Electric Grid Integration and Innovation

Resource Management and Climate Protection Committee (RMCP)

October 17, 2018

Together, Building a Better California

Overview

- California Context
- DER Growth
- Streamlining Interconnection Process
- Interconnection / Hosting Capacity Maps
- Incorporating Non-Wires Solutions
- EV Charging Network
- New Pilots

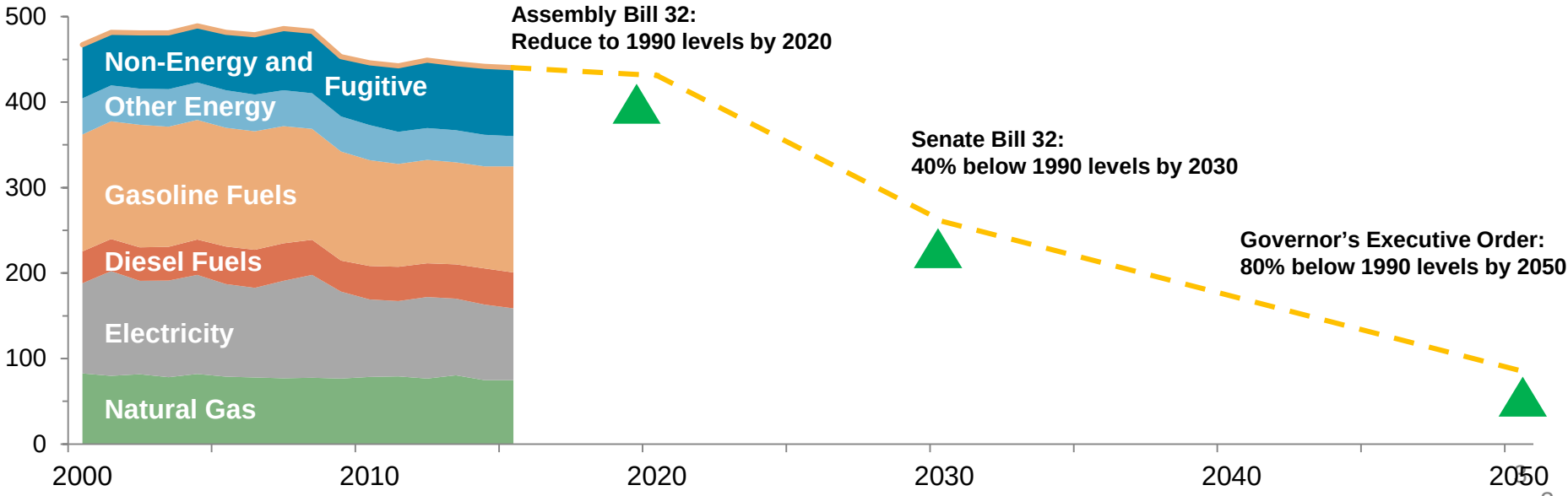
The California Energy Landscape is Changing Rapidly

Drivers of Change

Environmental leadership policies

California Greenhouse Gas emissions targets and historical emissions

Million metric tons CO_2 equivalent



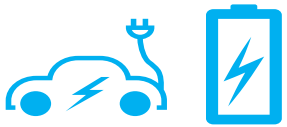
The California Energy Landscape is Changing Rapidly

Drivers of Change

Environmental leadership policies

15¢ / kWh

Rooftop Solar



Rapidly advancing technology

$25,000

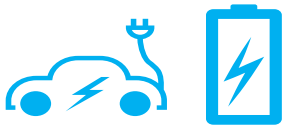
-73% in 6 Yrs.

