

Electrifying Transportation

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**Utility Technology Association 2015 Fall
Conference**

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Let's Talk about Electrified Transportation...

- EPRI's Electric Transportation Program
- Light Duty Plug-in Vehicles – Market Status
- Utility Infrastructure Activity
- Things to Come

EPRI's Electric Transportation Program

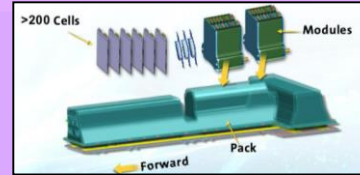
EPRI Electric Transportation Overview – What we lovingly call “Program 18”

18A

Plug-In Electric Vehicle Development



PEV Evaluation and Test Data Analysis



Advanced Battery and Powertrain Development for PEVs



Advanced Vehicle Technologies for PEVs

18B

Commercial, Industrial and Fleet Applications



C&I Electric Transportation Technology Assessment



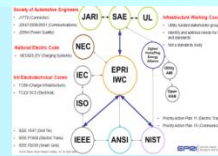
Fleet Applications for PEVs



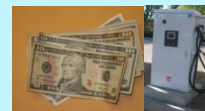
Plug-in Hybrid Marine Applications

18D

Electric Transportation Systems, Infrastructure, and Utility Readiness



Infrastructure Working Council



PEV Charging Infrastructure – Evaluation, Planning and Business Models



Grid Integration of PEVs



Utility PEV Readiness



Environmental and Economic Assessment of Electric Transportation

18E

Advanced PEV Infrastructure and Smart Charging



Smart Grid Technologies for PEV Grid Integration



PEVs as Distributed Resources



Advanced Infrastructure Development and Testing

Research Progress in Electric Transportation

A Few 2015 Highlights

- Deployed all Odyne plug-in hybrid bucket trucks and VIA trucks and vans in the DOE Medium-Duty PHEV program
 - Final report in last stages of publication
 - Data collection and analysis continues through 2016
- Released NRDC-EPRI Environmental Assessment Report
- Held successful Commercial and Industrial ET Meeting in Long Beach
- Held Truck and Bus Connector Meetings
- Three Example Supplemental Projects:
 - Open Vehicle-Grid-Integration Platform “Open Platform”
 - San Francisco 49er Stadium smart charging project
 - Deployment of Medium Voltage DC Fast Charger

Vehicle Grid Integration Phase 1: Proof Of Concept “The Big Demo”, Sacramento

- Development Phase: 08/2013-10/2014
- 12 utilities, 7 OEMs actively participated
- Status: **Completed** 10/16/2014 at SMUD
- Executed a simple DR Event Live through OVGIP to manage 7 OEM PEVs
- SEP2, OpenADR2b, ISO/IEC15118 protocols interoperability using telematics APIs

