

PEV's are here! – is there infrastructure?

I'm getting range anxiety!!!!!!



**Terry Penney, Technology Manager
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SAE 2010 Government Industry**



DOE funds **ecotality**™ ~\$100M EV infrastructure

- **Deployment of 4700 electric drive vehicles**
 - (5 markets – Washington State, Oregon, CA, Arizona, Tennessee)
- **Deployment of 11210 chargers planned**
 - 4700 Level 2 chargers installed in homes
 - 6250 Level 2 chargers installed in public locations
 - 260 Level 3 chargers installed



14 Major World Cities Announce Plans to Build More Electric-Vehicle Infrastructure



C40 Electric Vehicle Network are:
Bogota, Buenos Aires, Chicago,
Copenhagen, Delhi, Hong Kong,
Houston, London, Los Angeles, Mexico
City, Toronto, Sao Paulo, Seoul and
Sydney.

Auto OEMs involved;
BYD Auto, Mitsubishi, Nissan, Renault

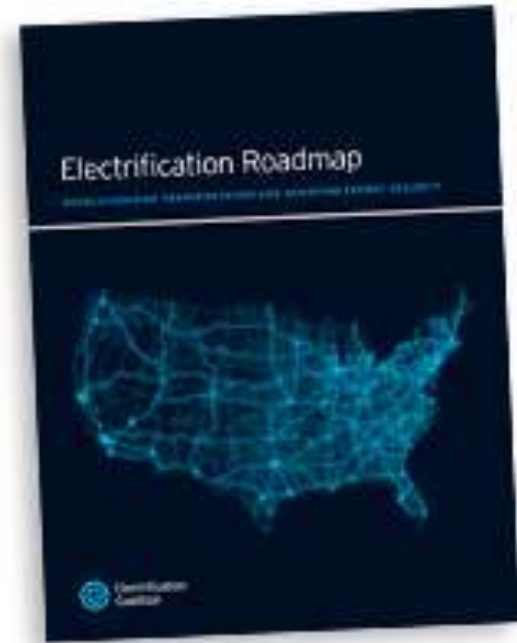
Electrification Roadmap Coalition formed

Purpose:

"To provide a public policy guide to transforming the U.S. light-duty ground transportation system from one that is oil-dependent to one powered almost entirely by electricity."

Goal:

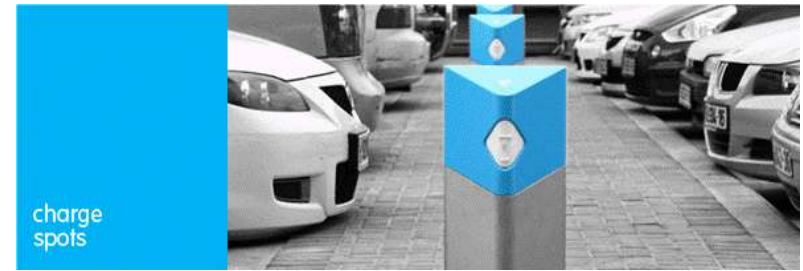
"By 2040, 75 percent of the light-duty vehicle miles traveled (VMT) in the United States should be electric miles."