Lithium-ion Prices

The California Energy Landscape is Changing Rapidly

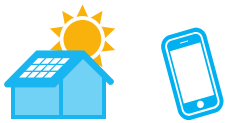
Drivers of Change

Environmental leadership policies



Rapidly advancing technology

Increasing customer choice and engagement



3,500 MW

Customer Solar

180K

Electric Vehicles

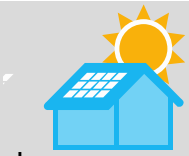
21%

CCA Customers

Sustained Momentum for Clean Energy In California

PG&E Customers lead the nation in clean technology adoption

>380,000 solar customers
Ranked #1 with ~25% of all U.S. rooftop solar



>180,000 electric vehicles
Ranked #1 with ~20% of all U.S. vehicles

800 GWh of efficiency savings
Ranked #2 among U.S. utilities

California is targeting significant clean energy goals

60% renewables by 2030

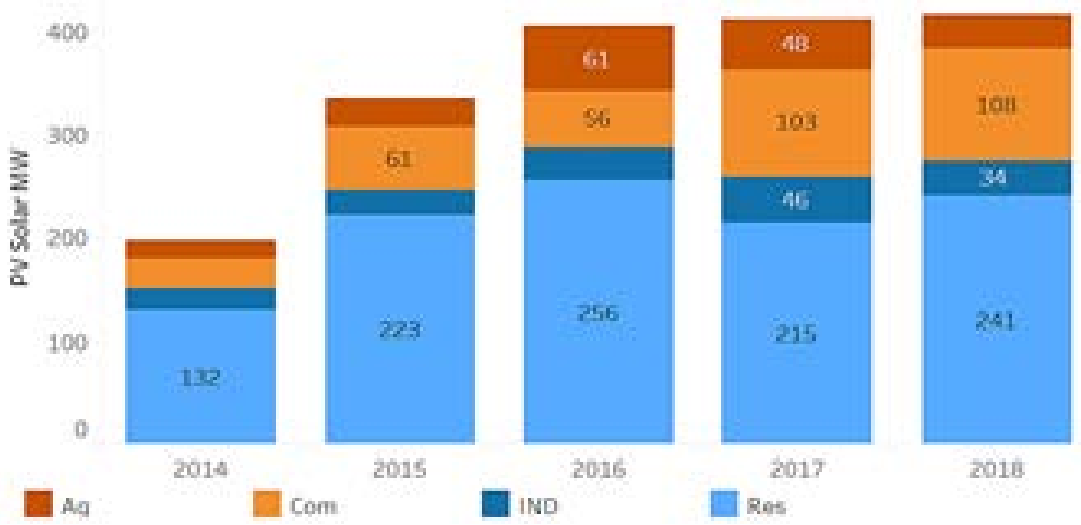
>1,300 MW battery storage by 2024

5 million zero emission vehicles by 2030

2X energy efficiency in buildings by 2030

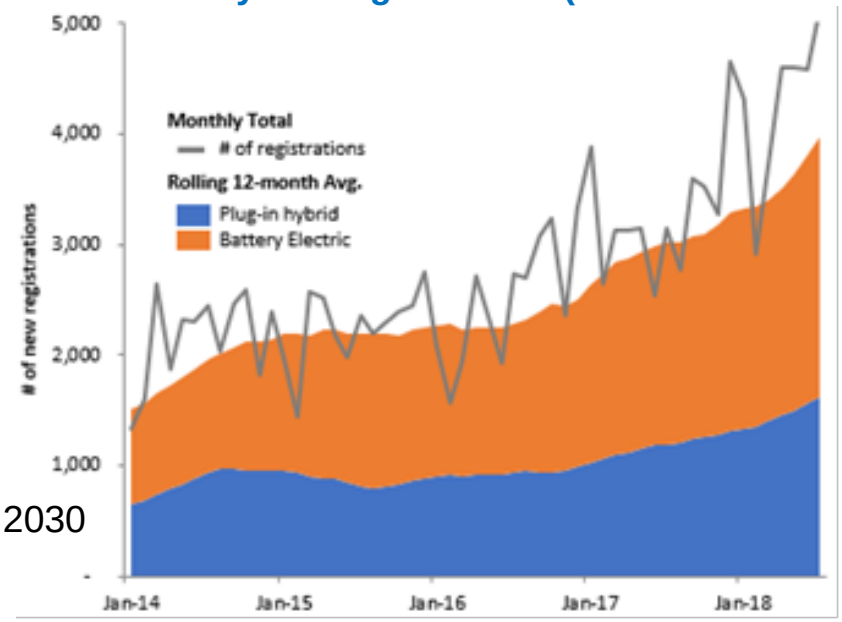
DER Trends Driving Decarbonization and Electrification

Annual PV (MW) Totals by Customer Sector (PG&E Service Area)



