



Transportation Electrification Role of the Electric Sector

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and Energy Storage

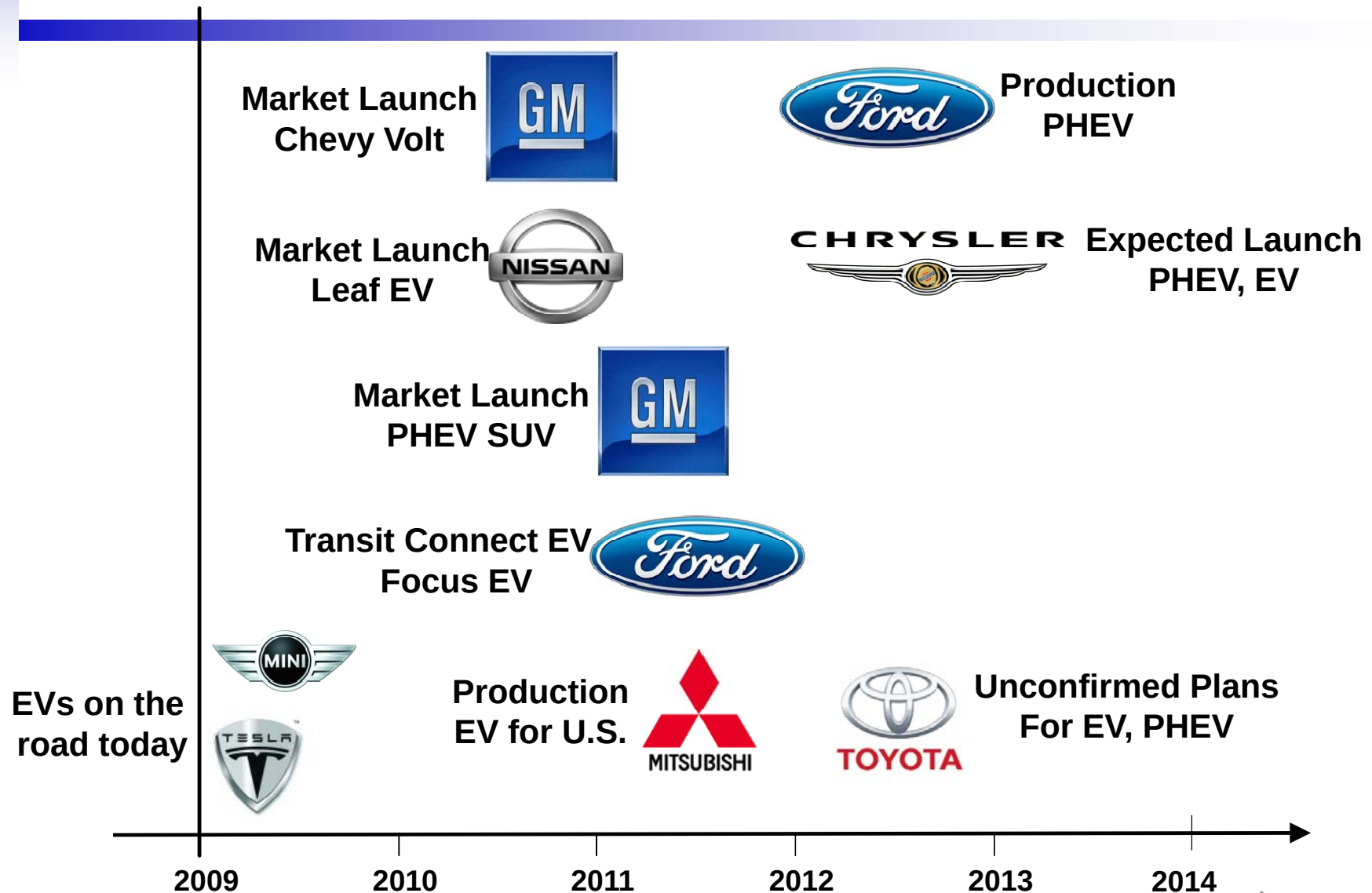
Overview

- Current status of auto industry
- Grid Impacts of Plug-In Vehicles
- Environmental Benefits of Electric Transportation
- Smart Charging
- Charging Infrastructure
- Utility Roles



Major Automaker Production Plans

Current Status



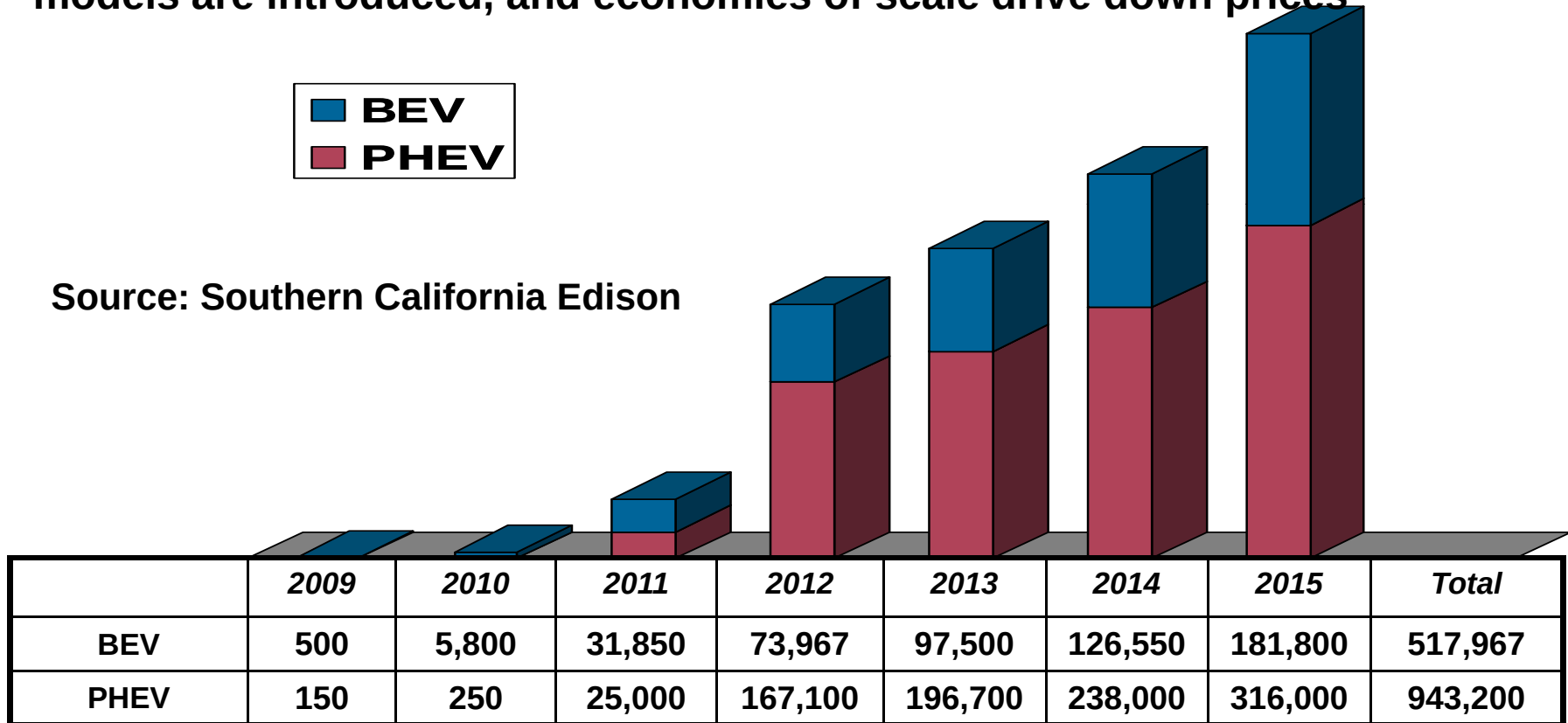
Plug-In Vehicles Enter Market in Late 2010

What is the Near-Term Achievable Market Penetration?