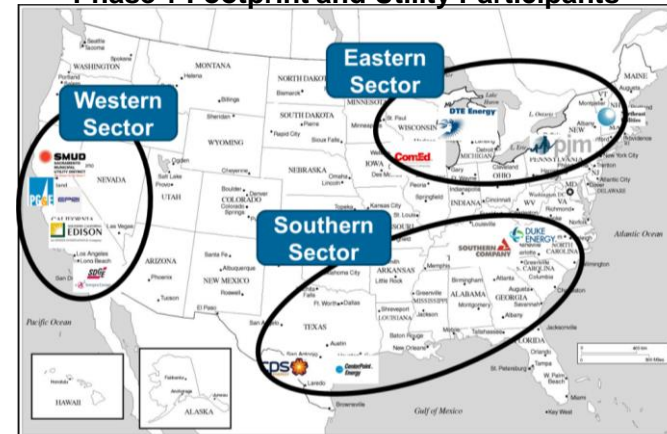


Charge Status Display



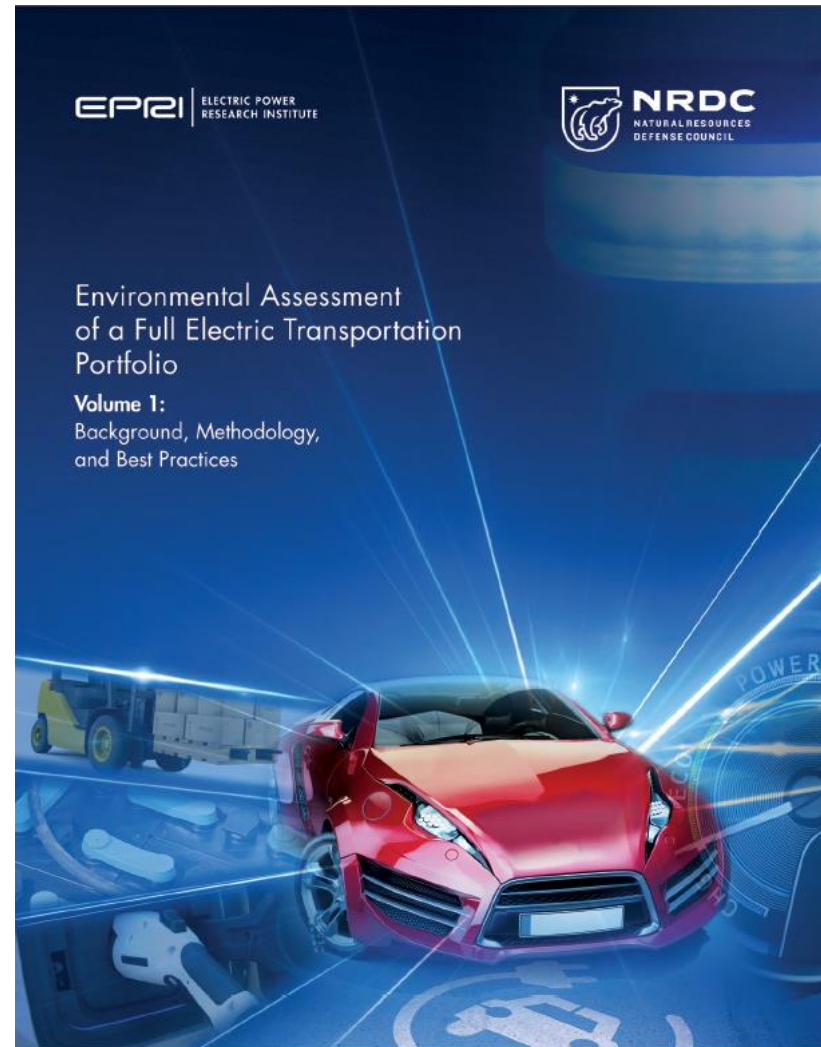
The Line Up: 7 OEM PEVs

Phase 1 Footprint and Utility Participants



Natural Resources Defense Council – EPRI: Environmental Assessment of a Full Electric Transportation Portfolio

- **Transportation electrification can lead to large reductions in greenhouse gas emissions while also improving air quality**
- **This study validates the assertion that electrifying transportation is beneficial**
- **This study also provides ‘best practices’ for modeling grid emissions due to a large-scale shift towards electricity as a transportation fuel, which can be used to interpret future studies from outside parties**



Light Duty Plug-in Vehicles – Market Status

Light Duty Plug-in Electric Vehicles - Trends

■ PEV Market – Positives

- ✓ ZEV mandate requires 3.3M PEVs in CA and ZEV states by 2025
- ✓ Accelerating global sales (> 1M since Q4 2010)
 - ✓ Roughly half of those vehicles were sold in the last 14 months
 - ✓ Top three countries are the U.S. (370k), Japan, and China
 - ✓ BMW i sales 9.3% of all BMW car sales in September 2015
- ✓ Costs are decreasing
 - ✓ GM states \$145/kWh battery today; \$100/kWh by 2022
- ✓ Potentially significant impact of Volkswagen's "Dieselgate"
- ✓ 25+ PEVs scheduled to launch by end 2019
 - ✓ Next-gen Volt and longer range LEAF coming Q4 2015

