across the state according to the objectives (e.g., CPUC framework that is defined by three attributes and eight use cases).

The goal is to create a cohesive framework to organize VGI activities.

Determine VGI value

- Translate VGI impacts into value, including estimates per application and stakeholder type (e.g., consumers, third parties, OEMs, the California ISO and utilities).
- Differentiate by type of VGI.
- Develop consistent methodologies and support tool development to assess value from VGI.

The goal is to assess the likely value of VGI based on its effects, which may differ by VGI type, approach and application.

Confirm VGI market potential

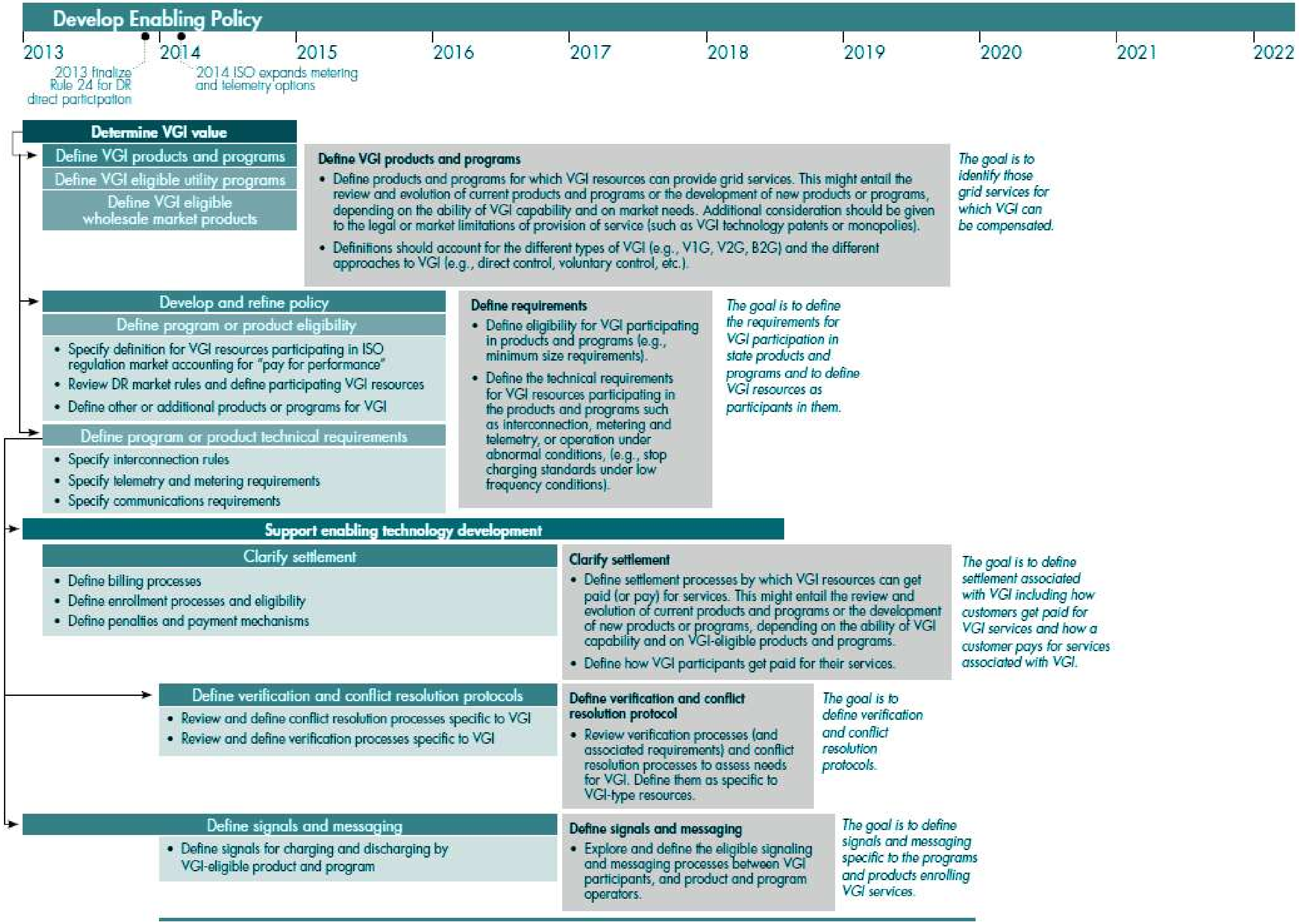
- Assist in the development and sharing of information that helps parties assess the size of the opportunity for VGI services and the longevity of this opportunity. These can be influenced by procurement requirements (such as storage procurement targets which include VGI resources), by potential for market adoption, or both.
- Studies could help explore potential for customer adoption and assess substitutes.

The goal is to provide parties interested in investing in VGI capabilities with information to assess the feasibility of its prospects.

Formulate VGI business models

- Assess what stakeholders need to develop business models and programs around VGI. Programs might assist with revenue potential, cost-benefit calculations, and sharing information sharing about business requirements.

The goal is to provide parties interested in investing in VGI capabilities with information to assess the feasibility of its prospects.



Define VGI products and programs

- Define products and programs for which VGI resources can provide grid services. This might entail the review and evolution of current products and programs or the development of new products or programs, depending on the ability of VGI capability and on market needs. Additional consideration should be given to the legal or market limitations of provision of service (such as VGI technology patents or monopolies).
- Definitions should account for the different types of VGI (e.g., V1G, V2G, B2G) and the different approaches to VGI (e.g., direct control, voluntary control, etc.).

The goal is to identify those grid services for which VGI can be compensated.

Define program or product eligibility

- Specify definition for VGI resources participating in ISO regulation market accounting for "pay for performance"
- Review DR market rules and define participating VGI resources
- Define other or additional products or programs for VGI

Define program or product technical requirements

- Specify interconnection rules
- Specify telemetry and metering requirements
- Specify communications requirements

Define requirements

- Define eligibility for VGI participating in products and programs (e.g., minimum size requirements).
- Define the technical requirements for VGI resources participating in the products and programs such as interconnection, metering and telemetry, or operation under abnormal conditions, (e.g., stop charging standards under low frequency conditions).