Market penetration grows as vehicle production numbers increase, new models are introduced, and economies of scale drive down prices



Source: Southern California Edison

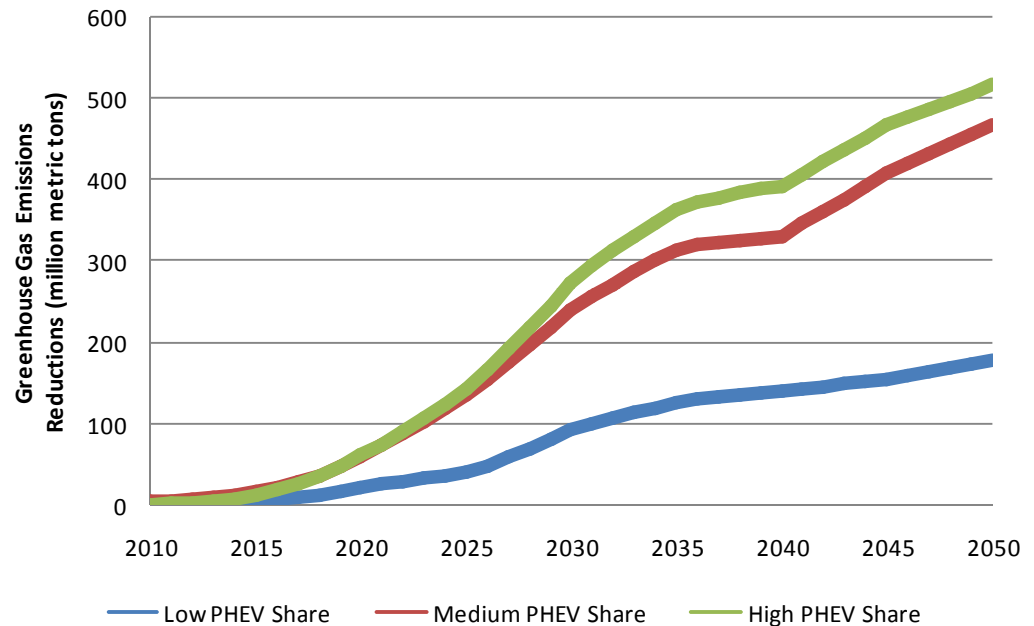


Market Penetration post-2015 difficult to estimate

Environmental Benefits of Plug-In Vehicles

Key Challenges

- Electricity is a low-carbon fuel
 - Potential 400-500 mton reduction
 - 3-4 million barrels/day petroleum reduction
- Ownership of CO₂ reductions
- Quantify societal value
- Competing perceptions – similar to energy efficiency studies