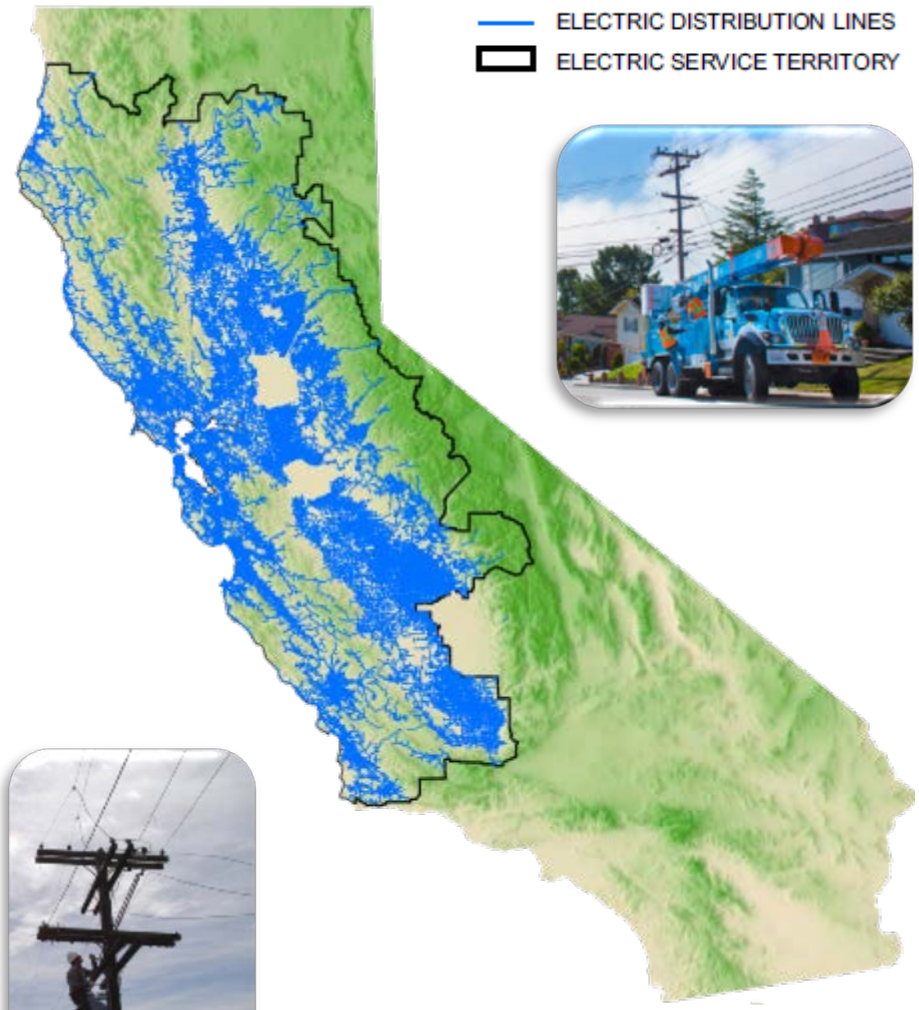
- Interconnected over 3,600 MW of BTM PV
- Interconnected BTM PV at over 380,000 sites

Monthly EV Registrations (PG&E Service Area)



- Over 180,000 EV Registrations (PG&E area)
- 34,455 registrations for 2018 (Year to Date)
- PG&E's goal is to have ~2M Clean Vehicles by 2030