Light Duty Plug-in Electric Vehicles – Trends, continued

■ The Market - Challenges

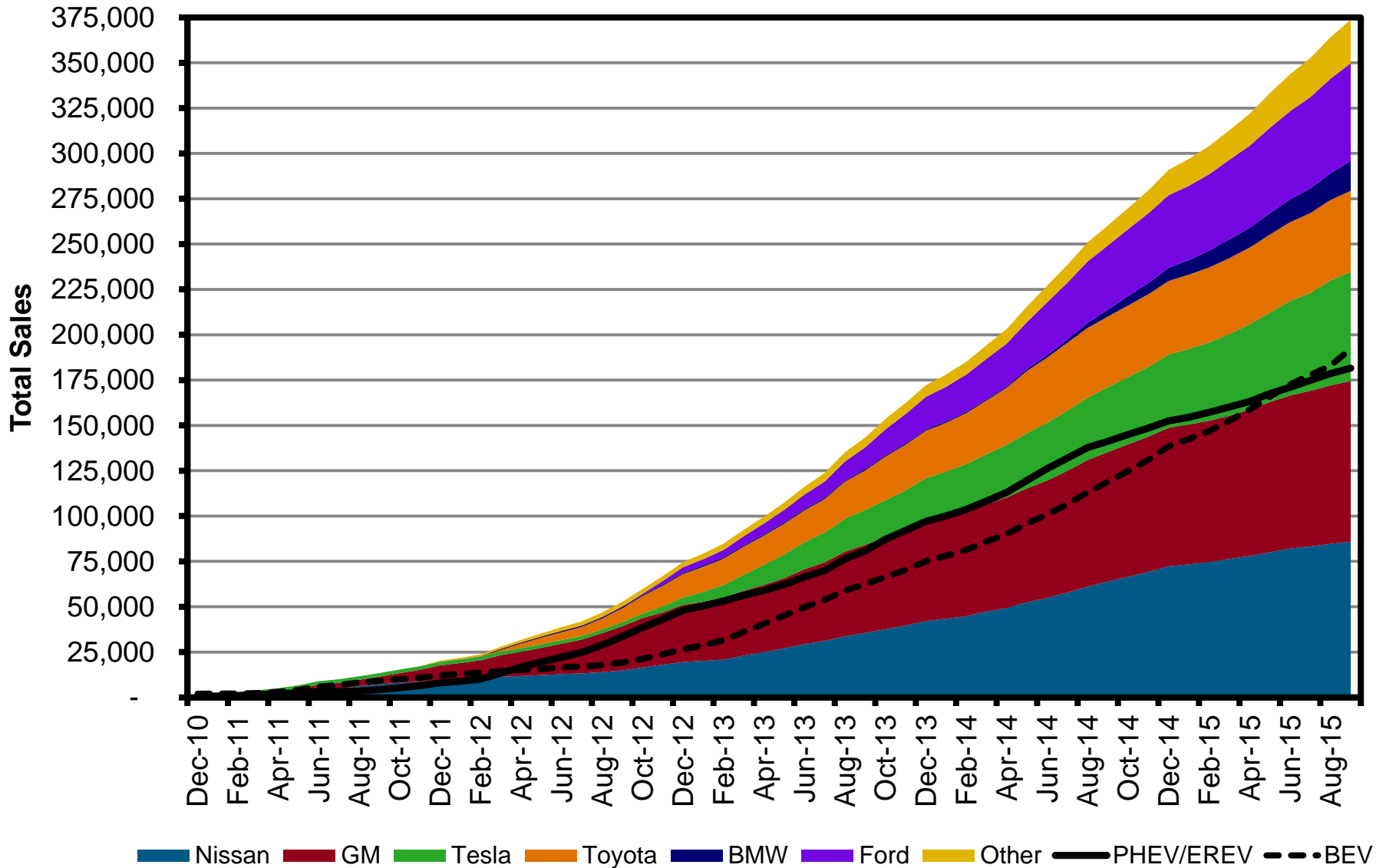
- Flat sales increase 2015 versus 2014
- No pickup truck (yet)
- Varied mass market awareness and limited 50 state vehicle availability
- Mixed dealer engagement

■ Charging

- ✓ Success of Tesla Supercharging Network
 - ✓ 521 globally installed stations with 2,941 charging ports
- ✓ Higher power coming 7+ kW AC (home) and DC fast charging (125+ kW)
- ✓ Challenges in approach to infrastructure planning and management
- ✓ Open versus closed networks and standards processes