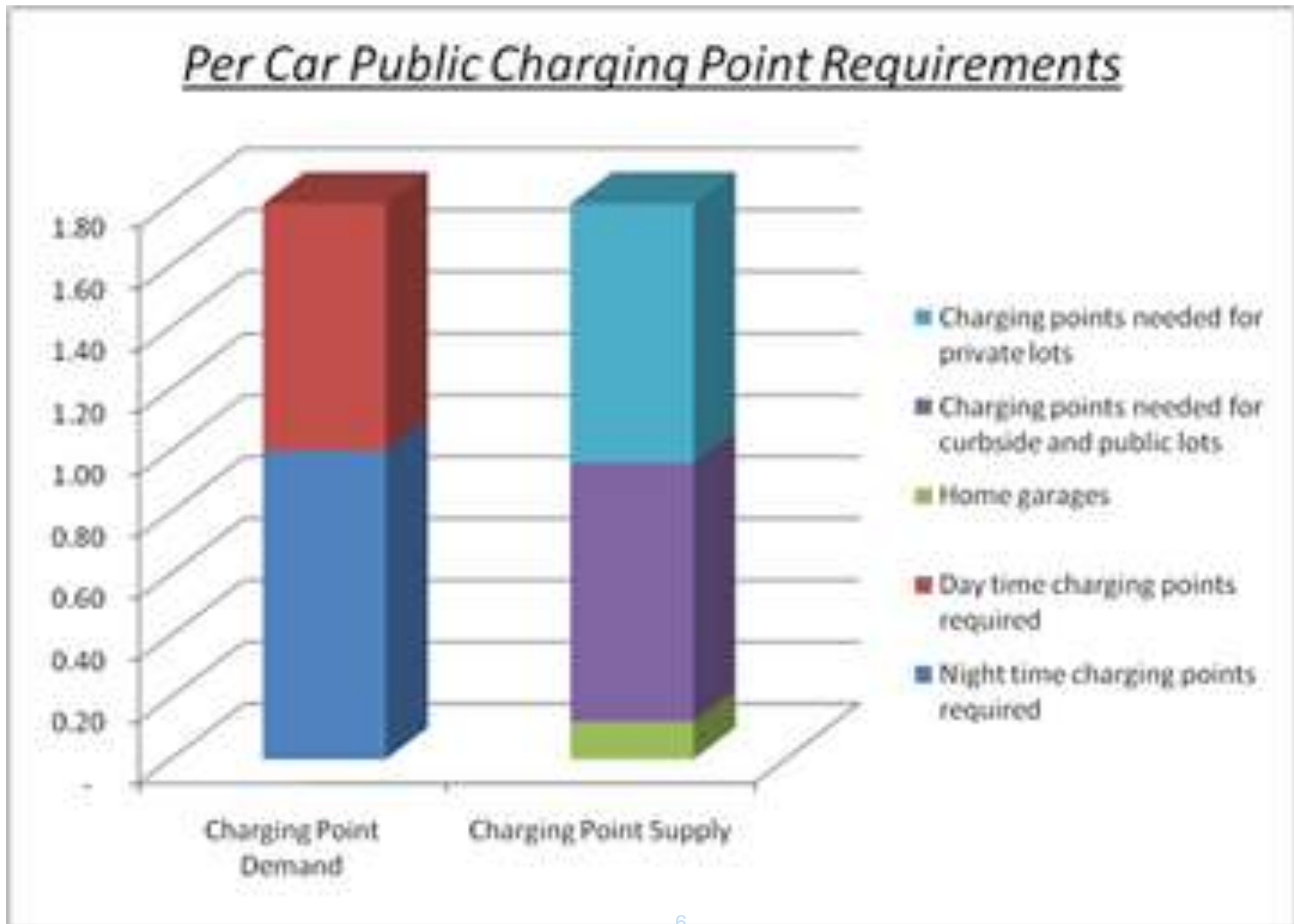
Electrification Coalition include:

- AeroVironment, Inc.
- GridPoint, Inc.
- NRG Energy, Inc.
- Coda Automotive
- Rockwood Holdings, Inc.
- Nissan Motor Company, Ltd.
- Johnson Controls Power Solutions
- Bright Automotive, Inc.
- FedEx Corporation
- A123 Systems, Inc

Vehicle Infrastructure – it's coming! But will it be here soon enough?



Coulomb's estimates.....



