Status Update:
EPRI-PG&E Smart Charging Pilot

2009 – 2011 DR Filing (CPUC D.09-08-027)

Reiko Takemasa
Pacific Gas and Electric Company
July 22, 2011

Agenda

Project Overview

- Pilot Scope
- Testing Set-Up
- Test Schedule

Test Results to Date

- EVSE Hardware Testing
- System Testing Results and Insights

Next Steps

- Step 3: Field Testing
- Real World Challenges
- Step 3b: Enhanced Field Testing

Acronym Review

- EVSE — Electric Vehicle Supply [Service] Equipment
- SCMS — Smart Charging Management System
- PEV — Plug-in Electric Vehicle
- SE — Smart Energy [Profile]
- AMI — Advanced Metering Infrastructure
- UIQ — Utility IQ™
- DRM — Demand Response Manager
- TIC — Technology Innovation Center
- HAN — Home Area Network

PG&E Smart Charging Pilot Overview

Partner: Electric Power Research Institute (EPRI)

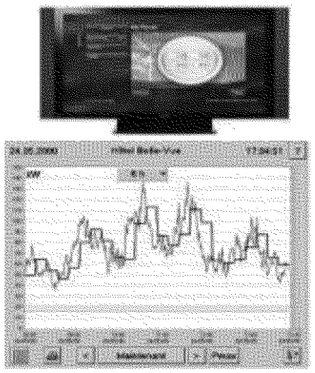
Vendors: Coulomb Technologies, Silver Springs Network/Clipper Creek

Pilot Duration: June 2009 – August 2011

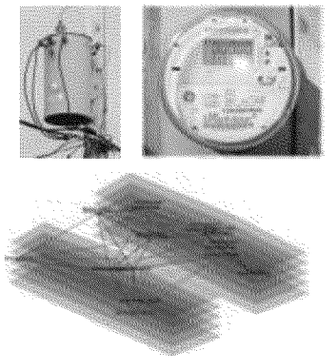
Funding: $1.01M Approved in CPUC D.09-08-027, $0.6M by PG&E/EPRI

Objective: Evaluate existing EVSE technology from a few vendors and demonstrate that PG&E can communicate with and control a limited number of Zigbee enabled EVSE over AMI both in a lab and field environments.

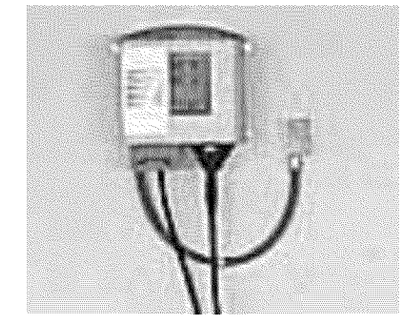
Scope of Smart Charging Pilot



Control Software (SCMS)