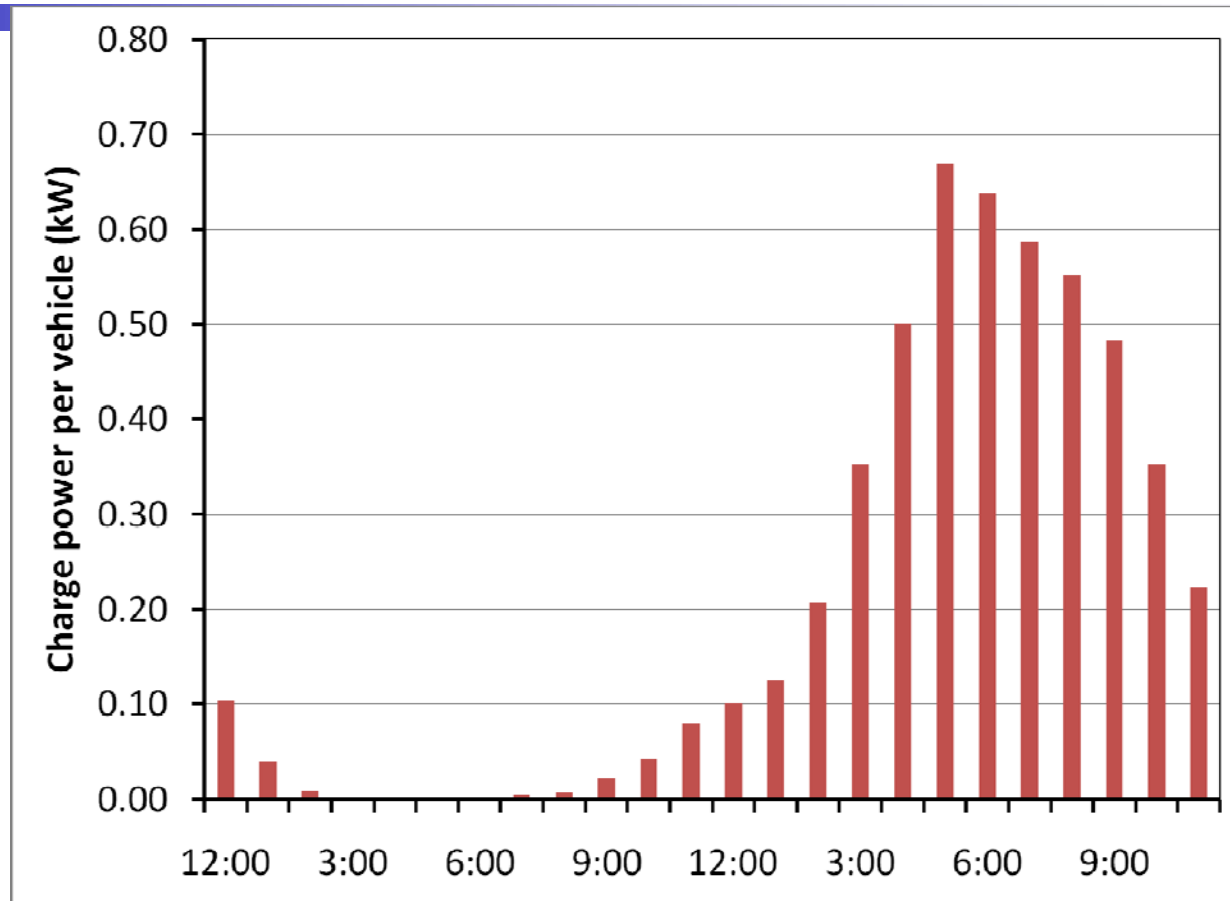


**Annual Reduction in GHG Emissions
due to PHEV Adoption**
Source – 2007 EPRI-NRDC Study

Grid Impacts of Plug-In Vehicles

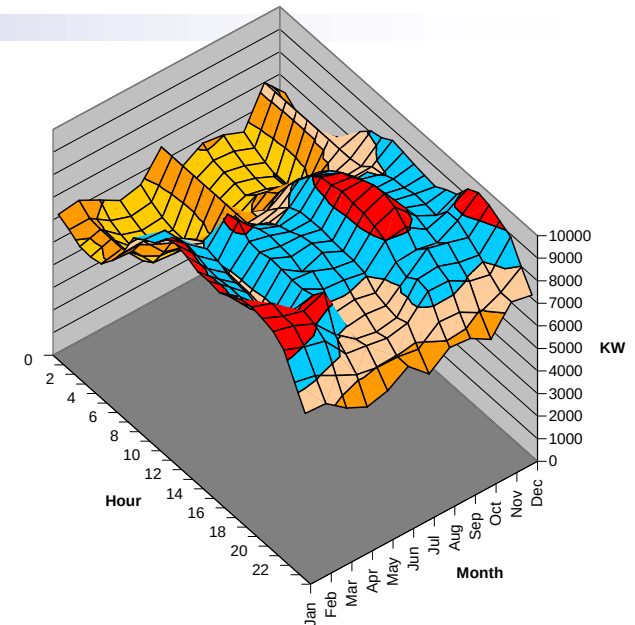
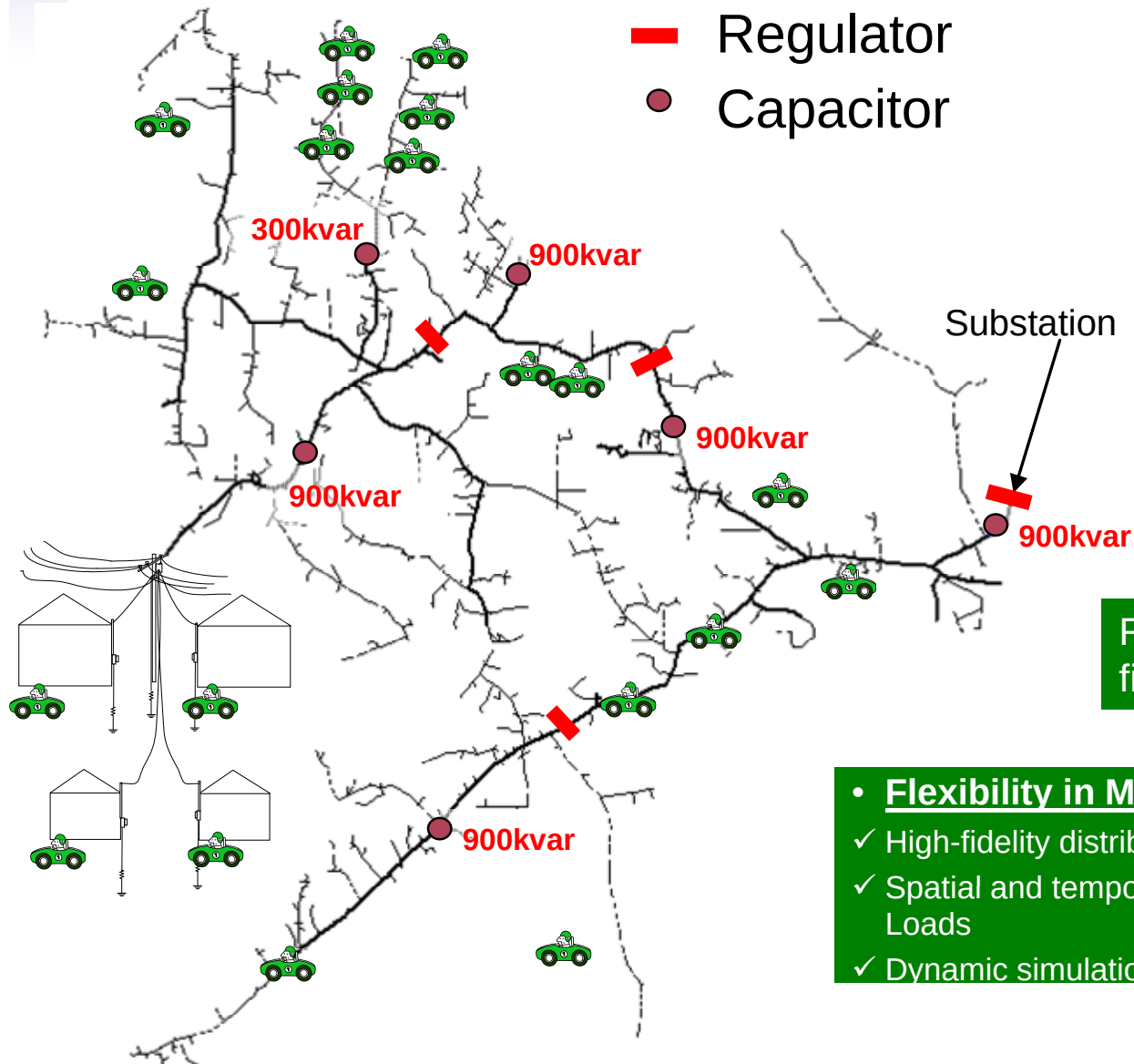
- Not all vehicles are 'created equal'
- Generation and transmission impacts likely minimal
 - Full light-duty fleet electrification at 7-8% of demand
 - Aggregate fleet charging demands are modest
 - Most drivers at 40 miles per day or less
- Distribution
 - Charging load first impact smaller residential transformers and other fully utilized equipment
 - Optimal system requires managing time and level of charging

Power demand for uncontrolled charging



- Vehicle mix is 30% E-REVs, 50% blended PHEVs, 20% EVs
- Average charge power is about 700W per vehicle