PG&E's Distribution System



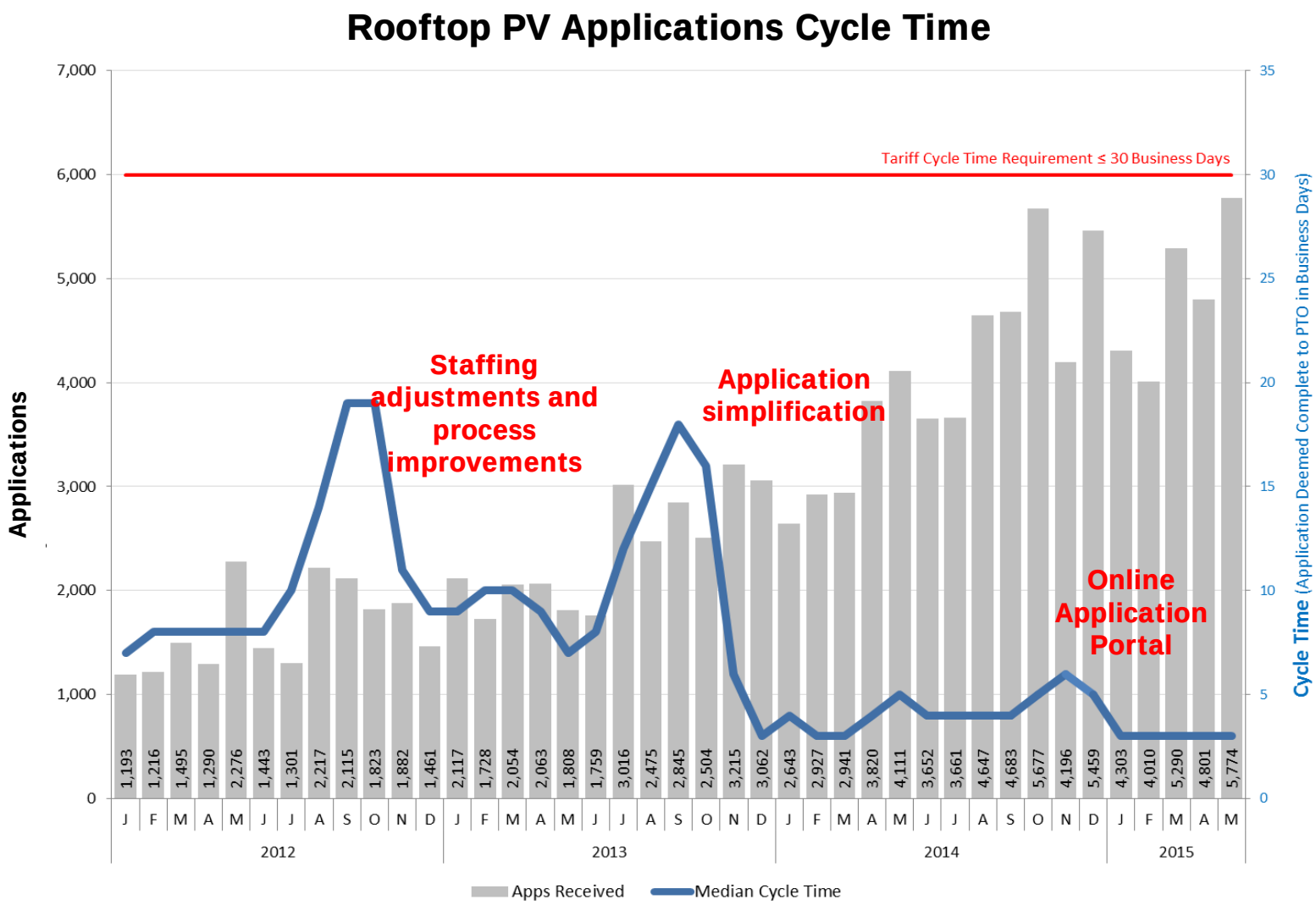
Distribution System Metrics

- **3 Distribution Control Centers**
- **4 Distribution Regions**
  - 245 Electric Planning Areas
  - 70,000 sq. miles with diverse topography
  - 5.5 million electric customers
  - 102,000 miles of distribution lines
- **785 Distribution Substations**
  - 1,300 Substation Distribution Transformers
  - 3,300 Distribution Circuit Breakers
- **3,000 Distribution Feeders**
  - 900,000 Distribution Line Transformers
  - 4.5 Million Nodes/Line Segments Modeled
  - 12,000 Dynamic Protective Devices
  - 150,000 Fuses
  - 2,500 Voltage Regulators
  - 12,000 Capacitor Banks