Utility Grid Network

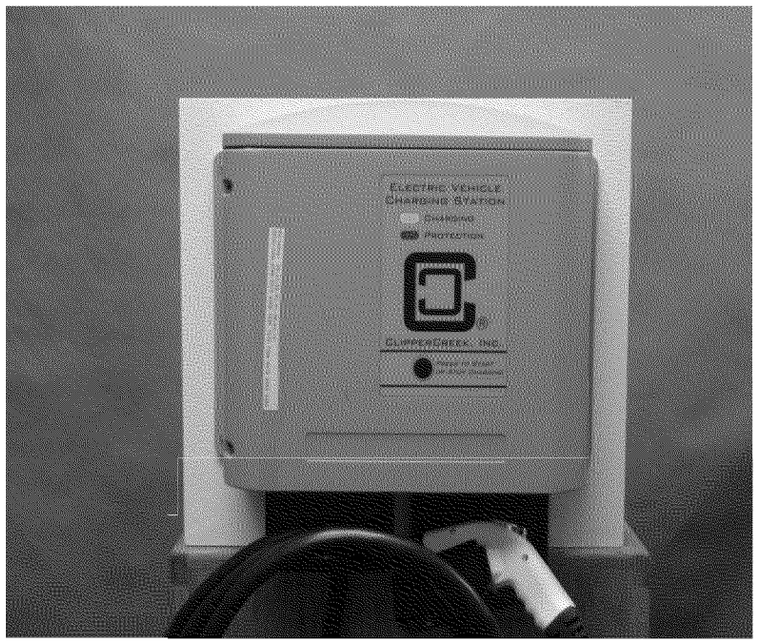


Smart EVSE

Out of Scope

On Board PEV Telematics

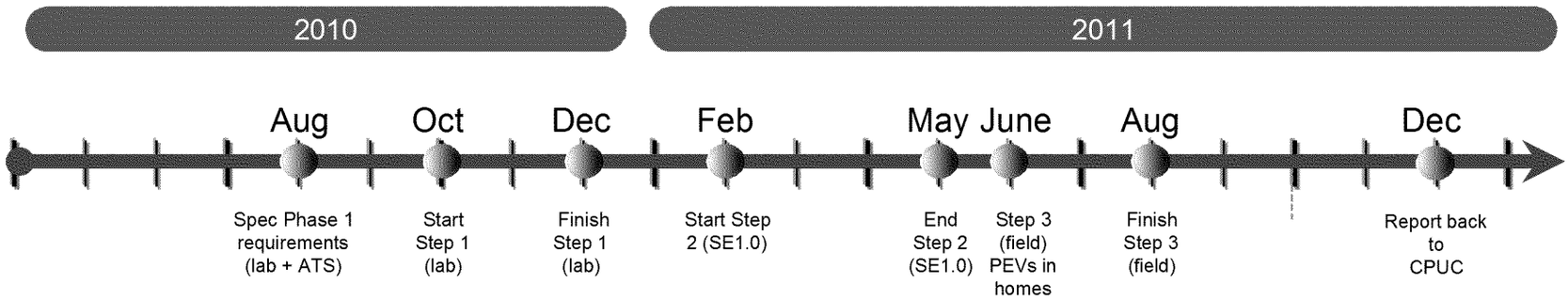
EVSE Devices Tested



- **Clipper Creek EVSE with Silver Spring Networks communication hardware installed.**
- **Model # DS-100**
- **Communication modes:**
  - **AMI network over 900 MHz radio**
  - **HAN over 2.4 GHz ZigBee radio**

- **Coulomb Technologies EVSE**
- **Model # CT-500-CDMA-ZIG**
- **Communication Modes:**
  - **Charge Point Network over cellular**
  - **HAN over 2.4 GHz ZigBee radio**

Recap: DR 2009-2011 Pilot



Step 1:

EVSE Control and Functionality

- Supplier selection, procure EVSE
- Test basic on/off/status communication between SSN/Vendor B EVSE and TIC lab (back office simulator)
- Test communication between EVSE and EV (load), back to TIC lab

Step 2:

SEP Communication and DRLC

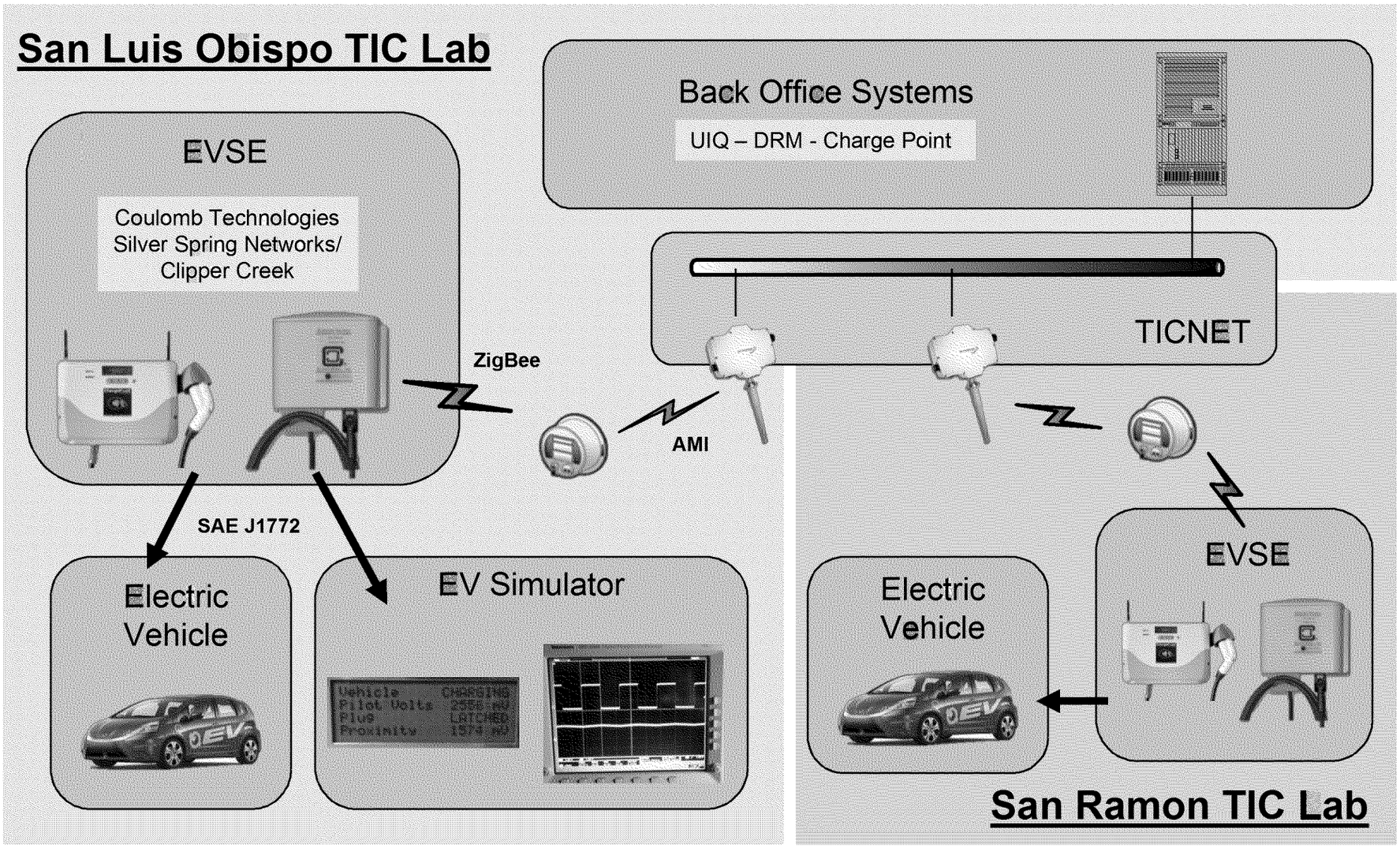
- Test EVSE to SCMS comm using SEP1.0
- Test ability to send basic DR event signals, but excluding pricing data
- Impact study to distribution transformer, and AMI network; excludes non-AMI networks
- Integration into SmartMeter, UIQ, and AMI network

Step 3:

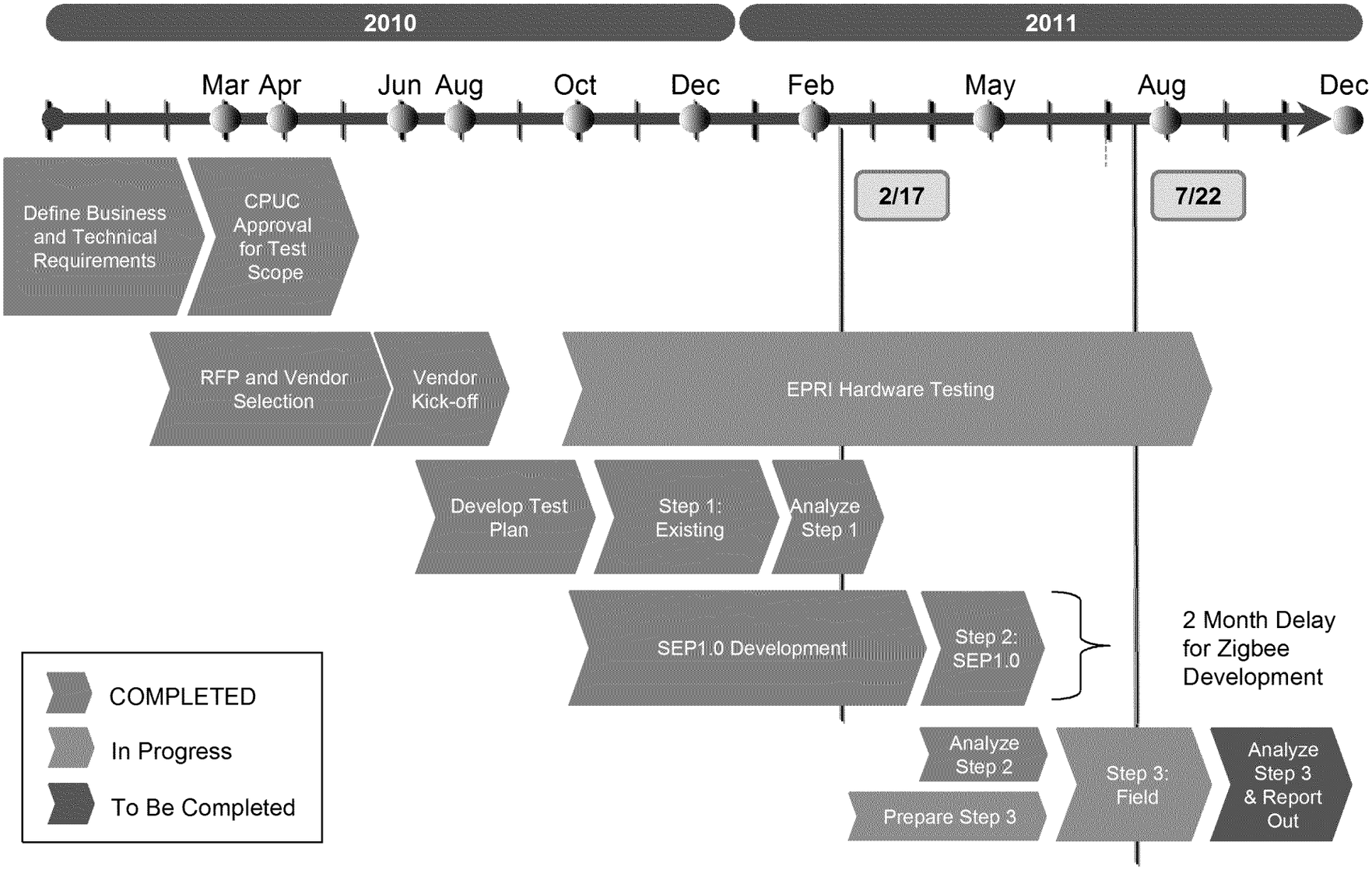
Controlled Simulation in Field

- PG&E locations simulating single residential with attached garage and with adjacent garage
- Technical and customer support
- Installation procedures
- Signal latency and communication robustness study

Test Environment



Smart Charging Pilot Status



Agenda

Project Overview

- Pilot Scope
- Testing Set-Up
- Test Schedule

Test Results to Date

- EVSE Hardware Testing
- System Testing Results and Insights

Next Steps

- Step 3: Field Testing
- Real World Challenges
- Step 3b: Enhanced Field Testing