Analyzing Distribution Impacts of PEVs

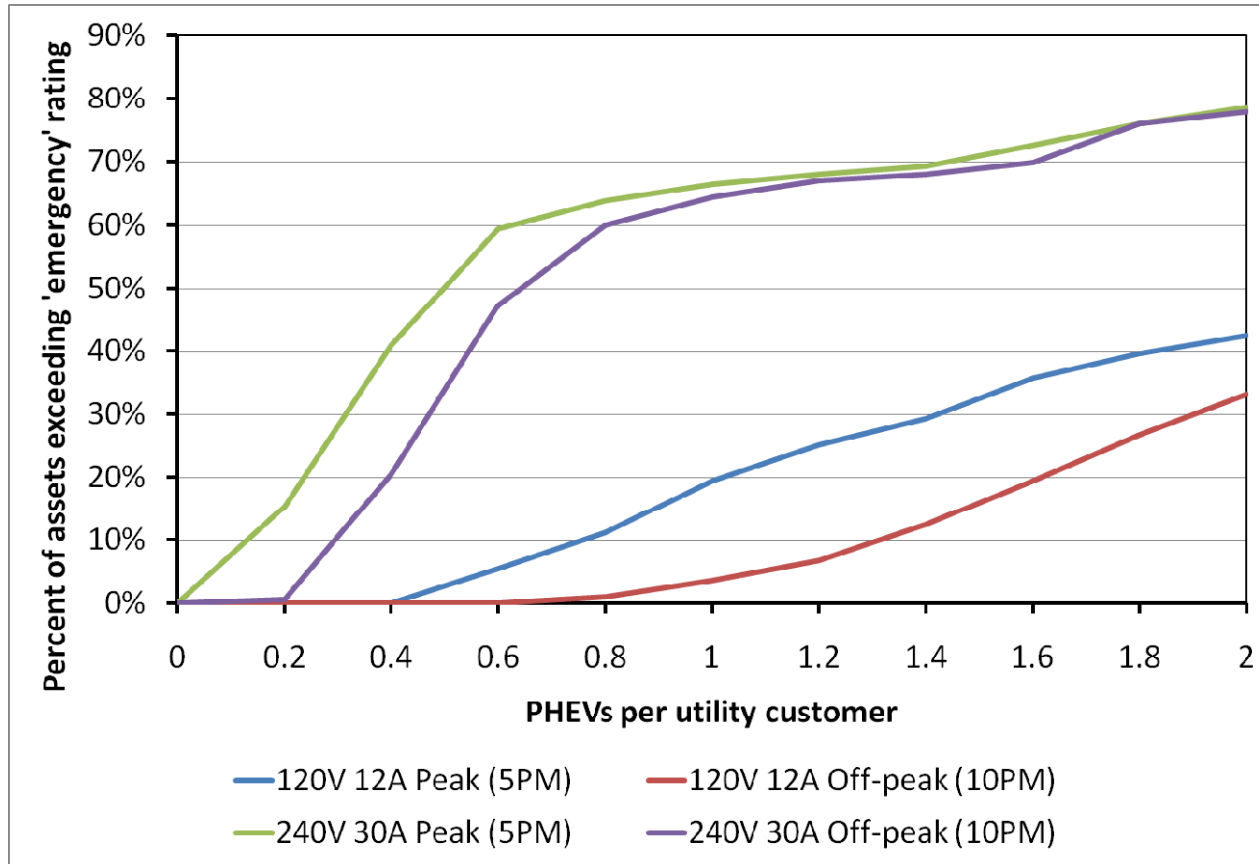


Residential transformers are the first assets significantly impacted

- **Flexibility in Model Development**

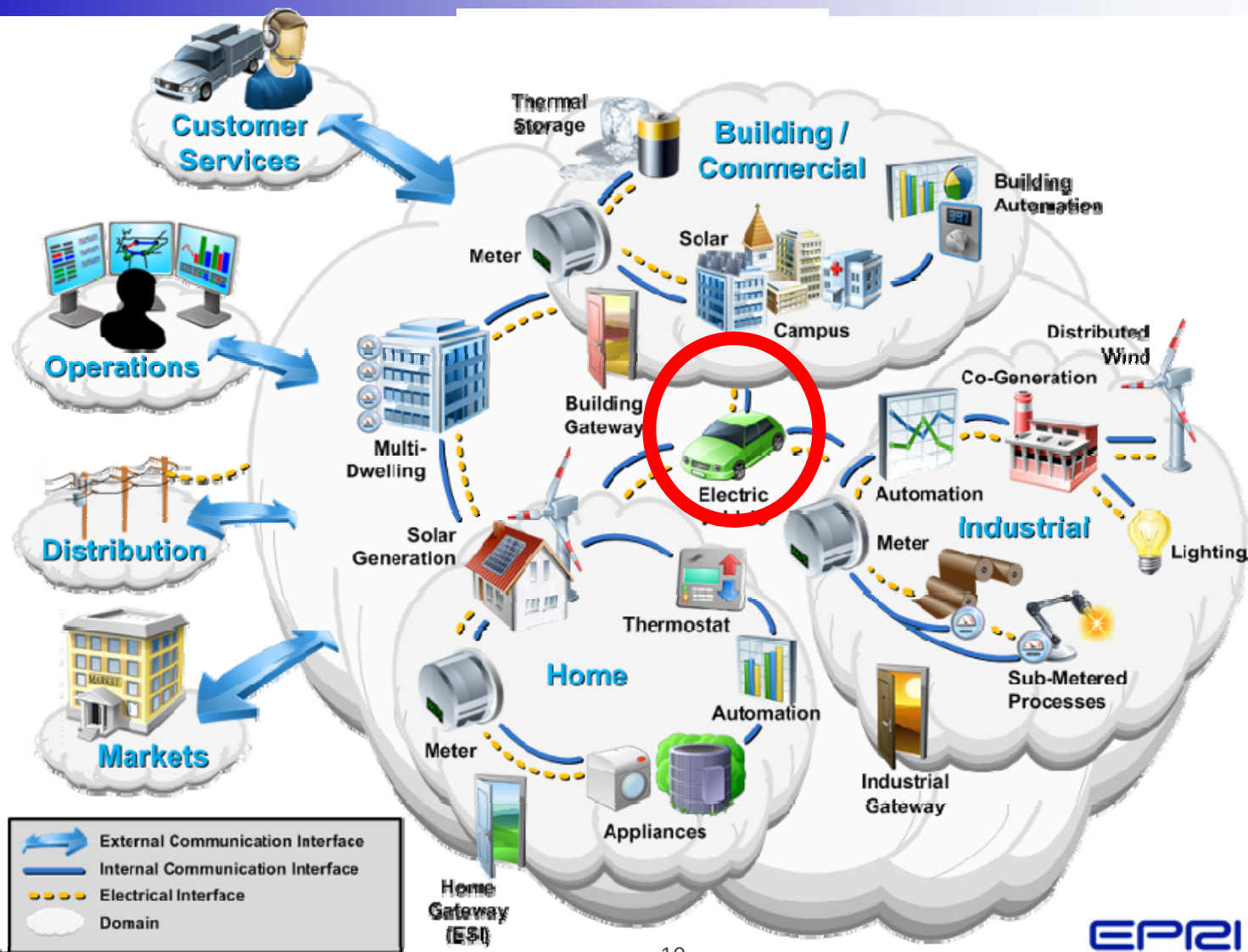
- ✓ High-fidelity distribution feeder models
- ✓ Spatial and temporal variation of circuit loads and PHEV Loads
- ✓ Dynamic simulation of full electrical model serving PHEV