The goal is to define the requirements for VGI participation in state products and programs and to define VGI resources as participants in them.

Clarify settlement

- Define billing processes
- Define enrollment processes and eligibility
- Define penalties and payment mechanisms

Clarify settlement

- Define settlement processes by which VGI resources can get paid (or pay) for services. This might entail the review and evolution of current products and programs or the development of new products or programs, depending on the ability of VGI capability and on VGI-eligible products and programs.
- Define how VGI participants get paid for their services.

The goal is to define settlement associated with VGI including how customers get paid for VGI services and how a customer pays for services associated with VGI.

Define verification and conflict resolution protocols

- Review and define conflict resolution processes specific to VGI
- Review and define verification processes specific to VGI

Define verification and conflict resolution protocol

- Review verification processes (and associated requirements) and conflict resolution processes to assess needs for VGI. Define them as specific to VGI-type resources.

The goal is to define verification and conflict resolution protocols.

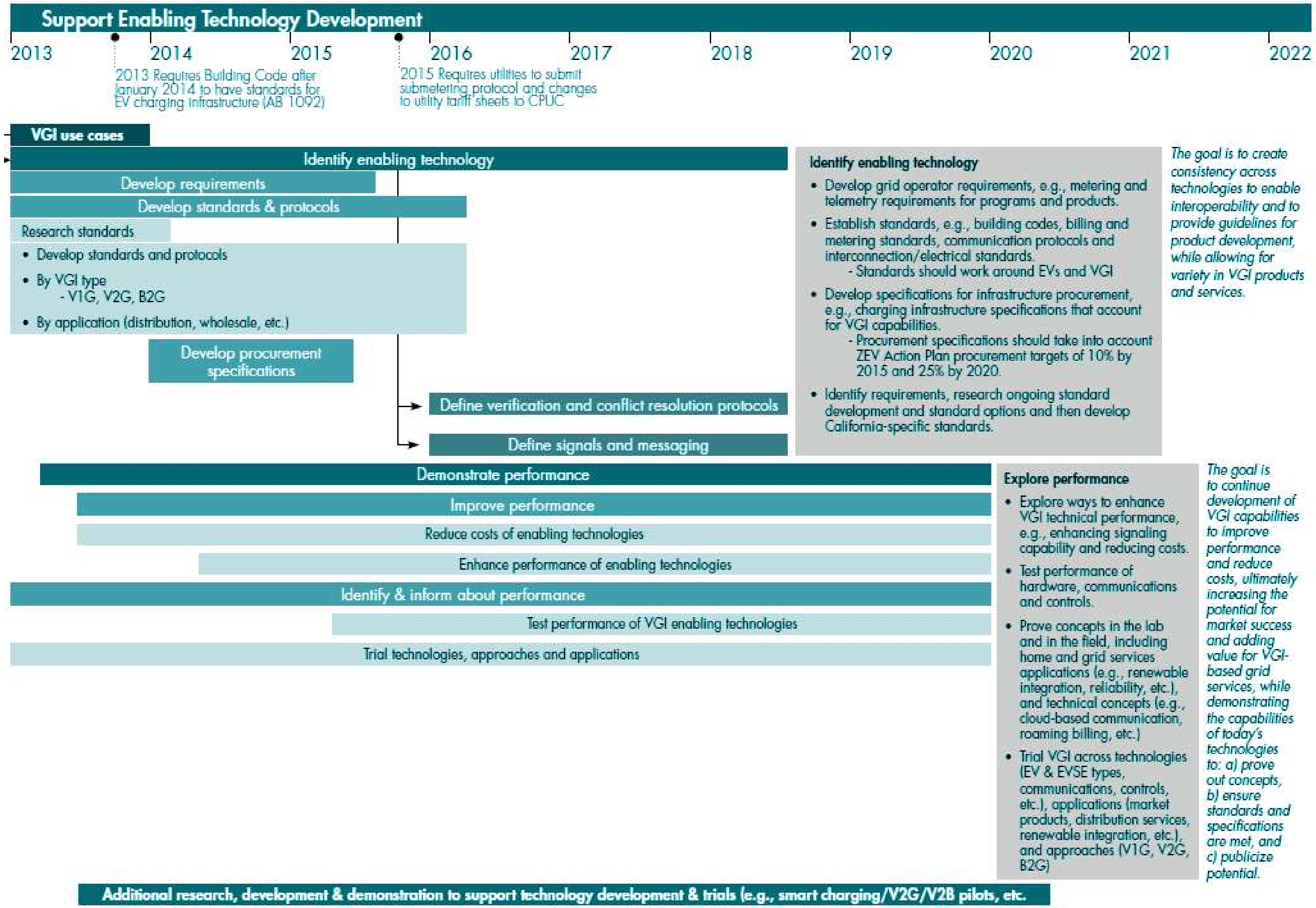
Define signals and messaging

- Define signals for charging and discharging by VGI-eligible product and program

Define signals and messaging

- Explore and define the eligible signaling and messaging processes between VGI participants, and product and program operators.

The goal is to define signals and messaging specific to the programs and products enrolling VGI services.



- Develop standards and protocols
- By VGI type
  - V1G, V2G, B2G
- By application (distribution, wholesale, etc.)

Identify enabling technology

- Develop grid operator requirements, e.g., metering and telemetry requirements for programs and products.
- Establish standards, e.g., building codes, billing and metering standards, communication protocols and interconnection/electrical standards.
  - Standards should work around EVs and VGI
- Develop specifications for infrastructure procurement, e.g., charging infrastructure specifications that account for VGI capabilities.
  - Procurement specifications should take into account ZEV Action Plan procurement targets of 10% by 2015 and 25% by 2020.
- Identify requirements, research ongoing standard development and standard options and then develop California-specific standards.

The goal is to create consistency across technologies to enable interoperability and to provide guidelines for product development, while allowing for variety in VGI products and services.