EVSE Power Quality Testing

Source: EVSE Power Quality tests performed by EPRI

Test Item	Results
Cold Load Pickup	• Vendor A: Restart times that varied with *range of 7 minutes* among the 5 tests. • Vendor B: Restart times that varied by *less than 15 seconds*.
Vehicle Disconnect Protection	• Vendor A: 32 ms • Vendor B: 83 ms
Voltage Sag	• Vendor A: Contactor stayed close; control signal degraded, but persisted. • Vendor B: Contactor chattered or opened, but charge cycle was not interrupted (contacts closed after sag).
Interruption Re-closure	• Vendor A*: Cannot be tested with current version of FW. • Vendor B: Control signal remains constant; output voltage follows input voltage as expected. *Charge cycle was uninterrupted.*
Over Voltage Sustained Over & Under Voltage Distorted Input Voltage	• Vendor A: No contact chatters or interruptions; performed as expected. • Vendor B: No contact chatters or interruptions; performed as expected.
Ground Fault Detection	• Vendor A: Detected fault immediately and opened main contactor. • Vendor B: Only detected the fault at the start of a charging session.

- *Note: FW version on tested Vendor A device has not been upgraded to latest version; current version requires the start button to be pressed to start cycle after contact opens.
- *At this point, it is unclear what the performance expectation should be for these devices; do we require standards around minimum performance and feature set?*

System Test Results

Test Set	Passed	Failed	Not Completed	Total	% Passed	% Failed	% Not Completed	% Total Executed
Product								
EVSE – Vendor A	15	24	2	41	36.6%	58.5%	4.9%	100%
SCMS – Vendor A	18	15	0	33	54.5%	45.5%	0%	100%
EVSE – Vendor B	22	17	2	41	53.6%	41.5%	4.9%	100%
SCMS – Vendor B	23	10	0	33	69.7%	30.3%	0%	100%
OVERALL TOTAL	***78***	***66***	***4***	***148***	***52.7%***	***44.6%***	***2.7%***	***100%***

- **Electric Vehicle Service Equipment (EVSE)**
  - Both devices can perform basic charging operations.
  - Neither device offers the extended features listed in the high level business requirements document.

- **Smart Charging Management System (SCMS)**
  - The software tested is not actually full-featured to the point of being called an SCMS.
  - Neither software suite offers the extended features listed in the high level business requirements document.

Observations and Insights

Product Features and Operational Guidelines

- Each vendor's product with respect to installation, configuration, and operation are significantly different.
  - For example, when stopping a charge locally at the EVSE by pushing the "Stop" button, the charging session on the Vendor A EVSE stops immediately.
  - Whereas the charging session on the Vendor B EVSE stops after releasing the "Stop" button.
- Remote starting of a charging session using the Vendor B EVSE is not possible without local intervention at the EVSE. For the Vendor B EVSE, once a charging session has been terminated (locally or remotely), a subsequent charging session cannot be started until after the EVSE charge connector has been unplugged from the PEV and re-plugged back into the PEV.
- Need to determine EVSE vendors with mass-production design and manufacturing experience and capabilities.

Should there be some level of standardization over product features, installation methods, configuration, and operation?

Should it be coordinated internationally?

Observations and Insights

Interpretation of Standards

- ❑ Vendor B designs their EVSE without the override function.
- ❑ The Vendor B EVSE and Vendor A EVSE respond differently to the Average Load Adjustment Command sent via the HAN to the EVSE.
  - The Vendor B EVSE interprets the adjustment value to be relative to the present load on the EVSE.
  - The Vendor A EVSE interprets the adjustment value to be relative to the maximum allowable load on the EVSE.

Standards need clarification and consistency in interpretation.

Developing Market and Technology

- ❑ Inside the Vendor A EVSE, the NIC is completely separate from the Vendor A charge controller circuitry. Therefore, over-the-air firmware modifications are only possible for the NIC, and field visit is required to modify the Vendor A hardware.
- ❑ The power-on-test sequence of the Vendor A EVSE includes unconditionally closing the main contactor for approximately 4 seconds, applying 240 VAC to the J-1772 power connector creating a potentially hazardous situation.
- ❑ At the time of testing, the Vendor B EVSE was more fully developed, having a Web-based portal, for instance.
- ❑ Neither vendor's SCMS provides forecasting services or aggregate PEV demand.