Asset overloading can increase quickly

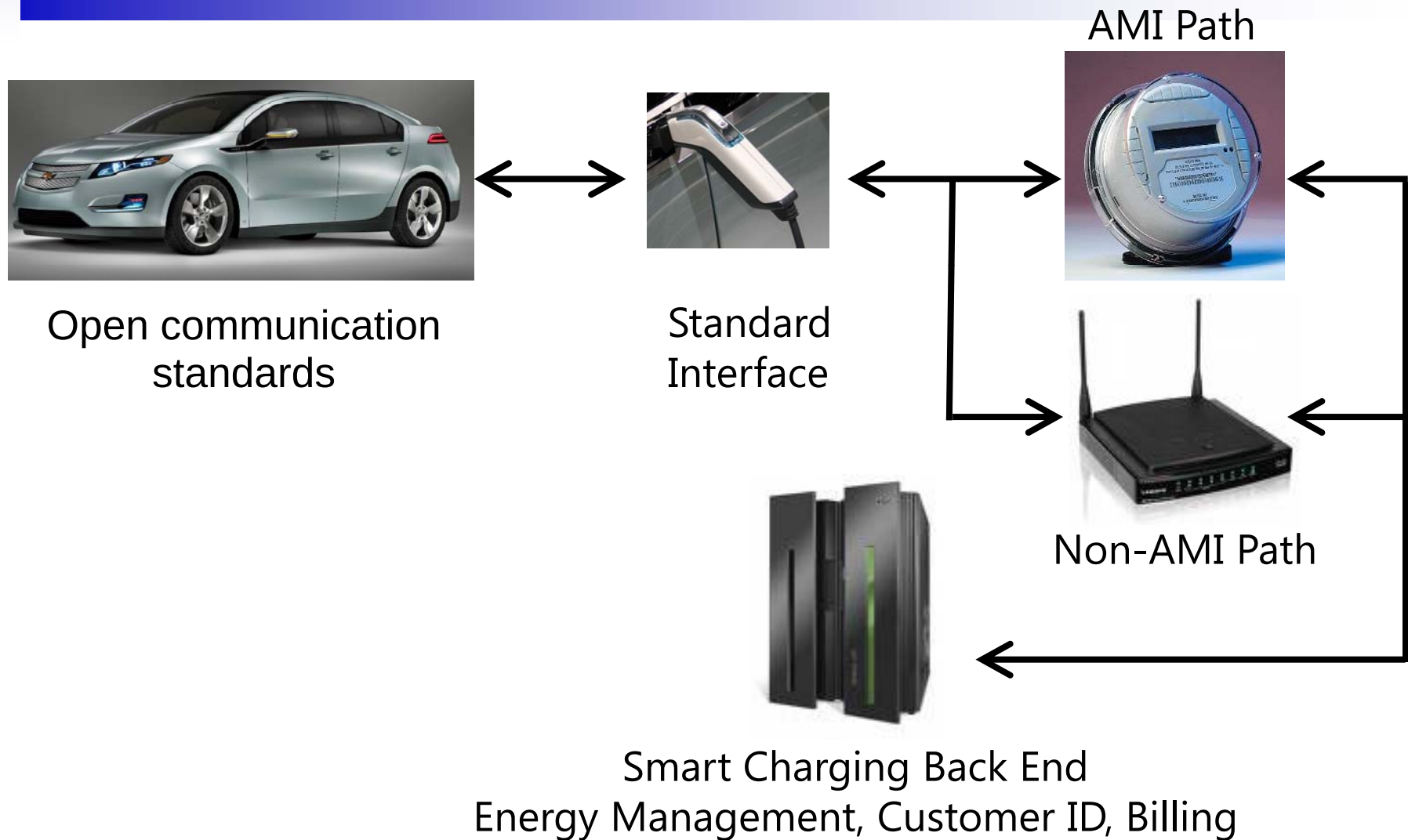


- With medium rate charging, it takes less than one PHEV per household to significantly increase overloading

Smart Charging – Integration of Plug-In Vehicles with the Smart Grid



Plug-In Vehicle Grid Integration



Standards Necessary for All Infrastructure Strategies

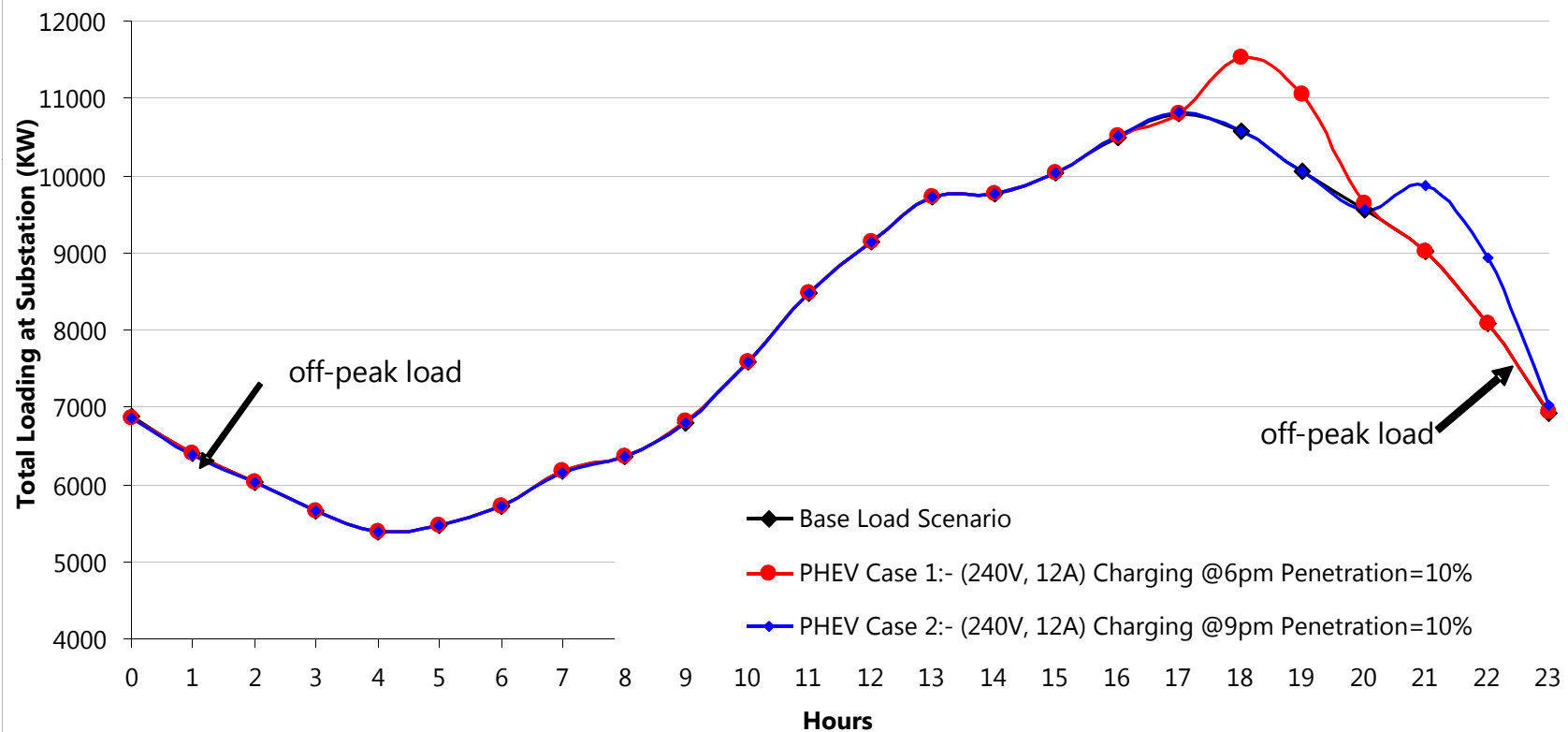
- Common Level 1 (120V) and Level 2 (240V) connector
- Communication standard governing vehicle-to-grid messages and information
- Standards for high rate charging, electrical installations, and others