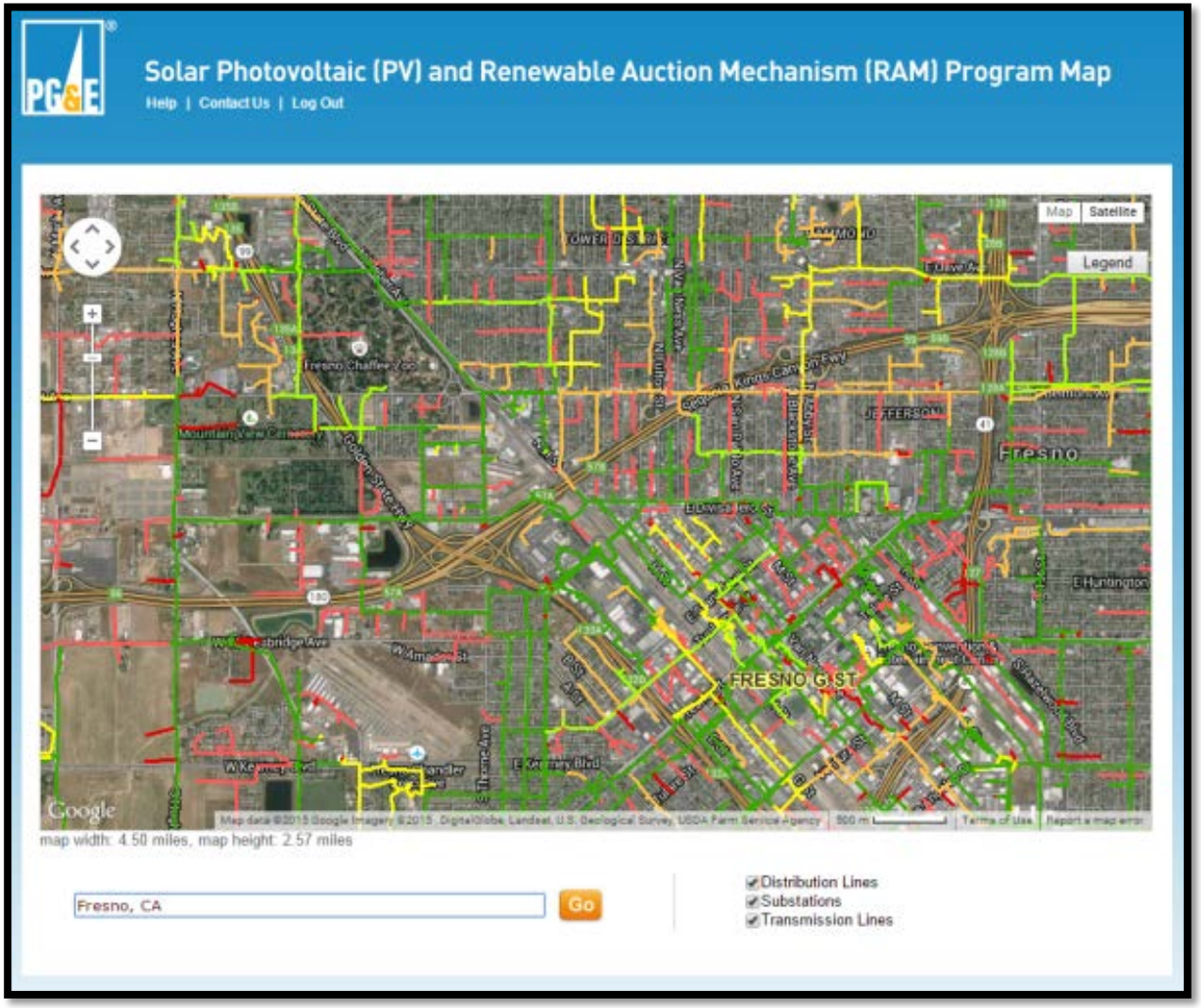
Streamlining the Interconnection Process

Streamlined Interconnection Process

Initiation and Application → Planning and Studies → Interconnection Agreement → Project Implementation → Permission to Operate



Hosting Capacity / Interconnection Maps



PG&E analyzed all three phase line sections for all the 3,000+ distribution circuits

- Results for approx. 102,000 line sections
  - *Average of 34 line sections per feeder*
  - *Largest number of line sections for one feeder was found to be 310*
- Locational results published by each DER type
- Granular down to fuse devices
- Initially colored by PV Results
  - *Line Section IC / Feeder IC*
  - *Red, Amber, Green color scheme with green being higher capacities*

EV Charging Network

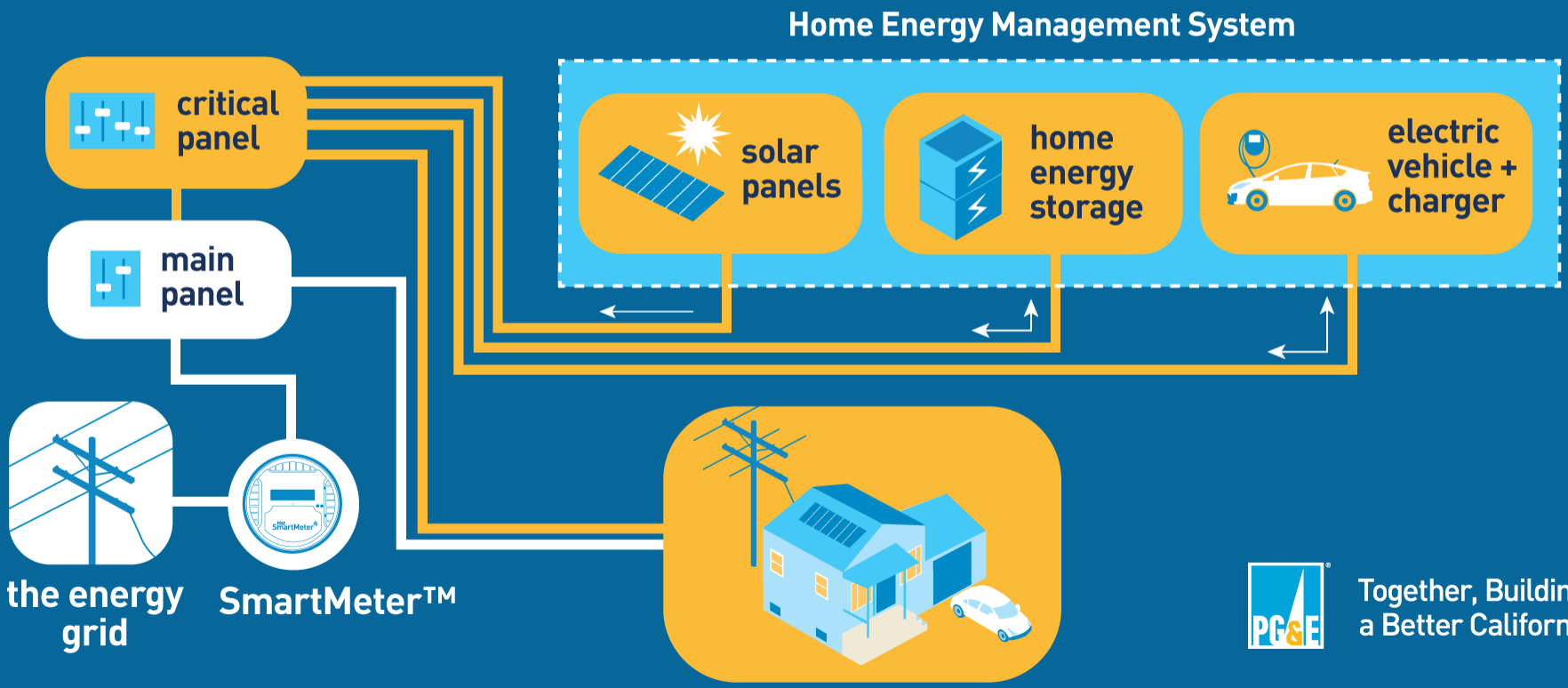
Electric Vehicle Online Interactive Siting Map