Battery Sizes and Relative Charge Times

Vehicle Type	Battery Capacity (kW hrs)	Level 1 Charger Time (hrs)	Level 1 20 amp (hrs)	Level 2 (hrs)	Level 3 (minutes)
<i>DC Power to Battery</i>		1.1 kW	1.5 kW	6kW	60kW
PHEV10 (mid-size)	4	3.6	2.7	0.67	4
PHEV20 (mid-size)	8	7.3	5.3	1.3	8
PHEV40 (mid-size)	16	14.5	10.7	2.7	16
BEV (mid-size)	35	31.8	23.3	5.8	35
City EV (economy)	20	18	13.3	3.3	20
Hybrid Bus 40ft transit	40	n/a	n/a	6.7	40

source: INL/EXT-08-15058, Nov 08, K Morrow, D. Karner, F. Francfort

Vehicle Charging Levels and Cost per unit

- Level - I (\$500 - \$2000 per unit)
 - 120V, up to 2.4kW (~8 mi/hr)
 - Typical 15A > 1.4kW (~4 mi/hr)



- Level -II (\$2000 - \$10000)
 - 240V, up to 19.2kW (~60 mi/hr)
 - Typical 30A > 6.6kW (~22 mi/hr)



- Level -III (\$20000-\$100000+)
 - DC charging up to 250kW
 - 60kW > (~200 mi/hr)



Cost per mile tells a different story.....

Type	cars per day	miles per day	Cost per charger	Life (years)	cents per mile (Low)	cents per mile (High)
Level 1	1	20-40	\$500 - \$2000	10	0.42	3.3
Level 2	2-4	60-120	\$2000 - \$10000	15	0.37	3.7
Level 3	15-20	750-1000	\$20000- \$100000	15	0.44	3.0

Auto OEMs, Utilities, Consumers, Governments, Public Officials, 3rd Party vendors.....working together for mutual success to achieve many things such as;

- Seamless and secure billing system
- Smart Grid integration – better load mgmt
- High availability to charge ports
- User friendly features in car, at charge port
- Time-of-use rate charging – shared savings
- Better/ less expensive option than the alternatives and positive experience for the consumer
- Reduce the dependency on oil improve the environment

Electric Vehicle Grid Integrations

Common questions facing utilities

- Environment Basics - *Analysis*

- How many vehicles?
- When will they arrive?
- Where will they connect?
- What is the load?



- Utility Participation - *Evaluation*

- How do I communicate with the car/consumer?
- What are my options for managing the load?
- What are the infrastructure challenges of EV fleet?

- Utility Leadership - *Demonstration*

- Experiment with slow/fast charge networks?
- Grid services with vehicle charge/discharge?
- Integration with Renewable expansion?

Hundreds of issues for auto OEMs...such as;

- How quickly will homing chargers be installed - (the early Mini-E , Tesla experience)
- Will customers without a garage be inconvenienced?
- Locating a charger inside a “cluttered garage”
- Customer experience – meeting and exceeding customer’s needs
- Cost of installations, who owns, operates
- Cost of charging when not at home
- Education of all stakeholder groups – consumer, utility, code officials, PUC etc
- Cost of electricity, cost of gas, mark-ups by 3rd parties – billing across many options

Many aspects of Electric Vehicle Grid Integration

- What is it?
 - Digital Communications
 - Information Flow Control
 - Power Flow Control
 - Decision Algorithms
- How
 - Vehicle becomes an active participant in grid operations
- What is being done, by whom and how soon will we know
 - Common Codes and Standards
 - Testing facilities
 - Simulation tools
 - Field applications
 - Experience as to what works, what doesn't and commonalities



Communication Standards - International cooperation

- IEC and SAE
- Sorting out the options
- Is it Utility/aggregator operated or user operated
- Who needs access to what info?