State of the PEV Industry

>373K PEVs Sold Through 9/30/2015



State of the PEV Industry

~25 New PEVs Are On The Way Though 2019



Make	Model	Type	Body Style	Battery Size (kWh)	All-Electric Range (miles)	Launch
Mercedes	S550e	PHEV	Luxury sedan	8.7	20	Q3 2015
Volvo	XC90 T8	PHEV	SUV	9.2	20	Q4 2015
Tesla	Model X	BEV	Crossover	80	250	Q4 2015
BMW	X5 eDrive	PHEV	SUV	9.0	20	Q4 2015
Chevrolet	Volt	PHEV	Hatchback	18.4	50	Q4 2015
Audi	A3 etron	PHEV	Wagon	8.8	30	Q4 2015
Mercedes	GLE550e	PHEV	SUV	8.8	18	Q3 2015
Hyundai	Sonata	PHEV	Sedan	9.8	27	Q4 2015
Mercedes	C350e	PHEV	Luxury sedan	6.2	20	Q4 2015
Mercedes	GLC350e	PHEV	Crossover	8.8	20	Q4 2015

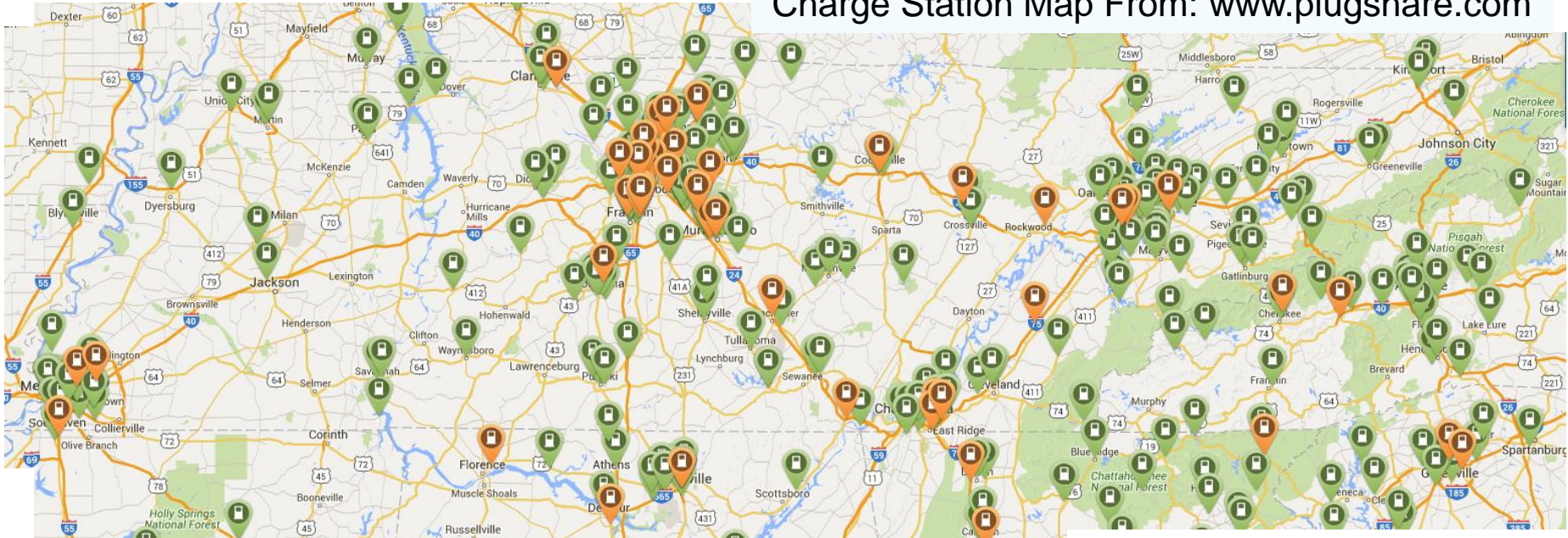
State of the PEV Industry

~25 New PEVs Are On The Way Though 2019

Make	Model	Type	Body Style	Battery Size (kWh)	All-Electric Range (miles)	Launch
Cadillac	CT6	PHEV	Luxury sedan	18.4	37	Q1 2016
BMW	330e	PHEV	Luxury sedan	TBD	22	Q1 2016
Mitsubishi	Outlander	PHEV	Crossover	TBD	TBD	Q2 2016
Audi	Q7 etron	PHEV	SUV	17.3	25	Q4 2016
Chrysler	Town & Country	PHEV	Minivan	TBD	TBD	Q4 2016
Volvo	V60	PHEV	Wagon	TBD	TBD	Q4 2016
BMW	740XeDrive	PHEV	Luxury sedan	TBD	20	Q4 2016
Nissan	Leaf	BEV	Hatchback	TBD	TBD	Q4 2016
BMW	X3 eDrive	PHEV	Crossover	TBD	20	Q3 2017