Explore performance

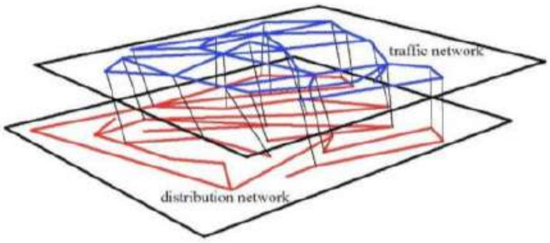
- Explore ways to enhance VGI technical performance, e.g., enhancing signaling capability and reducing costs.
- Test performance of hardware, communications and controls.
- Prove concepts in the lab and in the field, including home and grid services applications (e.g., renewable integration, reliability, etc.), and technical concepts (e.g., cloud-based communication, roaming billing, etc.)
- Trial VGI across technologies (EV & EVSE types, communications, controls, etc.), applications (market products, distribution services, renewable integration, etc.), and approaches (V1G, V2G, B2G)

The goal is to continue development of VGI capabilities to improve performance and reduce costs, ultimately increasing the potential for market success and adding value for VGI-based grid services, while demonstrating the capabilities of today's technologies to: a) prove out concepts, b) ensure standards and specifications are met, and c) publicize potential.

Annexure 6: Locational planning case studies

Case study- Charging Station and Power Network Planning for Integrated Electric Vehicles - New York data[28]

Overview of the model: The research considers the charging stations as both traffic service facilities and common electric facilities and hence a multi-objective model is built with the objectives of maximizing the captured traffic flow in traffic networks and minimizing the power loss in distribution networks.



In case studies, a 33-node distribution system and a 25-node traffic network are used to juxtapose and determine optimal charging locations.

The research was done using traffic flows to simulate the charging demand with an interception model and considering some restrictive factors, such as the maximum travel distance of EVs. The objective is to choose appropriate nodes for constructing charging stations, aiming to maximize the traffic flow (to provide a charging service for more users) as well as appropriate locations of the distribution network.

Methodology used for modelling: A fuzzy multi-objective model is proposed to deal with the two objectives, and the genetic algorithm (GA) is used to find the optimal solution. The overall objective is to maximize the captured traffic flow in the traffic network and minimize the power loss in the distribution network.

Key assumptions in the modelling

1. In the indicate traffic map, analysis revealed that the driver travel destination was concentrated in a few popular places. In practice, the daily routing of most vehicles is fixed. The traffic network is composed of these traffic flows.
2. EVs cannot deviate from their shortest path
3. Two types of charging facilities are considered in this model: normal charging stations and fast charging stations. Normal charging stations operate 24 hours a day, and fast charging stations only operate during rush hours to relieve charging pressure. The size of the fast charging station (FCS) is determined by the mean arrival rate, service demand, and demand
4. Charging behavior limitations:
    - Fast charging: The FCS is important in providing electricity for EVs during peak demand hours. The service of FCSs is based on a first-come first-served (FCFS) rule signifying that the waiting time for EVs that have just arrived is determined by the mean arrival rate. The objective is to minimize the size of FCSs to decrease the cost of construction as well as cater to the charging demand

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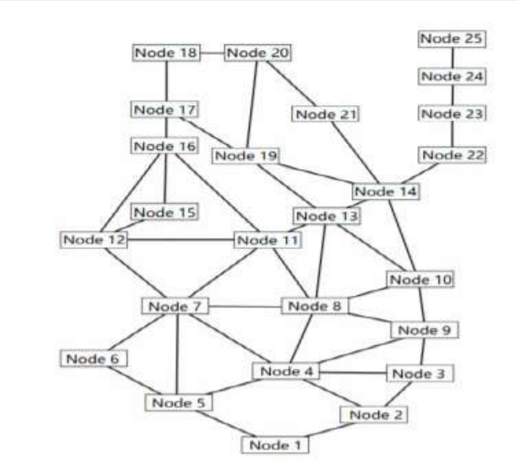
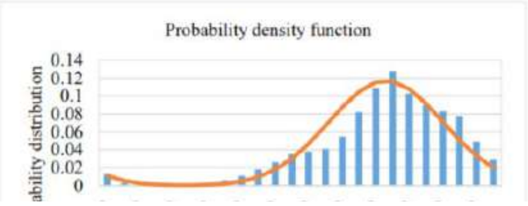
[28] *https://www.mdpi.com/1996-1073/12/13/2595*

- The capacity of charging stations should not be less than the requirement of the maximum load
- Only one type of charging station can be built at a node
- Considering the shortage of urban land resources, the number of charging poles should be limited to avoid the waste of idle resources

5. Distribution network assumptions: The power at each node and the power flow on each branch should not be greater than the limits of the distribution network to avoid damage to power grids.
6. Number of charging stations to be placed: four
7. Importance of each traffic node is set according to the degree of demand at each traffic node

Traffic network	Distribution network
	

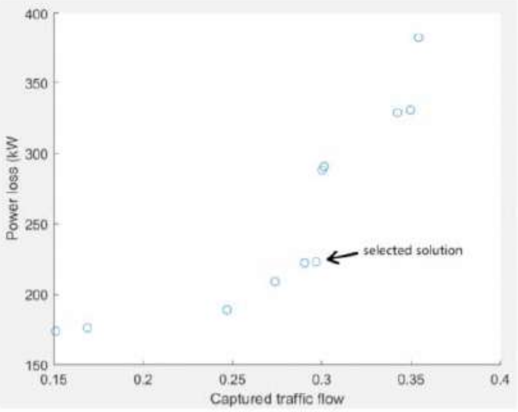


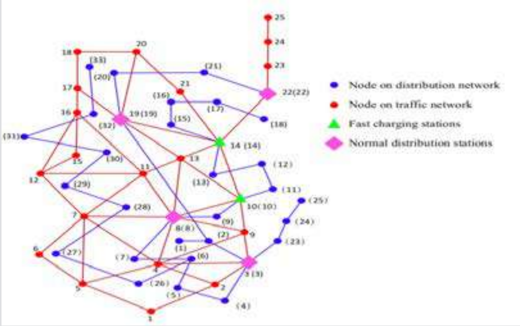
As per the survey mentioned in the research, 14% of household vehicles were unused, 43.5% travelled for 20 miles a day (about 32 km), and 83.7% travelled for 60 miles a day (about 97 km). By observing two groups of data, the ending time of the last trip is found to satisfy a normal distribution, and the daily driving distance is found to satisfy a logarithmic normal distribution. The probability density function of the ending time of the last trip and driving distance is shown alongside:

The EV selected for the case study is the Toyota RAV4. Key parameters assumed are as follows. Battery size of 27 kWh and average range: 150 km

Simulation and results: The multi-objective model is built with objectives maximizing the captured traffic flow and minimizing power loss in the distribution networks. As shown in the plots, the abscissa and ordinate values are the captured traffic flow and the power loss, respectively for different placements of charging stations in the network.