Distribution System Analysis

Smart Charging is a Key Technology to Reduce Impacts

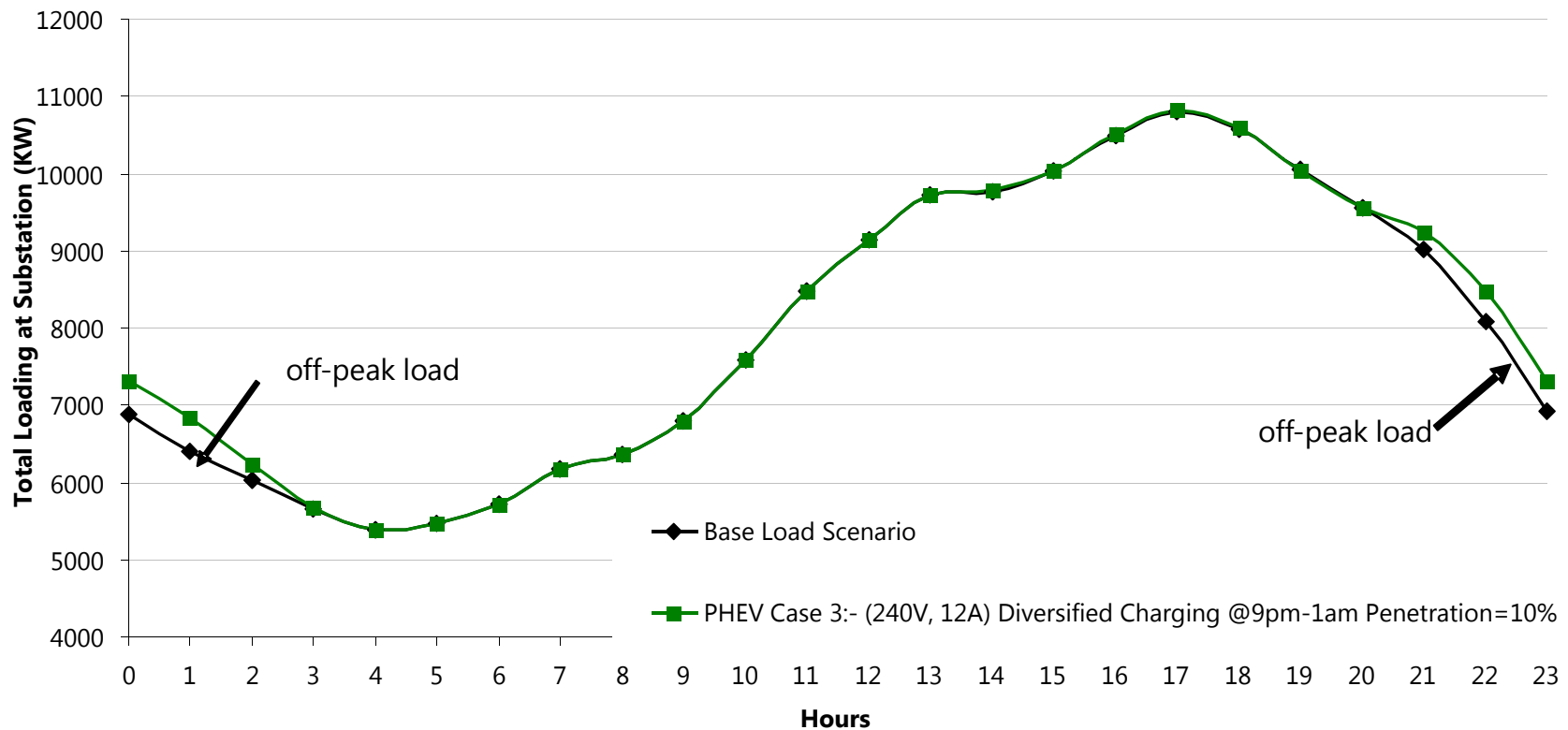
July 27th 2007 24 hr: Total Loading for the Feeder Under Study



Distribution System Analysis

Smart Charging is a Key Technology to Reduce Impacts

July 27th 2007 24 hr: Total Loading for the Feeder Under Study



To Electrify Transportation, You Must Get Electricity to the Vehicles

Build Today's Infrastructure Today

Focus on Residential

- Seamless installations for homeowners
- Permits, electricians, inspections
- Rates and customer programs