Chevrolet	Bolt	BEV	Hatchback	TBD	200	Q4 2017
VW	CrossCoupe	PHEV	SUV	14.1	20	Q4 2017
Subaru	Crosstek XV	PHEV	Crossover	TBD	TBD	Q2 2018
Porsche	Pajun	BEV	Luxury sedan	TBD	220	Q4 2018
BMW	i5	PHEV	Luxury sedan	TBD	TBD	Q4 2018
Jaguar	F-Pace	BEV	Crossover	TBD	300	Q2 2019

Vehicles and Public Charge Stations in Tennessee

Charge Station Map From: www.plugshare.com



Tennessee has a little over 3000 vehicles with main concentrations in these ten counties:

WILLIAMSON	757
DAVIDSON	752
RUTHERFORD	521
SHELBY	322
KNOX	203
HAMILTON	163
SUMNER	111
WILSON	95
MONTGOMERY	69
SULLIVAN	51

Utility Infrastructure Activity



Utility Charging Infrastructure & Market Support Proposals

Background

- \$1.145B proposed and in process
- Why are utilities proposing to own and/or operate PEV charging infrastructure?
 - Market hindsight
 - 2010-2014 public investment (taxpayer) had mixed results in establishing a widespread, reliable PEV charging infrastructure network
 - Broader stakeholder willingness to consider utility role in PEV charging as providing a public good
 - Business goals
 - Support PEV drivers (customers)
 - Capture benefits to grid
 - Better understand, plan for, and minimize cost of grid impact
 - DC fast charging power increasing (150+ kW per charging station)