The selected solution is the one which ensures a balance between capturing adequate traffic data as well as ensuring optimal power loss in the distribution system. The simulation then produces the most optimal location and capacity of slow and fast charging locations by juxtaposing the traffic and network data as follows:



Location details	Optimized location of Normal and Fast charging stations
Normal charging stations: Station 1- Node 3- 0.3 MW Station 2- Node 8- 0.6 MW Station 3- Node 19- 0.7 MW Station 4- Node 22- 0.7 MW Fast charging stations: Station 1- Node 14- 5 MW Station 2- Node 10- 5 MW Station 3 Station 4 Total captured traffic flow: 47.47% Total power loss: 222.9647 kW	

Key inferences

1. In order to maximize the captured traffic flow, the charging stations are mainly constructed in transport hubs, which have a higher node weight
2. In order to minimize the power loss of the distribution network, the charging stations with a high capacity are mainly constructed on the front end of a system feeder.
3. The model proposed in this paper is based on an assumption that all EVs travel along the shortest path to their destination. In practice, the driving path can be influenced by traffic jams and driver negligence which cannot be adequately modelled.

Annexure 7: EV Managed Charging Case Studies

Managed charging by OEMs

Chevrolet Volt	The Chevrolet Volt offers a special delayed charging mode that can be used to mitigate a timer peak. The driver programs the desired departure time, and the vehicle calculates when charging should begin in order to be fully charged by that departure time. This particular program randomizes the start of charging, so if a number of similar vehicles employed the technology, their charging loads would be distributed as desired.

Case study - EV charging pattern analysis

FleetCarma[29] offers a connected car platform and cloud-based software system. The connected car platform not only offers real-time insights into driving and charging behavior for fleets, but can also be provided to residential EV owners as part of a utility EV load management program. The platform can also be used by utilities to understand the potential impacts of EVs on the grid and help with load forecasting as EVs scale across their service territory.

Various utilities in the US have now signed up for FleetCarma's smart charging services. The implementation will provide the concerned utilities with all the information required to understand the impact of EV charging load in the service territory. Data which is gathered and shared with the utilities includes:

- Profile of EV charging load
- Pinpoint trend of consumption on the grid
- Determine charging load patterns (duration, peak, quantum etc.)

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[29] *https://www.fleetcarma.com/smartcharge/utilities/*

Key aspects of this system include the following:

Particulars	Details
Participating utilities	• Con Edison Company of New York • Tennessee Valley Authority • Tacoma Public Utilities • Duke Energy Florida • Lincoln Electric System
Objective	To collect charging information for EVs and Plug-In Hybrid Electric Vehicles (PHEV) in the service territory. Results of the study will help the utilities better understand how EVs affect the electric system
Study period	1-2 years
Incentives to participants	Participating customers may receive up to $250 per year for a maximum of $500 over the study
Eligibility	• Participants must be a residential customer • Must own or lease a fully battery electric vehicle or plug in electric hybrid, and own their own EV charging equipment.
Registration	• Participants will first register at registration website post which they would be given a FleetCarma C2 device with instructions for installation and how to activate the C2 device. • The device can be plugged into the vehicle's onboard diagnostics (OBD II) port or Tesla diagnostics connector. The OBD II port is typically located below the steering wheel and is the same port mechanics use for diagnostic checks. • Charging data will be continuously relayed to the utility through this device.
Information collected	Charging session duration, energy consumption, location, trip duration and distance travelled.
Eligible auto OEM vehicles	Audi, BMW, Chevrolet, Fiat, Ford, Hyundai, Nissan, Tesla, Toyota, etc.

Source: fleetcarma

Managed charging by Utility – OEM partnership

OMEs are also entering the managed charging space primarily through existing smart vehicle communication systems, such as GM's OnStar, or through utility pilot programs. Some case studies of the same are highlighted below:

Case study - BMW and Pacific Gas & Electric[30]

Project overview	
Eligible participants	BMW i3, i8 or iPerformance drivers in the San Francisco Bay Area
How does it work	Charging will be optimized by BMW's intelligent charging software, with commands sent wirelessly to each participating BMW vehicle. No physical modifications would be required.

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[30] *https://www.bmwchargeforward.com/#/home*

Project overview	
Intelligent charging	Key factors evaluated include: 1. Departure time of the EV 2. State of charge 3. Rider preference 4. Prevailing grid conditions If an e-mobility charging event occurs or in other words, a demand response signal is sent and the customer chooses not to participate, they will have the ability to "opt out" of the event, to allow for immediate vehicle charging. That vehicle remains "opted out" until the next time the owner plugs the vehicle into a charger.
Incentives	$300 at program launch and two additional same payments in 2018 and 2019.
Pilot implementation	The California Energy Commission awarded grant to BMW to research the benefits and opportunities that may result from shifting vehicle charging over time to meet the needs of the grid, while prioritizing each driver's expressed mobility need
	Phase 1 • BMW enrolled 96 Model i3 drivers and utilized proprietary aggregation software to delay charging via cellular (GSM-based) telematics • The drivers were provided with a L2 charging station at their homes and directed to charge primarily at home during the pilot • During the 18-month trial, the vehicles were called upon 209 times. BMW met the performance requirements for 90% of those events, **Phase 2** • It expanded to over 350 participating vehicles and focused on the customer experience by giving users more managed charging information to make smart choices • PG&E provided BMW with data on the status of renewable energy generation as well as excess supply on the system, and BMW optimized the EV charging by sending push notifications to participating drivers. • Because the vehicles are controlled using on-board vehicle telematics, a vehicle can participate regardless of where it is currently charging