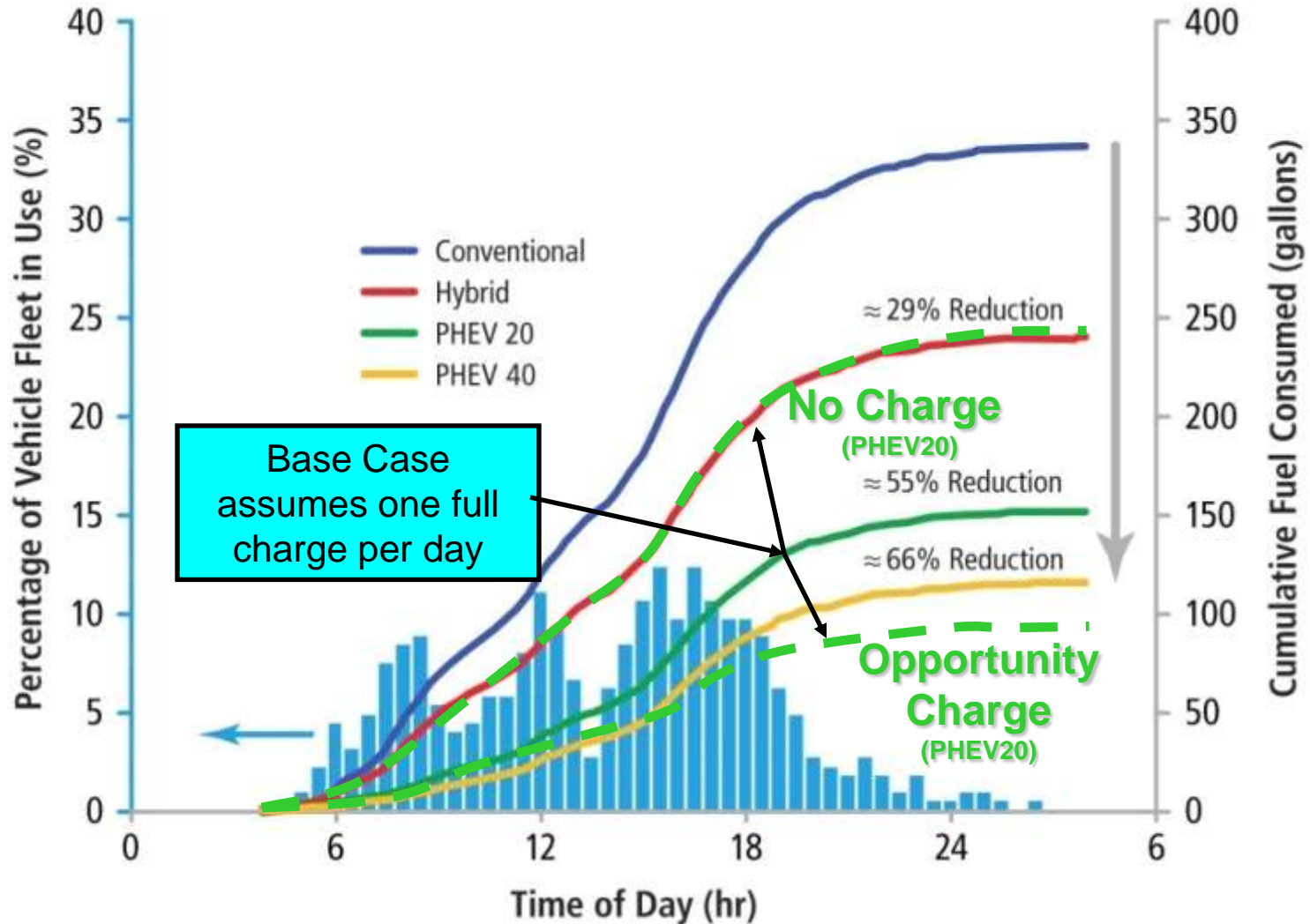
Different stake holders working on different “Standards”

Organizations	Inter-national standardization		National standardization		Additional Consortia & companies or standardization bodies					Interest groups			Rule making				
	ISO	IEC	EN 50119	DIN	EN54	ZigBee Alliance	IEEE 802.11p	ETSI	ETSI	ETSI	VDA	SCA	AAUW	...	UNECE
Use cases																	
Optimized recharge (cost, renewables, load leveling, ...)																	
Payment & billing																	
Electric vehicle status (SOC)																	
Remote services (pre-conditioning, EOC configuration, I&M)																	
Communication technology																	
Physical & data link layer																	
Application layer protocols																	