- Created on-line interactive map tool, in partnership with UC Davis
- Identified 300 areas with high-need for DCFCs by 2025
- Pinpoints 14,000 potential sites in those areas with local capacity for DCFCs

Vehicle to Home Demonstration

PG&E Tests Innovative Clean Energy Technologies to Power Homes

The project's goal is to better understand how much electricity load a combination of clean energy resources would be able to meet a residential customer's needs in case of a power outage or during demand response events.



PG&E Demand Response Pilot - BMW ChargeForward

PG&E is partnering with BMW to explore the potential for using EV charging as a reliable grid resource without impacting customer mobility

Phase 1 (Complete)

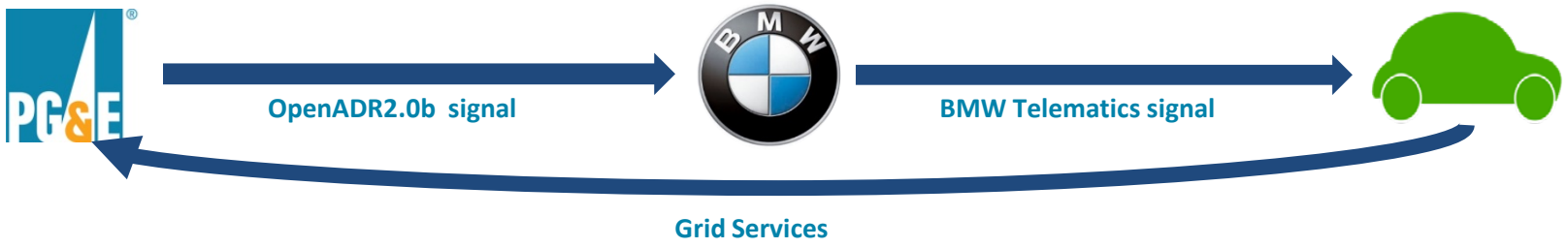
Tests BMW ability to supply 100 kW demand response contract by combining:

- **Electric vehicle charging**
- **"Second life" vehicle batteries**

Phase 2 (On-going till 2019)

Expanded Tests :

- **Longer curtailment events**
- **Optimizing nighttime charging**
- **Increasing Charging in response to excess solar**
- **Shifting charging across grid locations**
- **New messaging to engage customers**



PG&E has proposed to invest $380M in EV infrastructure programs and pilots

EV Charge Network

APPROVED

- 7,500 Level 2 chargers (10-20 chargers per site)
- $130 million; 3 years
- Targeting workplaces and multi-unit dwellings
- Turnkey installation from utility covers most costs; rebate / participation payment for site hosts
- Installations beginning Q1

FleetReady & Fast Charge

PROPOSED

- Make-ready infrastructure for non-light-duty fleets ($211 M) and public fast charging ($22M)
- 5 year deployment sized to meet customer demand
- Additional incentives for disadvantaged communities, school and transit bus fleets
- Proposed decision expected March; Program development after approval