Case study - IBM, Honda, and PG&E

Project overview	
Aim[31]	To demonstrate and test an electric vehicle's ability to receive and respond to charge instructions based on the grid condition and the vehicle's battery state
	This demonstration combines grid and vehicle data to create an individualized charging plan for Honda's Fit EV battery electric vehicles (BEV), using IBM's cloud-based software platform. By utilizing the existing in-vehicle communications system in the Honda Fit EV, the EV can interact with utilities and the grid, creating a direct channel for sending and receiving usage information that could improve local grid management.

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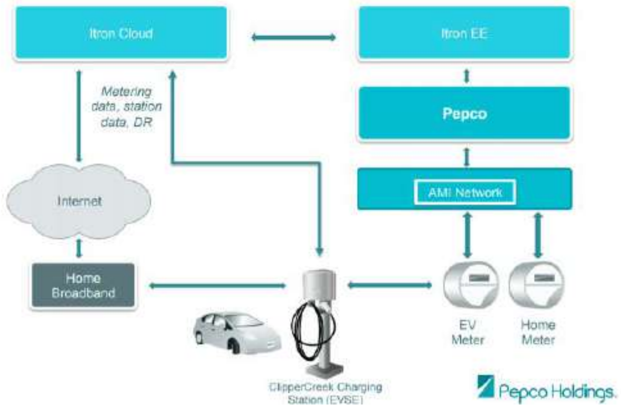
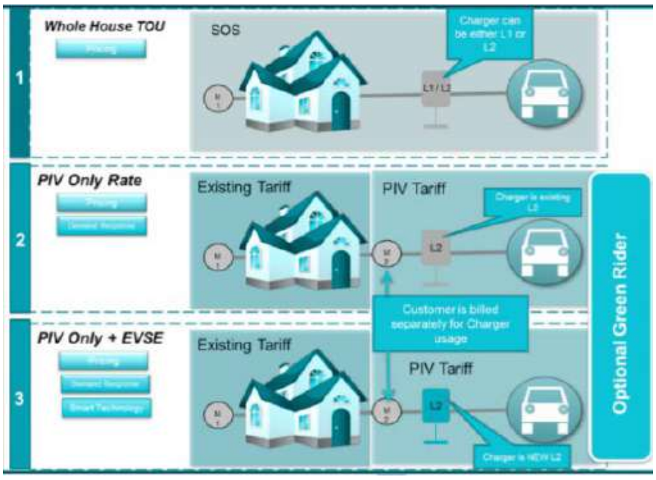
[31] *https://www-03.ibm.com/press/us/en/pressrelease/37398.wss*

Project overview	
How it works	• Once plugged into a charge post, the Honda Fit EV initiates a charge request via the vehicles telematics system, an integrated telecommunication application that is often used for navigation. • This request is sent to IBM's EV Enablement Platform where vehicle data such as location, battery state of charge and grid data, as received from PG&E, is combined to create an optimized charge schedule for the corresponding vehicle. The same is then communicated back to the vehicle in seconds. • Using this aggregated data, the vehicle has the intelligence to charge to the level that is needed while factoring any current grid constraints. • The IBM EV platform can collate historical EV charging data and create a profile that can be used to forecast the location and duration of EV charge loads. For example, the program can determine how many EVs are plugged in one neighborhood and the time it will take for each to reach a full charge. This allows PG&R to optimize grid operations and help reduce the chance of outages
Communication platform and other features	• The IBM's cloud-based platform also provides charge post location information and availability directly to the EV, using the telematics and Satellite-Linked Navigation to guide the driver to the most convenient place to charge. • The smartphone app shows the vehicles battery level, range of travel distance, vehicle location, and current energy costs in real time.

Case study-Pepco utility



Pepco, in the Maryland/Washington D.C. area, tried a residential managed charging pilot, placing 35 ClipperCreek chargers using an Itron smart charging architecture that could respond to DR events. The pilot used smart chargers with Itron meters, which worked alongside the utility's AMI for the charge point. Pepco signed up 101 customers in the pilot



Two rate structures were introduced by PEPCO:

- With the whole-home rate, which included one retail tariff for the entire home.
- Separate tariff for home and EV-specific rate. Peak charging tariff was about 23 cents/kWh. Off-peak rates dropped to 5 cents/kWh.
- Within the EV-only rate, a "green rider" was introduced by Pepco. Over 30 consumers opted for this option which allowed them to pay $2 cents/kWh extra for their energy. About 30% of

customers in the EV-only rate opted to pay slightly more for the cleaner power.

When Pepco called a DR event, they reduced the chargers from Level 2 to Level 1 rate of charge for an hour, while also providing opt-out capabilities for customers. The small scale of the residential pilot limited results with respect to customer choices and cost savings When assessing the economics of the pilot, Pepco found that that the ongoing costs of the communications link were too expensive. Identifying a cheaper solution would increase the viability of future projects.

Pepco deployed 50 smart chargers and reported that the DR programme was successful. The utility said that during days when there was a need for curtailment, charges were turned down from Level 2 to Level 1 capabilities for an hour only. The pilot successfully demonstrated "active" incentives (demand management) towards off peak charging, while providing the customer "opt out" alternatives

Case study – Aggregation

Marin Clean Energy (MCE), a Community Choice Aggregator in the US, found that it had an estimated 4,000 EV customers in late 2016 and forecasted a total of 25,000 EV customers by 2020. In response, MCE announced a private-public partnership to provide a $150 discount on new smart-grid enabled EV charging stations. Customers with existing EVSE were eligible for a free adapter that would upgrade their EVSE to be controlled via a smartphone app. Given the long-term projected demand, MCE used the eMotorWerks JuiceNet platform to manage the deployment of these chargers to better respond to grid load and pricing conditions to and thus "avoid grid bottlenecks and lower electricity procurement costs."