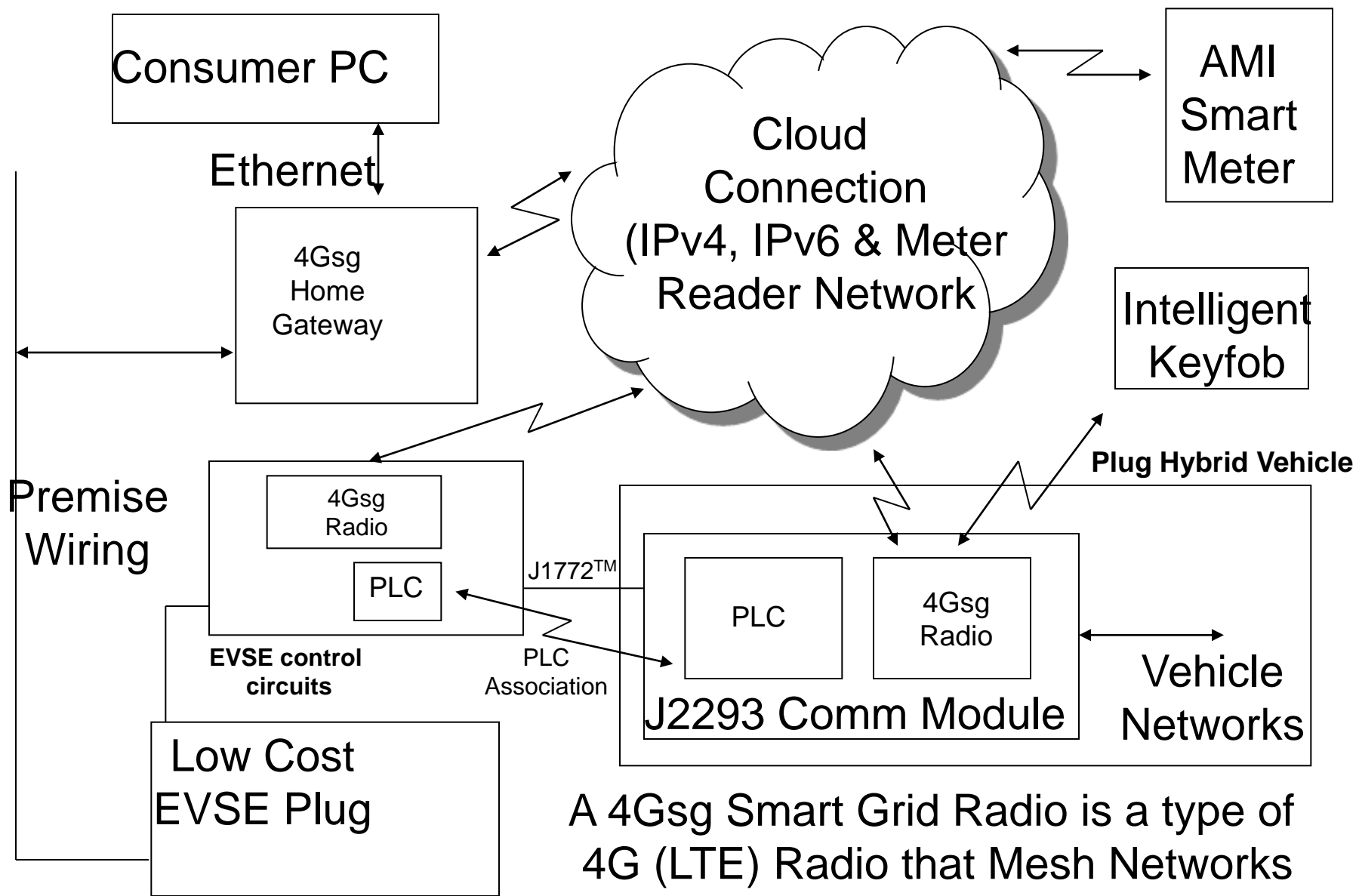
Confirmed activity
 Interest expressed, concrete activity not yet confirmed
 Action required

Recharge Scenario Impacts on PHEV Petroleum Consumption Benefits

Opportunity charge: connect PHEV charger to grid any time that the vehicle is parked.