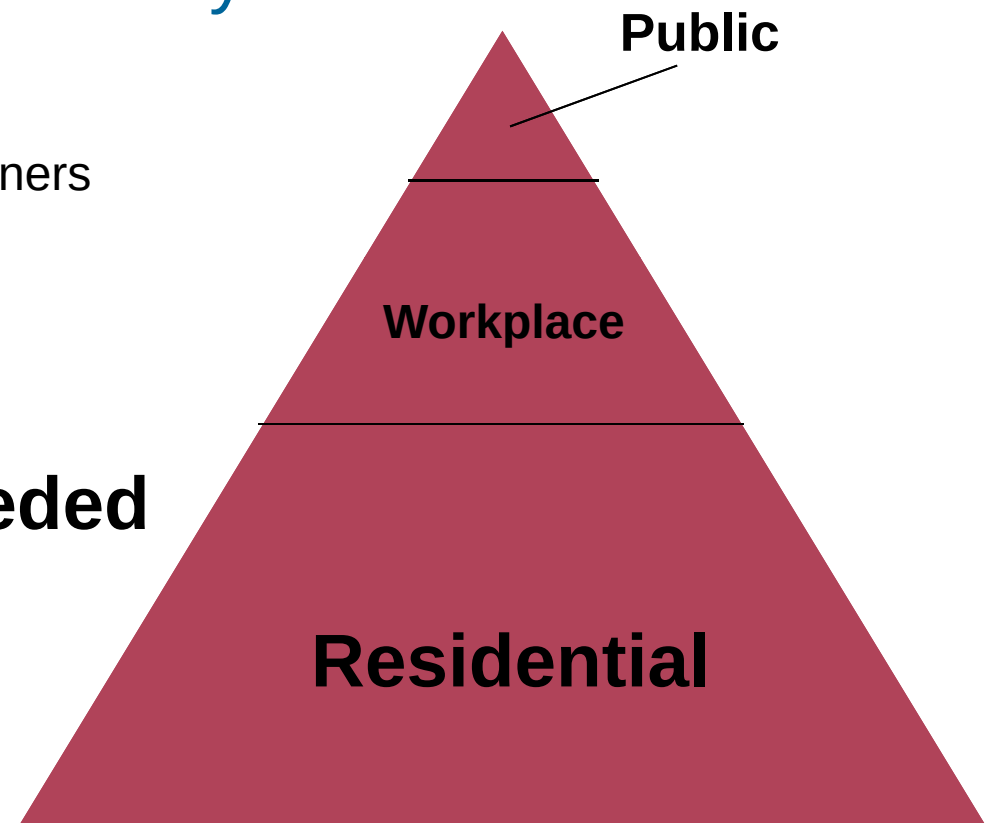
Workplace

Public Charging – as needed

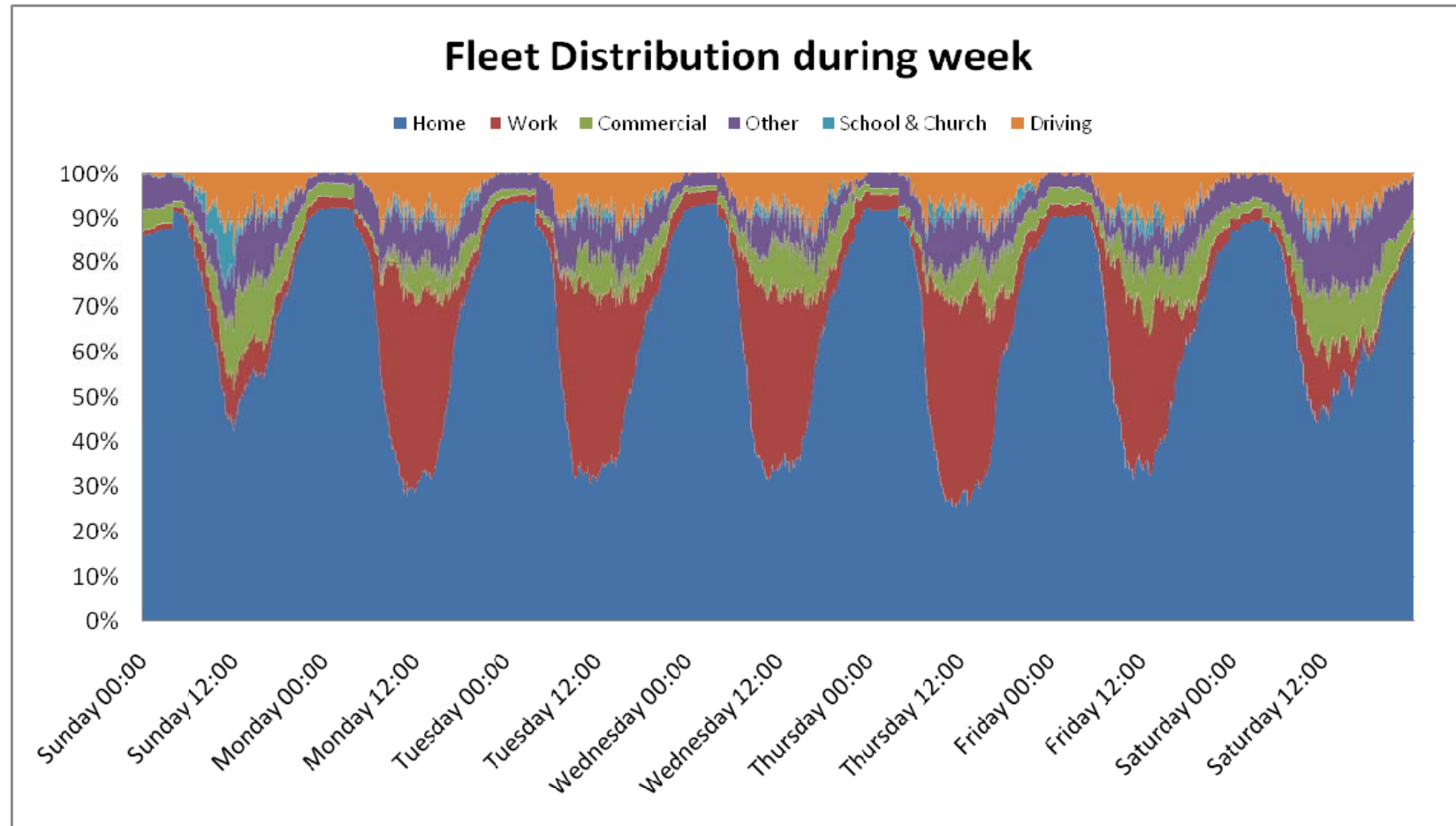
- Retail, private, public spaces
- Open access