JuiceNet is a patented communication, control, and intelligence platform that dynamically matches drivers' historical charging patterns, real-time input and signals from grid operators and utilities to aggregate and manage charging station demand. Employing open APIs, JuiceNet can control any WiFi connected charging station and coordinates periodic, changes in charge rate and timing, which the driver can override at any time.

By deploying both smart-charging Electric Vehicle supply equipment (EVSE) and cloud software solutions on a commercial scale, electric car and truck fleet owners as well as workplace and commercial real estate facility managers can:

- Remotely manage fleets of chargers at various locations from a single cloud dashboard;
- Maximize EV charging capabilities on their properties, helping to keep costs to electrical building upgrades low; and
- Enjoy new revenues as well as offset costs from participating in energy service programs such as demand response.

Key features:

1. Through the dynamic load balancing control of the JuiceNet Enterprise solution, EV owners can install more stations on their property without costly electrical upgrades to their building infrastructure, balancing the charging load in real-time to match site electrical capacity.

1.1 Case study – Los Angeles

The Los Angeles Department of Water and Power (LADWP), through its "Charge Up L.A.!" program, offers up to $500 for Level 2 residential chargers or $4,000 for commercial chargers. As a condition of the rebate program, recipients must agree to participate in LADWP's demand response program for the life of the installation in the event the utility needs to curtail that load. Further, LADWP can disconnect the load from the EV charger for the duration of the event without notice.

1.2 Case study- Managed charging for bidding in CAISO

eMotorWerks, which developed a Vehicle Grid Integration platform called JuiceNet, has its own smart grid enabled JuiceBox EV charger, and provides JuiceNet platform capabilities to five other Electric Vehicle Supply Equipment (EVSE) manufacturers. Additionally, eMotorWerks has started deploying its platform to control vehicle charging directly over the telematics link with select OEMs. By controlling how and when large quantities of EVs charge throughout the day, eMotorWerks can bid that capacity into wholesale power markets such as the California Independent System Operator (CAISO), use it to balance renewable generation, or provide traditional DR services to the utilities, while observing driver behaviors and allowing driver override to avoid customer dissatisfaction.

1.3 Case study- New York-EV Connect

Partnership with VGI platform providers
EV Connect, a leading provider of EV (EV) charging solutions, including development of the industry's most innovative, robust and open cloud-based software platform for managing the EV charging ecosystem, was awarded a $4 million contract from the New York Power Authority (NYPA) to install and manage approximately 300 additional Level 2 EV charging stations throughout New York State. This follows a contract that NYPA awarded to EV Connect for a public charging station pilot program within the State. EV Connect provided management of the charging ecosystem, which includes the charging stations, host locations, electric utility interaction and the driver experience.

For this expanded program, EV Connect partnered with GE and EV Box to provide the charging stations, and local contractors for installation work. EV Connect was also entrusted with activities such as initial site assessment, to recommending the right charging stations to fit the need, installation, on-boarding/training utility administrators and configuring admin portal with utility preferences. EV connect also provides on-going care and management 24/7.

EV Connect's EV Cloud is currently used by NYPA to manage charging stations from multiple station manufacturers who apply both OCPP and proprietary cloud protocols. EV Connect's platform provides NYPA with access to its OpenADR Virtual End Node (VEN) to manage charging loads throughout its territory regardless of station manufacturer, type, or protocol. The platform architecture can also manage dynamic pricing signals, load aggregation, carbon credit monetization, data analytics, and other features and functionality required by other industry stakeholders.

Key inclusions in EV charging as a service

- Site Planning
- General Electric EV Charge Station
- Base EV Connect Management Software for managing EVs
- 24/7 Management Services
- Maintenance

Additional options

- Enhanced EV Connect Software by Industry or Application
- Custom Branding for the Charge Stations
- Installation
- >3 Year Term Packages

Overview of the EV cloud platform

The EV Connect management system is consisted of a cloud-based network that communicates with the charging station, driver mobile app, site host portal, and utility. Communication from the EV Cloud to the stations is either via OCPP or a cloud-to-cloud integration. The platform can manage an unlimited number of geographically dispersed charging stations and provides the following features:

- **Charge point management and operation:** The platform can manage chargers and sessions remotely, letting the user to monitor and adapt charging sessions based on up-to-date analytics. Chargers can be connected via an M2M connection to the Microsoft Azure cloud-based platform, which supports open protocols such as OCPP, OCPI and OSCP. Utility can also input remote commands including start/stop charging, unplug connector, remote firmware updates or change charger configuration and access a live KPI dashboard.

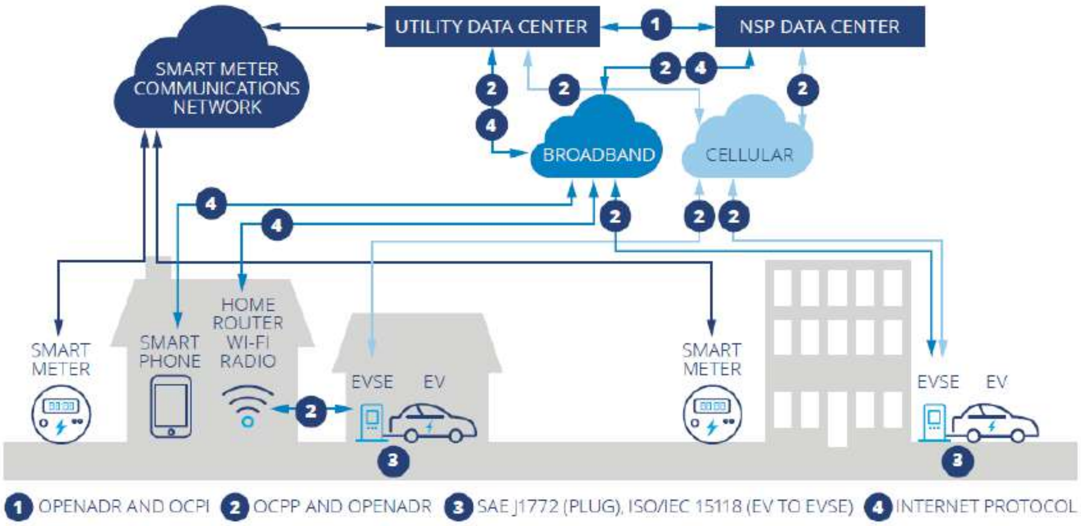
- **Smart charging:** Smart Charging through the EV cloud uses algorithms to manage EV charging sessions. Thus the utility can smartly balance between the supply of power and available grid capacity and the demand for energy for charging the cars.