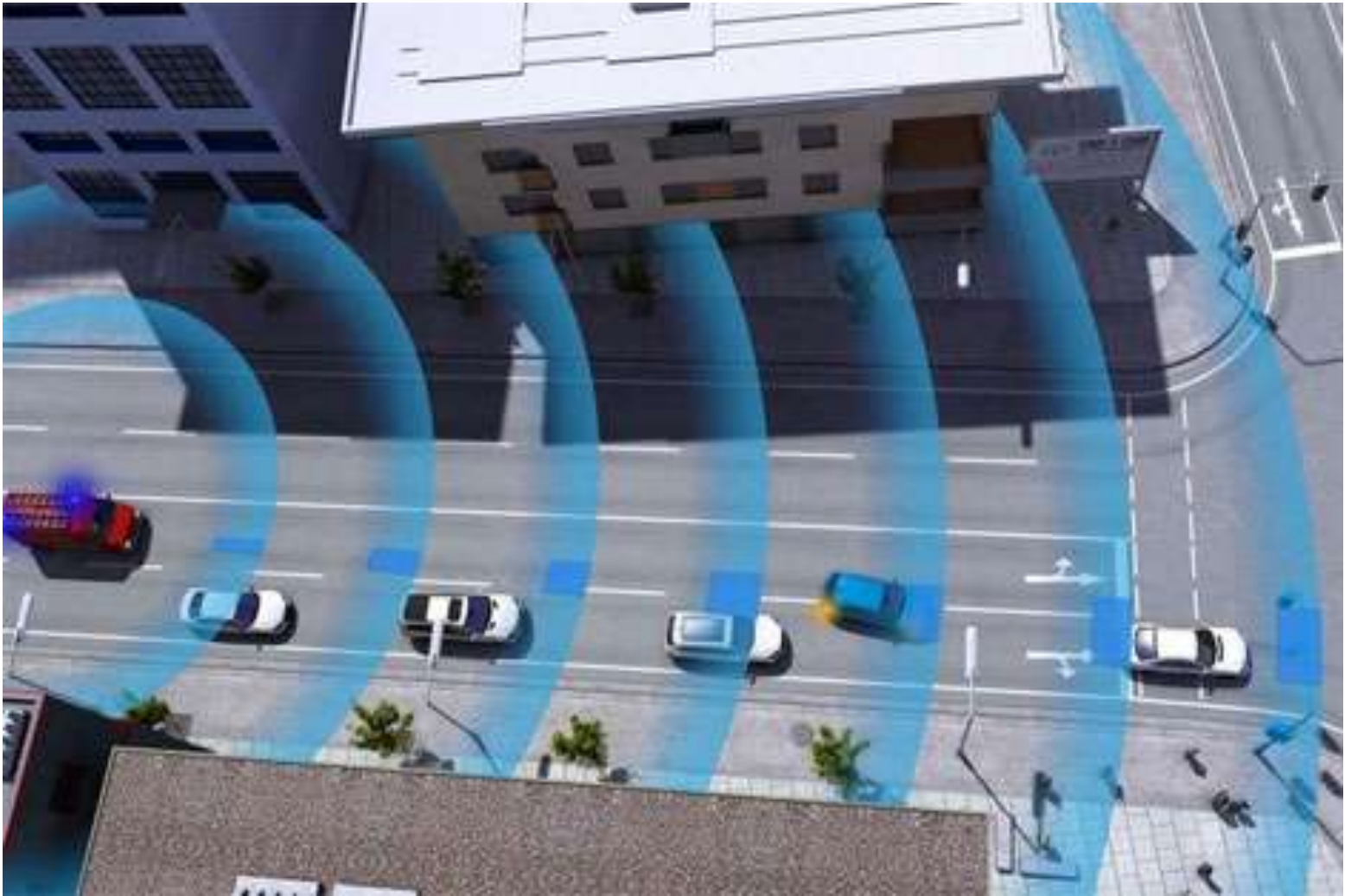


SAE J2293 PHEV with Very Low Cost EVSE using PLC Association and 4Gsg Cloud Connect