Agenda

Project Overview

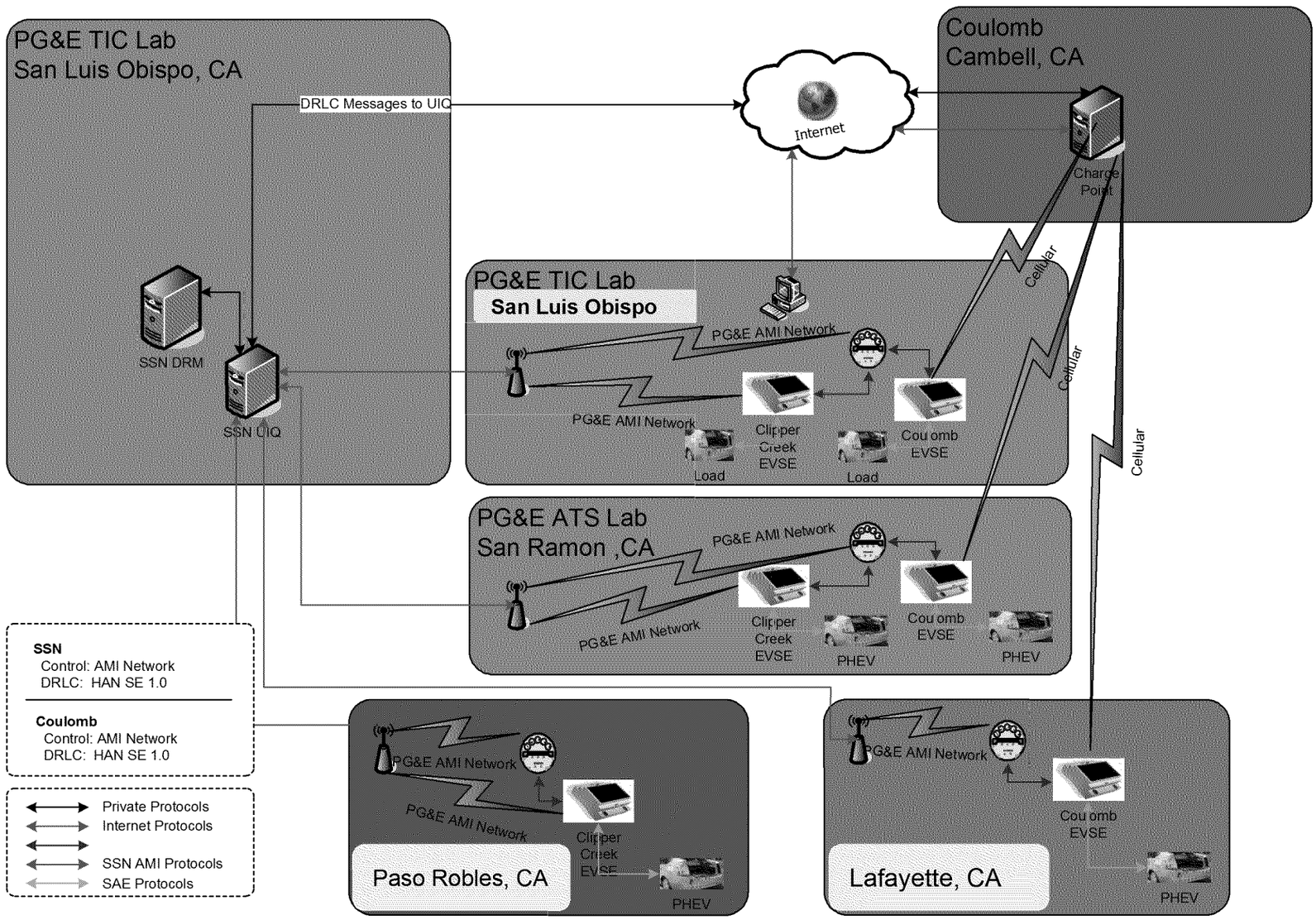
- Pilot Scope
- Testing Set-Up
- Test Schedule