- **Price control:** Set pricing policies unique to different stations, station groups, locations, and drivers. Some of the pricing policies include: charging per kWh, per connected time, per charging time, etc.

- **EV-driver app and interactive map:** The EV connect can helps drivers find and monitor the perfect charge point; charge and pay with your app; see exactly how fast, how much and at which rate the car is charging etc. The platform also provides users information of health of charging stations, geographical locations and real-time availability.

- **Insights and Reporting:** The dashboard gives detailed insights on historical charging station data analytics, session data, energy usage, utilization by station or driver, and more.

Annexure 8: Use of open protocols in managed EV charging



The scenario above illustrates managed charging network communication interface options. The transport layer is illustrated in two scenarios, one using cellular for the home and the other using broadband for a workplace program. The scenario also illustrates how multiple messaging protocols may be layered between the EV, the EVSE, and the aggregator, which can be leveraged for different purposes. This diagram demonstrates complexity of managed charging ecosystem. There are currently no industry-wide standards for the entire "ecosystem" of information exchange and communication, which is an obstacle the industry, is currently working to solve. Most of the managed charging debate today is related to which messaging protocols to use in charging equipment. Many industry stakeholders are advocating for open, non-proprietary communications messaging protocols to reduce the cost of managed charging implementation and prevent future stranded assets.

In a report, California Public Utilities Commission (CPUC) does not require the use of a single protocol but provides an elaborate discussion on two standards in particular, ISO/IEC 15118 and IEEE 2030.5 (SEP 2.0). Some details on these standards and some other standards is mentioned in the figure below

Standard	Description
OSCP 1.0, OCPP 1.5, OCPP 1.6, OCPP 2.0	The Open Charge Point Protocol (OCPP) and the Open Smart Charging Protocol (OSCP) were developed by the members of the Open Charge Alliance and are an open protocol for communications between charging points and the EV charging network administrator. These protocols provide charging station owners the option of changing EV charging network administrators without stranding equipment assets. The OSCP acts between the charging station and the energy management system, can provide 24-hour prediction for local available capacity, and fits charging profiles to grid capacity. OCPP 1.6 includes smart charging support for load balancing. The most recent version, OCPP 2.0, includes support for ISO/IEC 15118 (among other things). Although not yet formalized as a standard and managed by a recognized standards defining organization (SDO), there is significant adoption of the OCPP protocol and efforts are underway to develop it into a full standard within the IEC.

Standard	Description
OpenADR 2.0	The Open Automated Demand Response (OpenADR 2.0b is the most updated version) standard is currently managed by the OpenADR Alliance, and provides an open and standardized way for Virtual Top Nodes (e.g., electricity providers and system operators) to communicate with various Virtual End Nodes (e.g., aggregators, EV charging network operators, etc.) using a common language over any existing IP-based communications network. Originally developed as a peak load management tool, it has since expanded to include other DERs. Messaging protocols such as OpenADR can also be used in combination with other protocols, such as those used to communicate between a charging station and a network operator (e.g., OCPP76, IEEE 2030.5, etc.).
ISO/IEC 15118	ISO/IEC 15118 (also referred to as "OpenV2G"), enables the managed charging functionality in an EV, such as optimized load management. More specifically, it specifies the communication between the EV and the EVSE and supports the EV authentication and authorization (also known as "Plug & Charge"), and metering and pricing messages. Version 2 is currently under review with the final version anticipated by mid-2020 that will include V2G.
IEEE 2030.5/ SEP2.0	IEEE 2030.5 (formerly Smart Energy Profile 2.0 or SEP2.0), is an application layer protocol that defines messages between any client/server. Pricing, demand response, and energy use are among the types of information that can be exchanged using the protocol and can integrate a wide variety of DER devices, including EVs and EVSE.
IEC 63110	IEC 63110 is an international standard defining a protocol for the management of EV charging and discharging infrastructures. It is part of an IEC group of standards for electric road vehicles and electric industrial trucks, and is assigned to the Joint Working Group 11 of the IEC Technical Committee 69. At the date of publication it was still under development

Annexure 9: Cost Recovery and Rate Structures.

Cost Recovery Process for Network Upgrades – Department of Public Utilities in US