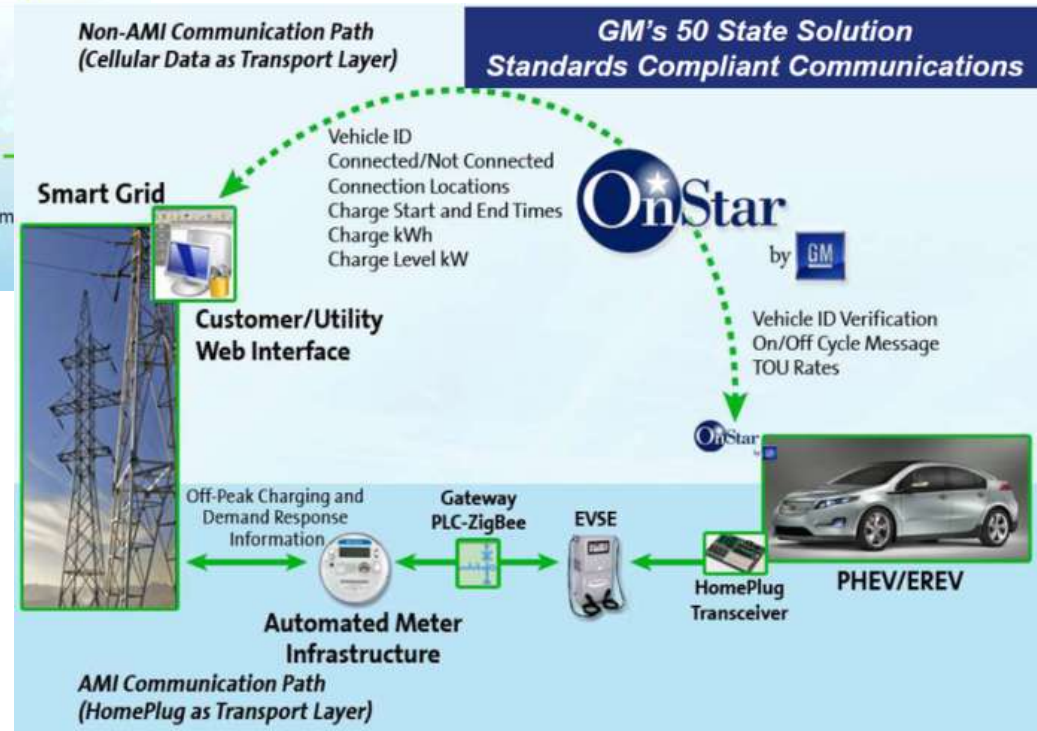
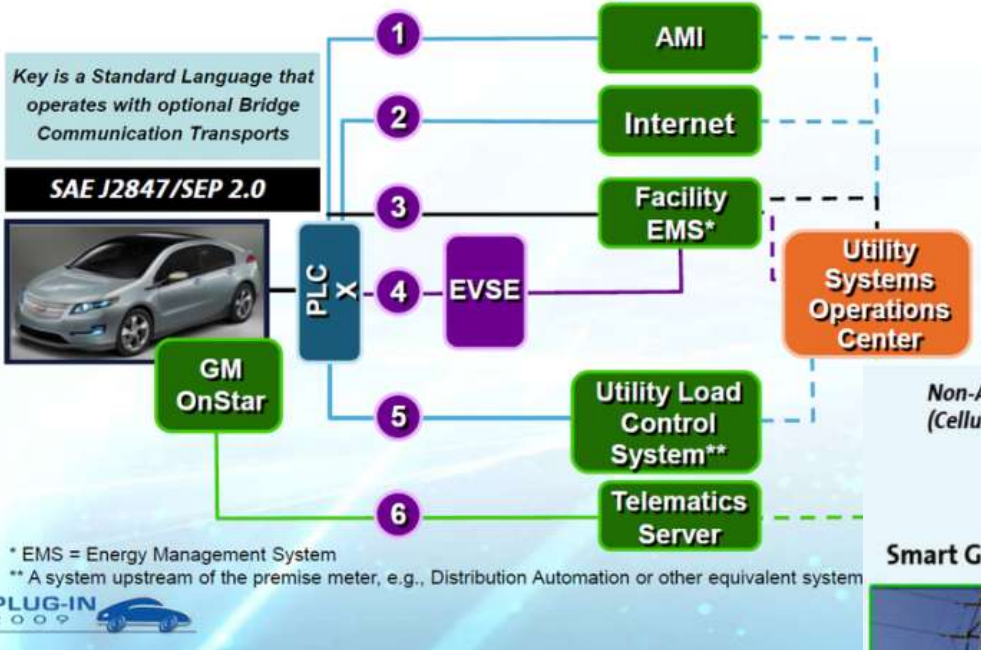
A 4Gsg Smart Grid Radio is a type of 4G (LTE) Radio that Mesh Networks with others via IPv6. It is the convergence of the Consumer and Utility Equipment.