Test Results to Date

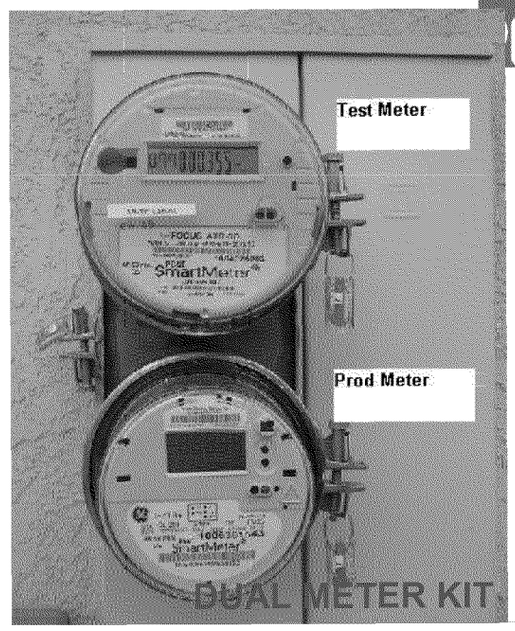
- EVSE Hardware Testing
- System Testing Results and Insights

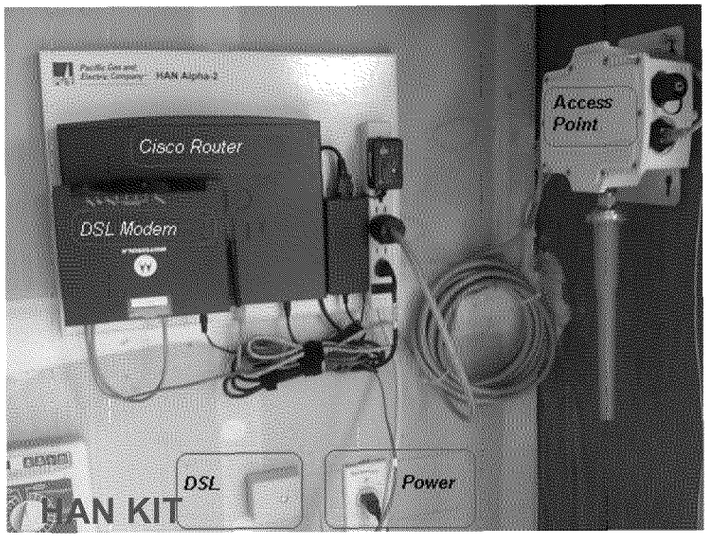
Next Steps

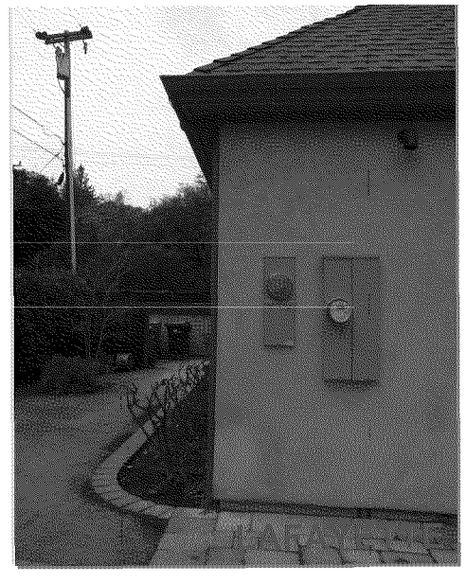
- Step 3: Field Testing
- Real World Challenges
- Step 3b: Enhanced Field Testing