Utility	Proposed Investment	Approved Cost Recovery Mechanism
National Grid (Massachusetts)	Grid Modernization Plan (GMP) investments as proposed by national grid has the following four main components: 1. Field deployment: • Advanced metering infrastructure ("AMI") • Customer load management (load control switches, smart thermostat etc) • Advanced distribution automation • Volt/Volt-ampere reactive optimization ("VVO , including capacitor banks, voltage regulators, transformer tap changers etc) • Feeder monitors (Power monitoring device) 2. Enabling infrastructure: • Advanced distribution management system, SCADA, Information/operational technology, billing systems. • Cybersecurity and workforce training. • Asset management, and marketing, education and outreach 3. Distributed energy resources (voltage ground fault protection and direct transfer trip protection) 4. Research development and deployment (targeted inverter conversion, high density community energy storage, short term renewable forecasting, DC to DC charging, fault location analysis, a sensor analytics development program, and analytics for asset management) National Grid has proposed three investment scenarios with a timeline of five years: 1. Balanced Plan : $792.9 million 2. AMI-Focus: $619.6 million. 3. Grid-Focus: $584.6 million. 4. Opt-in: $ 238.6 million.	Department of public utilities (DPU) has approved the utility to recover cost for grid modernisation through a short-term targeted cost recovery mechanism Key steps taken by regulator and utility: 1. Proposal: National Grid submits a five year timeframe investment proposal(s). 2. Preauthorisation: DPU preauthorizes investments for a specific period (three years) with a spending cap ($82 million-NG, $45 million- Eversource) and selected components: • VVO, • advanced distribution automation, • feeder monitors, communications, and • Information/operational technologies, ADMS). 3. Deployment: Preauthorisation is an approval by DPU for National Grid to go ahead with investments. 4. Proof of benefits: During cost recovery approval, National Grid has to showcase that the assets are in use and beneficial to customer. 5. Expense approval: Capital investments will be eligible for inclusion in base rates after DPU has approved final cost recovery in a grid modernization proceeding at the end of three-year term. 6. Final Recovery: Post approval, National Grid shall collect DPU approved grid modernisation expenses and revenue requirements from ratepayers using a volumetric rate. A distribution revenue allocator is used to allocate cost to each rate class. **Note:** 1. Under GMP, National Grid can only recover cost of investment for new technologies relative to its current investment practices. It should be with a purpose to accelerate progress in achieving grid modernisation objective.
Eversource (Massachusetts)	Proposed EV research and demonstration projects initiative, which includes investments of $45 million for development of EV charging infrastructure. Key components of make-ready infrastructure is as follows: 1. Distribution primary lateral service feed; 2. Necessary transformer and transformer pad 3. New service meter 4. New service panel 5. Associated conduit and conductor necessary to connect each piece of equipment	

Source: Department of Public Utilities, Massachusetts

Rate Structure for EV charging in US:

Utility/Program	Number & Type of EVSE	Market Segment	EVSE Ownership	Rate Structure
Kansas City Power & Light Clean Charge Network	Level 2 with 15 DCFC stations provided by Nissan	Municipally-owned locations	Utility ownership, installation, O&M	Free charging provided by city for first two years
Avista EVSE Pilot Program	265 stations: 120 residential Level 2, 145 non-residential Level 2 chargers, 7 DCFC	Workplace, fleet, MUD, public	Utility ownership	Residential Level 2 charging added to monthly bill; public Level 2 host sites to determine rate charged in coordination with utility; $0.30/minute for DCFC use
Georgia Power Get Current Program	Over 550 Level 2 and DCFC already installed	Workplace, residential	Utility ownership, O&M	$0.25/minute for DCFC charging; $1/hour for the first 3 hours and $0.10/minute thereafter for Level 2 use; TOU rates available to residential PEV owners
Austin Energy Plug-In Everywhere Network	Over 250 charging stations currently in network	Workplace, MUDs	Host site ownership, installation and electricity costs; utility provides maintenance	$25 for unlimited charging with 6-month membership, or $2.00/hour; residential TOU pricing with $30 fixed cost
Green Mountain Power EVgo Network	20 Level 2 stations and 11 DCFC stations installed as of early 2016	Municipalities	Municipality ownership, O&M, electricity costs	EVgo pricing options
Southern California Edison Charge Ready Pilot	Phase I: 1,500 charging stations; Phase II: 30,000 stations	Workplace, MUDs, public/retail, 10% DACs	Host site ownership, O&M, electricity costs	TOU rates as applicable, subject to change based on Phase I result
SDG&E Power Your Drive Program	3,500 Level 2 stations	50% Workplace, 50% MUDs, 10% DACs	Utility ownership, O&M, host site pays electricity costs	Rate-to-Driver or Rate-to Host pricing options, host site participation fee
PG&E Smart Charge and Save Program	7,500 Level 2 stations	50% Workplace, minimum 20% with 50% goal MUDs, 15% with 20% goal DACs	Utility ownership, host site O&M and pays electricity costs	Site host can choose between two options: TOU Rate-to-Driver or TOU Rate-to-Host pricing options, host site participation fee

Utility/Program	Number & Type of EVSE	Market Segment	EVSE Ownership	Rate Structure
Massachusetts National Grid EV Market Development Program	Level 2: 600 stations; 1,200 ports DCFC: 80 stations; 80 ports	Long-dwell locations for Level 2 sites; High traffic locations for DCFC sites; 10% of EVSE in DACs	Host site EVSE ownership, O&M for minimum of 5 years after installation	Site host to pay for electricity consumed at charging site at current rate for at least first 5 years and decide how driver pays at station
Massachusetts Eversource EV Infrastructure Program	Phase I: 32 DCFC stations, 1,000 Level 2 ports Phase II: 35 DCFC stations, 3,100 Level 2 ports	Long-dwell locations for Level 2 sites High traffic locations for DCFC sites 10% investment in DCFC sites; 10% of EVSE in DACs	Host site EVSE ownership, O&M for minimum of 10 years after installation	NA
Pacific Power Public Charging Pilot Program	Total of 7 charging "pods" consisting of both dual standard DCFC and Level 2 stations	Pacific Power to choose locations based on proximity to travel corridors, MUDs, other charging stations; proximity to existing electrical network; ease of public access; ease of permitting	Utility ownership, O&M	Pacific Power to develop and implement TOU rates to encourage off-peak charging
Portland General Electric Community Charging Infrastructure pilot	Six new charging sites, each with 4 dual-head DCFC stations and one dual port Level 2 station	PGE to choose locations based on proximity to travel corridors, MUDs, other charging stations and transportation networks; proximity to existing electrical network; ease of public access; cost of real estate; potential installation barriers	Utility ownership, O&M	Proposed two pricing option: monthly subscription for PGE customers or pay-per-use for nonsubscribers

Source: Utility Regulatory Filings and M.J. Bradely and Associates

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About Greening the Grid Program

USAID's Greening the Grid (GTG) is a five-year program implemented in partnership with India's Ministry of Power (MOP) under the USAID's ASIA EDGE (Enhancing Development and Growth through Energy) Initiative. The program aims to support the Government of India's (GOI) efforts to manage the large-scale integration of RE into the grid and combines the following three components which interact with each other.

Disclaimer

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