Priority Demonstration Projects

APPROVED

- Three customer/fleet demonstrations to test smart charging and energy storage for MD/HD vehicle technologies:
  - Transit agency
  - Idle reduction (e.g. truck refrigeration)
  - School bus
- Home charger installation information resource
- Project development and implementation in 2018

Additional PG&E Transportation Electrification priorities:

- Rate design for commercial EV charging
- Filing for infrastructure proposal to support state parks and schools
- Ridesharing + fast charging R&D pilot
- Improving EV service connection process

Microgrids

Microgrid interest is growing significantly. A wide range of integrated technical and strategic opportunities are being explored

Primary Drivers

Resilient Energy

Self-reliance

Sustainability

Early customer pull

e.g., Blue Lake Rancheria

Growing community interest

10+ cities expressed interest in building microgrids for resilience at recent ABAG workshop

Increasing policy support from CEC

$70M in grant funding for microgrid projects

U.S. DOE provides the standard microgrid definition. CEC adds two elements focused on critical resources and grid services.

The vast majority of U.S. microgrids are grid-tied[1]. The unique functionality relative to other collections of DERs is the ability to disconnect and re-connect from/to the broader grid during emergencies for enhanced resilience.

DOE Definition

1. *interconnected loads*
2. *distributed energy resources*
3. *clearly defined electrical boundaries*
4. *single controllable entity*
5. *can connect and disconnect from the grid*
6. *operate in both grid-connected or island mode*

CEC Additions to DOE Definition

7. *manage customer critical resources[2]*
8. *provide customers, utilities and grid system operators critical services[2]*

GTMR (2017) and BNEF (2018)[1]; CEC GFO 17-302 (2017)[2]

Microgrids in PG&E Service Area

Vast majority of microgrids are grid-tied

(1) Single-customer facility

Description

- Customer-side of the meter
- Military bases, universities, prisons, commercial facilities/campuses, schools, hospitals

Key Drivers

- Customer Resilience
- Sustainability
- Avoided customer outage costs

Example

- Blue Lake Rancheria (operational)

(2) "Remote"

Description

- Typically utility-sponsored projects, hybrid ownership (e.g., utility-owned distribution assets, customer-owned DG)

Key Driver

- Potential T&D alternative in remote locations

Example

- Angel Island (planning)

(3) Multiple accounts on-grid

Description

- Communities seeking to enable multiple critical facilities to island in the event of broader grid outage and enhance local resilience

Key Driver

- Community resilience

Example

- Arcata Airport community microgrid – EPIC 3.11 site (planning)

Image Credits: Indian Country Media Network; PG&E

Blue Lake Rancheria Microgrid

Blue Lake Rancheria Tribe

PG&E is beginning to integrate more advanced microgrids into the broader energy grid

- Operational community microgrid to provide the tribe and local citizens with life, health and safety support in the event of an emergency
- Powered by 0.5 MW solar, 950 kWh battery storage, biomass fuel cell, and diesel generators
- Developed in partnership with Schatz Energy Research Center, CEC, PG&E, Tesla, INL, Siemens, and others

SCHATZ ENERGY RESEARCH CENTER

CALIFORNIA ENERGY COMMISSION

PG&E

Idaho National Laboratory

TESLA

SIEMENS

Awards

Distributech 2018
DER Integration Project of the Year – Winner

PowerGen International 2017
Renewable Project of the Year – Runner-Up

Platts 2017
Commercial Application of the Year— Runner-Up

EPIC 3.11 Multi-Customer Microgrid at Arcata Airport

Customer Objective: enhanced resilience

SCHATZ ENERGY RESEARCH CENTER

Grant writer
Project developer
EPC

CALIFORNIA ENERGY COMMISSION

Funder: $5-7M
(GFO-17-302 Advanced Microgrids in Support of CA Energy & GHG Policies)

REDWOOD COAST EnergyAuthority

Retail energy provider
Battery owner (2MW/4HR)
Solar owner (2MW)
Local MG Controller Owner

PG&E

Grid owner/operator
Microgrid controls
Microgrid operator in island mode

New DER Pilots Launching in 2018

EPIC 3: New Pilots Launching 2018

	Pilot	Description
3.03	DERMS Advanced Functionality	Leverage DERMs to facilitate enhanced visibility and control of DERs integrated with grid operations
3.04	Blockchain: Multi-Nodal Distributed Digital Ledger	Demonstrate and evaluate blockchain as an enabling technology to address efficiency, accuracy, transparency, and security
3.02	DER optimization in market participation	Build tool to optimized wholesale market participation by DER aggregations, subject to constraints
3.11	Microgrid: Location-Specific Options for Reliability and/or Resilience Upgrades	Evaluate configurations using multiple DER technologies, microgrid controllers, and isolation and protection equipment enabling islanding
2.32	Electric Load Management Ride Sharing	Evaluate grid impacts from EV ridesharing, and assess ability to use demand managements to actively manage load