Utility Charging Infrastructure & Market Support

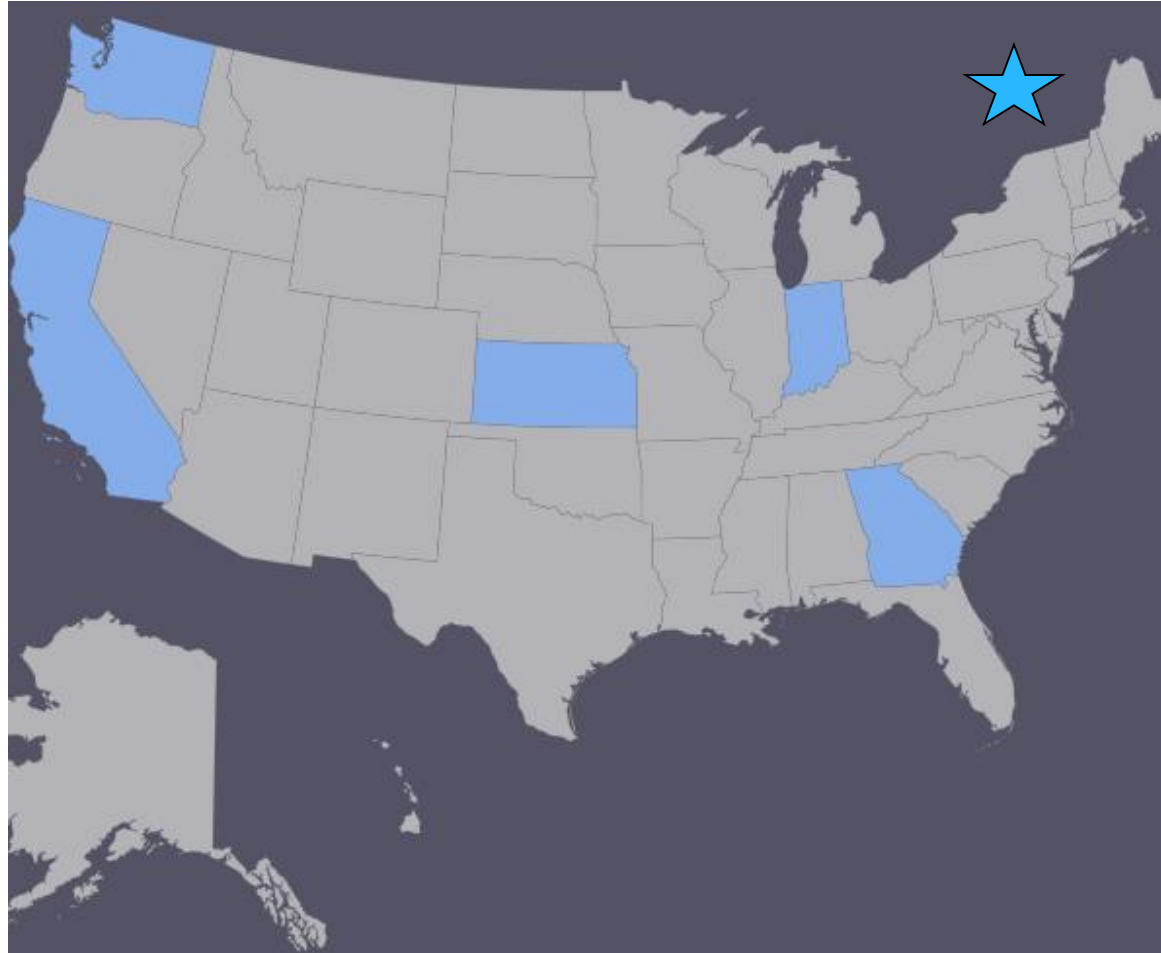
Current Movement And Actions

Washington State: Bill allows utilities to ratebase charging infrastructure with an additional 2% return on equity allowance

PG&E: \$654M pilot filing. Rate base installation, ownership and operation of 25k stations at MuD, public, and workplaces. Provide market education

SCE: \$355M pilot filing. Rate base construction of up to 30k stubs in long dwell locations, provide rebates on stations and market education

SDG&E: \$103M pilot filing. Rate base 5.5k stations at MuDs and workplaces. Provide market education. Real time pricing for drivers plus delayed grid investment for all



Hydro Quebec: Le Circuit de Electricite. L2 (625) and DC fast chargers (60) installation with site hosts partners