Car to Car networking is on the way



GM Communication

Smart Charging Communications Technology Vision



Nissan Interface



Ford Communication



FORD'S PHEV VEHICLE-TO-GRID COMMUNICATION



PHEV Charge Plug



PHEV User Interface



Smart Meter



Electric Grid



Power Plant



Future Renewable Energy Sources



FORD'S PHEV USER INTERFACE



Selects recharge completion time

Schedules daily recharge start times

Only accepts charge at lower rates, off-peak hours

Toyota's solar charge port concept



McDonald's to install EV charge ports



Encouraging sign if business decides it's in their best interest to install charge ports

How many other companies will follow?



France issues 14 Commandments to speed up electric vehicle adoptions

- Launch "enough" demonstration charging stations in 2010.
- Integrate EVs into all new city mobility plans.
- Help universities establishing battery development programs.
- Purchase up to 100,000 EVs by 2015.
- Achieve final passage of the €5,000 subvention for consumers to purchase EVs.
- Make sure all cars can be charged at home using standard plugs.
- Starting in 2012, require all new buildings with parking facilities to include EV charging points.
- For existing developments, create a "right to charge" so no opposition can be made to installing charge points.
- Starting in 2015, require all office buildings to have EV charging points.
- Use and promote the upcoming standard European EV plug.
- Make sure local governments get help to create EV charging stations.
- Organize the development of an EV charging network.
- Assure that non fossil-sourced energy is used to charge cars [this is an easy one, since France uses so much nuclear power].
- Promote battery recycling.

Numerous Information resources

- Idaho National Lab – PHEV infrastructure review, data and in field testing of hardware
- “Project Get Ready” – wealth of data, tools, templates from RMI
- EV charge port locations (Google Maps, NREL, vendors)
- Lessons learned by Cities installing infrastructure – typical costs, issues, etc – vendors selling/installing equipment.
- SAE standards committee information
- Many Utilities and Auto OEMs joint projects



Key Take-away Points for “Standards”

- Open standards are the key to deployment of interactive electric vehicle charging infrastructure -once standards are in place, the free market and early innovators can drive solutions that move down cost
- The electric vehicle supply equipment out there today can meet the SAE J1772 interface needs and NEC Part 625 connection electrical codes – level 3 standards need to be fast tracked
- SAE J2836 Use Case Scenario (bonding of charger to infrastructure/billing systems), and SAE J2847 (charger communication messages) is set to go to ballot this spring

Observations.....

- Many organizations have a vested stake to make this work – scale of announcements consist with production builds
- Each Stakeholder has different motives, concerns and opportunities
- Codes and Standards are proceeding – both nationally and internationally – will they be ready in time and consistent across borders?
- Large (tens of B\$)DOE investment has been focused on component enablers to vehicle electrification – smaller amounts (hundreds M\$) on infrastructure – multiple T \$ will be required
- High degree of software and hardware innovation taking place – many competitors, lots of options

Concluding remark;

- **Keep you eye on what happens Internationally
.....especially China!**