APPENDIX

Existing Battery Energy Storage Pilots at PG&E

Vaca Dixon

2 MW / 14 MWh NAS Battery
Vaca-Dixon Substation

Project Initiation : 2007
Operational Date: August 2012
First Resource in CAISO NGR Model (08/14)
Current Use Case: 100% CAISO wholesale market participation. Primary revenue drivers are regulation capacity

Yerba Buena

4 MW / 28 MWh NAS Battery
Customer R&D Facility, San Jose

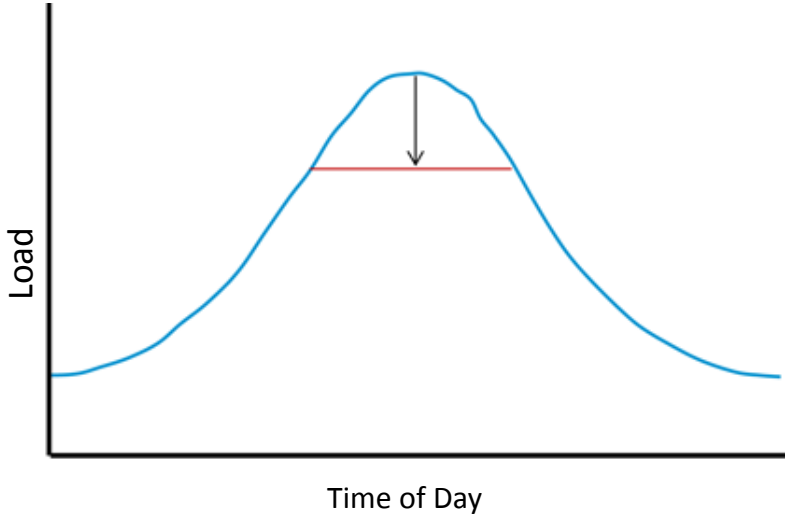
Project Initiation : 2007
Operational Date: May 2013
Completed Islanding Commissioning: Sep 2013
Current Use Case: 50% of Energy and 100% of Capacity used in CASIO market participation. 50% of Energy used for islanding

Existing Battery Energy Storage Pilots at PG&E

Browns Valley

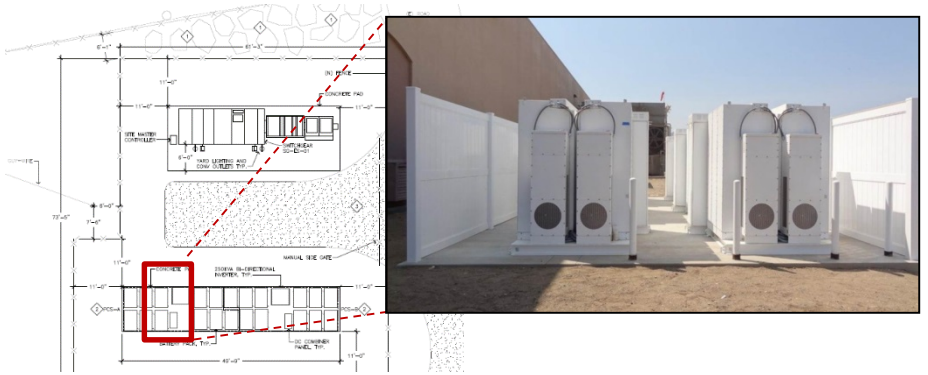
0.5 MW / 4 hour Tesla Lithium-Ion

Co-Located with PG&E Substation, Yuba County



Operational Date: Q2 2017

Use Case: Peak Shaving



San Jose DER Demonstrations

Unlocking the Next-Gen Grid through Distributed Energy Resources

Driving a clean energy future through innovation, integration of new technologies, and collaboration

PG&E: Demonstrating how smart inverters and battery storage can be dispatched by DERMS to meet grid needs.

SolarCity: Installing and testing residential battery storage systems and smart inverters to evaluate how customer-sited solar can be controlled and coordinated with grid management technology.

Green Charge Networks: Installing and testing commercial battery storage systems to evaluate how they can be used operationally to support the grid during periods of high electric demand.

GE Grid Solutions: Developing the new Distributed Energy Resource Management system (DERMS).