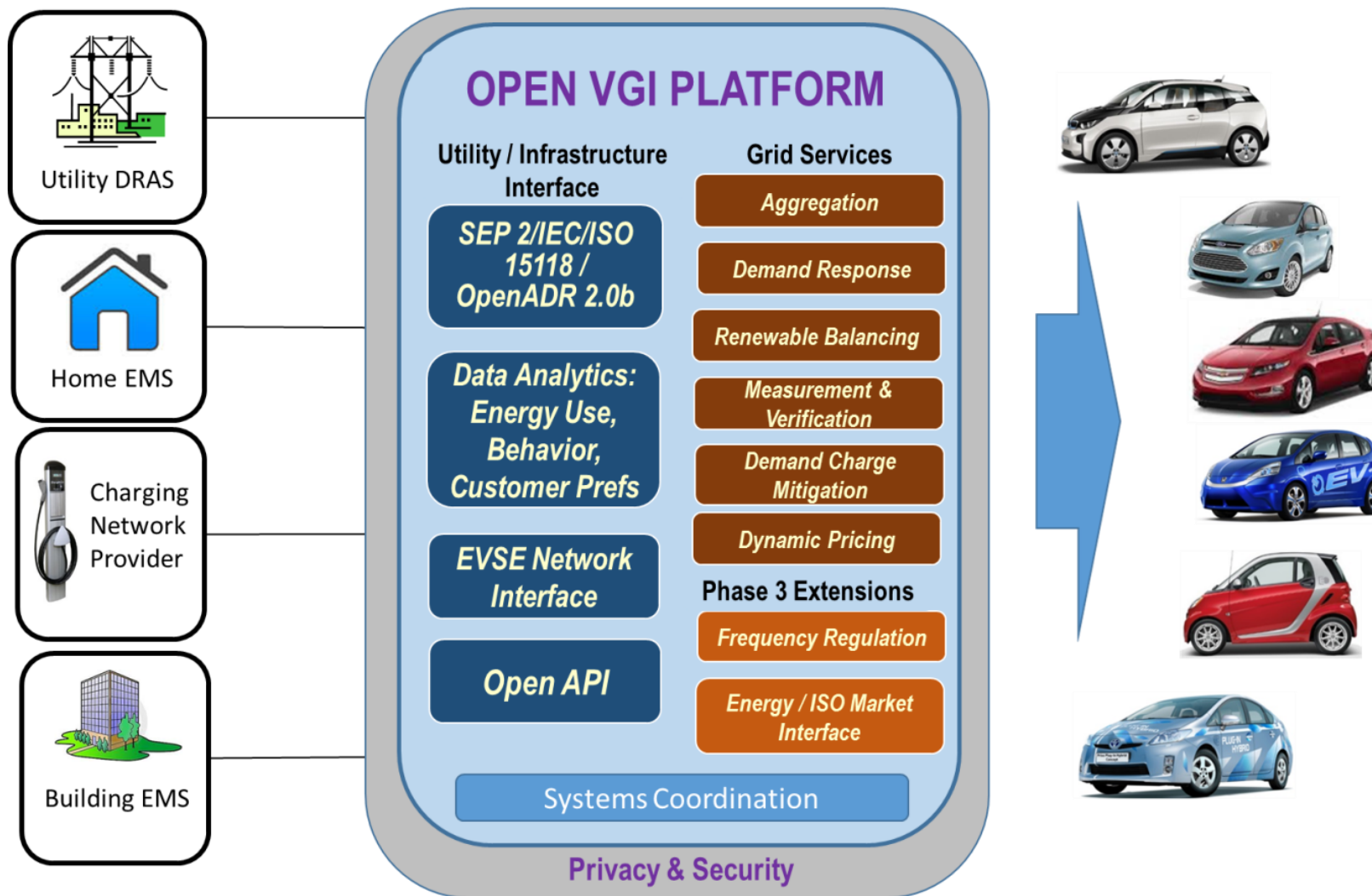
IPL: \$12M filing. Approved for \$3M for distribution upgrades "in public interest"

KCP&L: \$20M shareholder funds. Own, operate, and maintain 1000 charging stations. No cost to host for installation or drivers for electricity for two years. Asking for cost recovery in parallel.

Georgia Power: \$12M for 61 DC Fast Chargers and 2752 Level 2 for residential, business, multi-family, community, outreach & fleet. Provides \$250 home / \$500 commercial rebate & market education