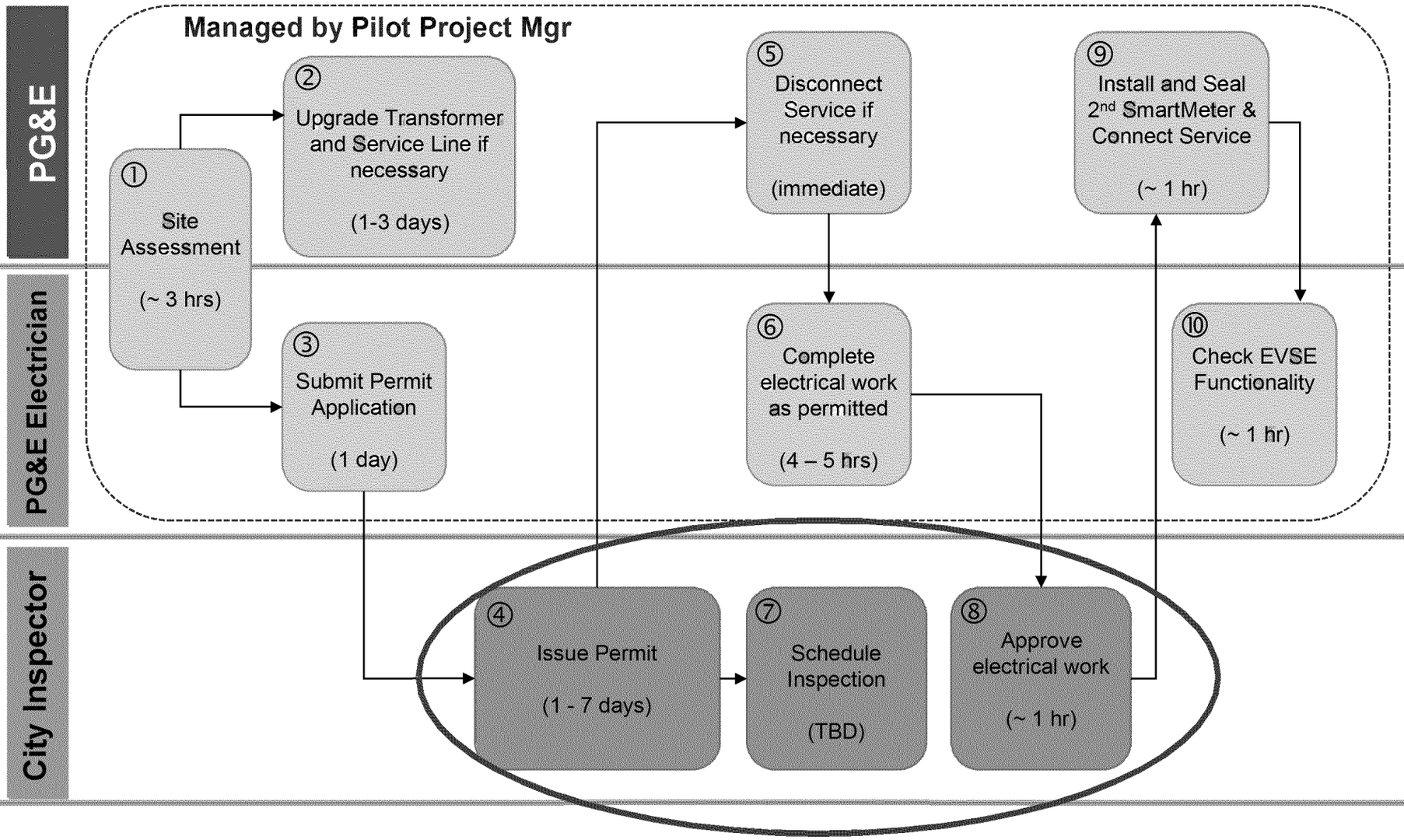
Field Installation







EVSE Installation Challenges



The Last Leg