Things to Come

Integrating Vehicles with the Grid

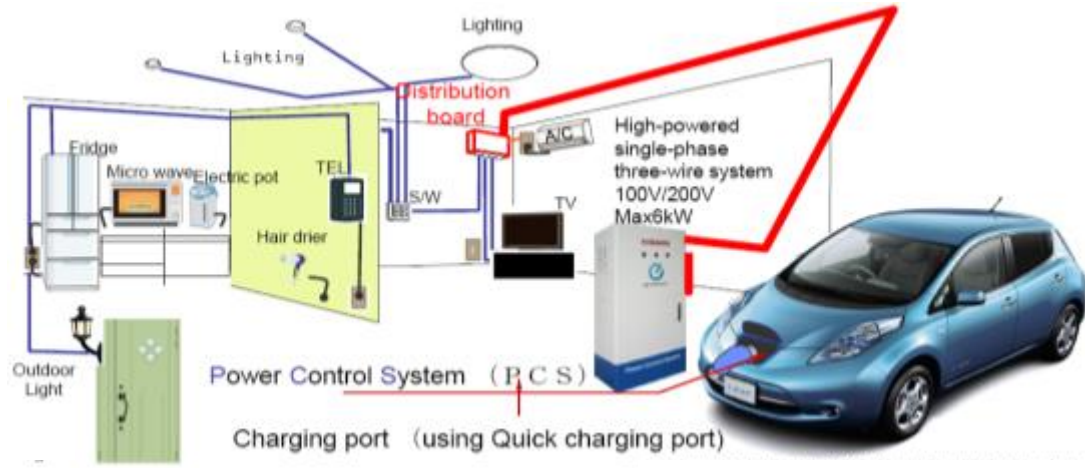


Plug-in Vehicles for Resiliency

- Unique capabilities when compared to other back up power sources
 - Mobile
 - Well maintained
 - Some are “dual fuel”
 - Better emissions controls than typical generator
- Offer reasonable power and energy capacities
- They are available



Nissan 6.6KW Home Appliance System

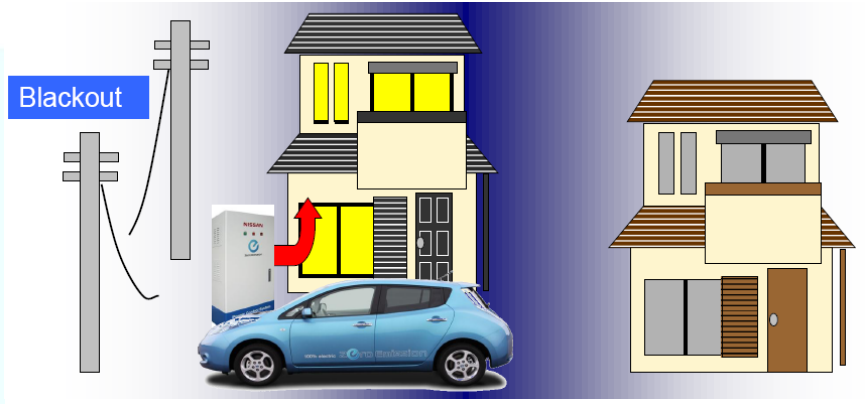
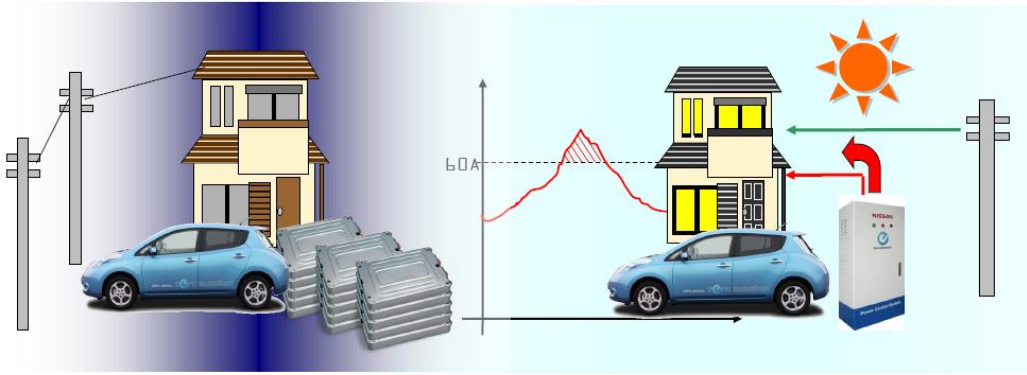


Optimized Energy Usage

Back-up Power

charge at night

Discharge during peak demand



Source: EPRI IWC Meeting, March 2012, Leaf to Home, Joseph Thompson

What's Next for Our Program?

- We will continue working with utilities in developing best practices for electrifying transportation
 - Charging Infrastructure
 - Opportunities in goods movement
 - Bus and truck electrification
 - Port, rail, intermodal electrification opportunities
 - Standards development
- Valuation studies
 - Helping utilities understand best roles to move technologies forward
 - Understanding customer needs
 - Building sustainable business cases
- Next generation technologies
 - Vehicle to grid
 - Wireless charging

Questions?

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Together...Shaping the Future of Electricity