Know what drivers need

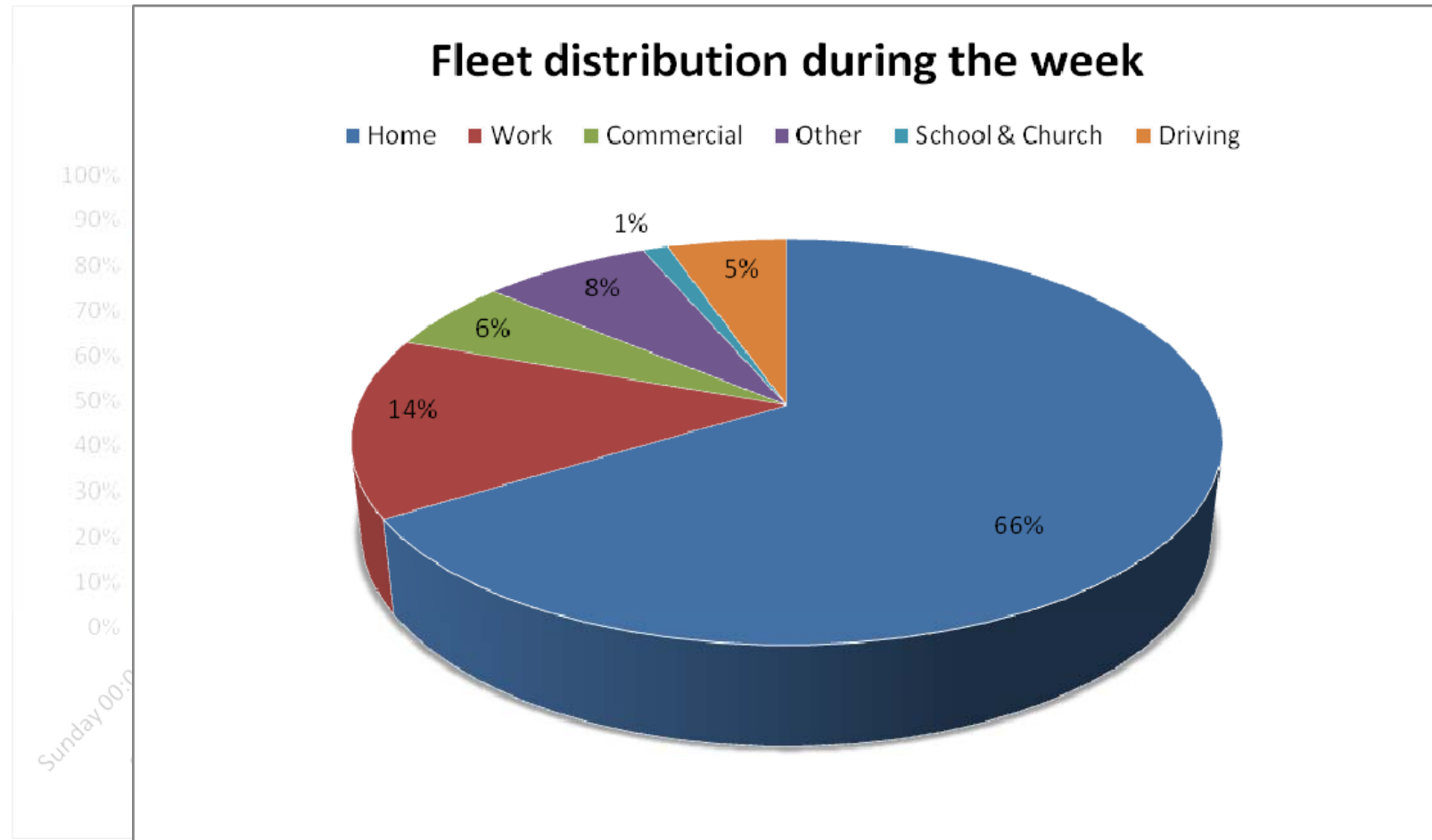
Know where cars are parked



Deliver Electricity, Charging Infrastructure to the Vehicle's Location

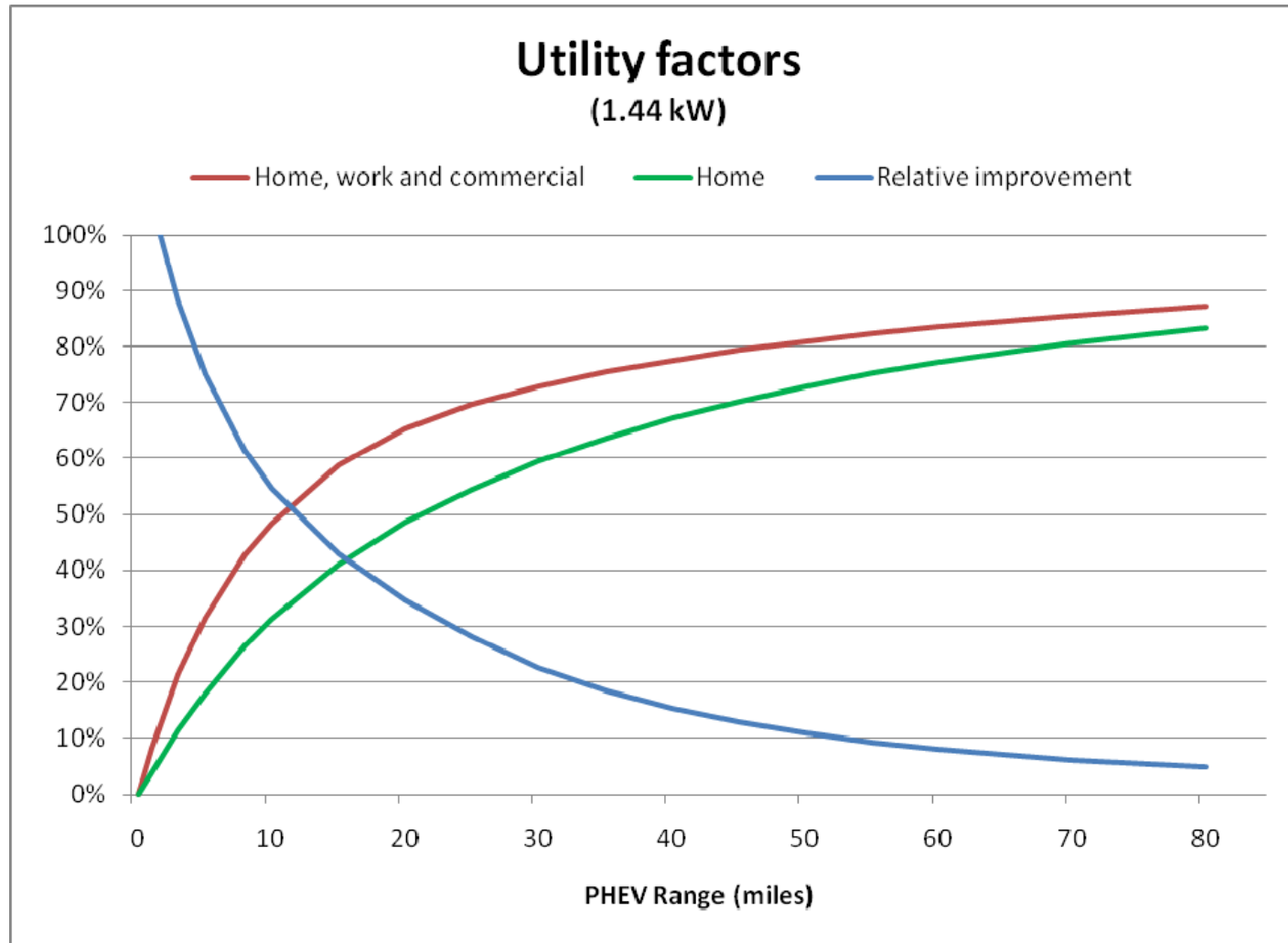


Deliver Electricity, Charging Infrastructure to the Vehicle's Location



Opportunity Charging Increases Electrification

Impact Depends on Vehicle Range



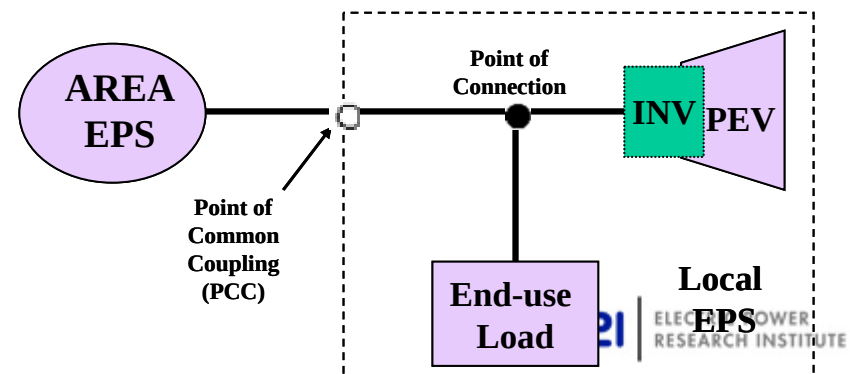
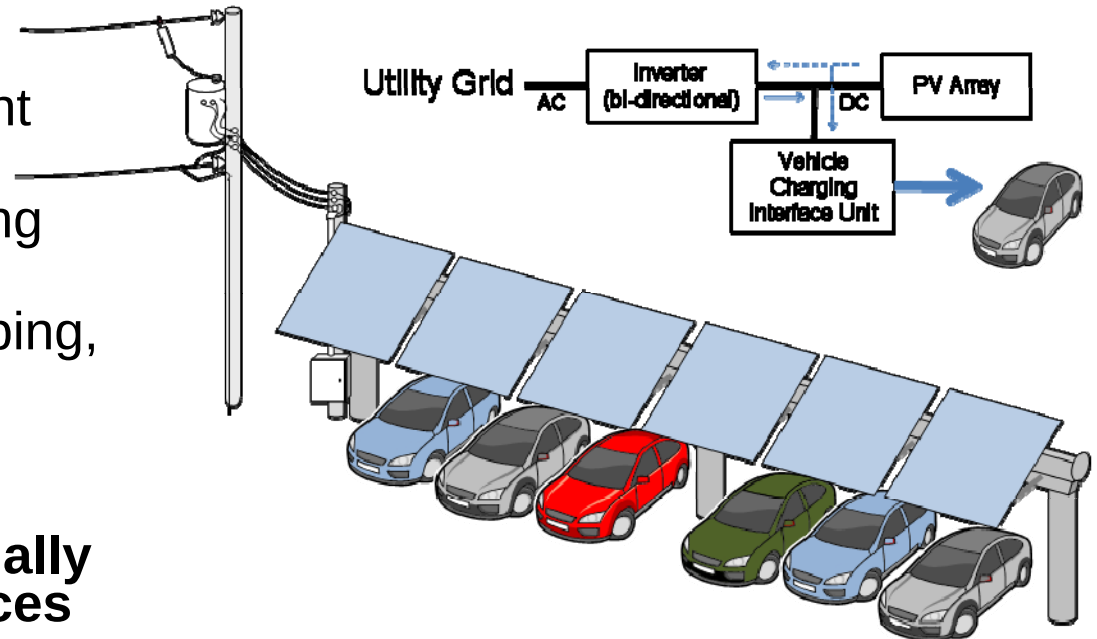
Plug-In Vehicles as Distributed Energy Resources

- **Definitions**

- V2G – bidirectional transient power & ancillary services
- V2H – premise peak shaving and DR
- Smart charging – load shaping, DR, etc.

- **Whether or not true V2G is realized, vehicles will eventually be aggregated for grid services**

- 3rd party DR
- Grid regulation, even if one-way
- 3rd party smart charging
- Renewables integration

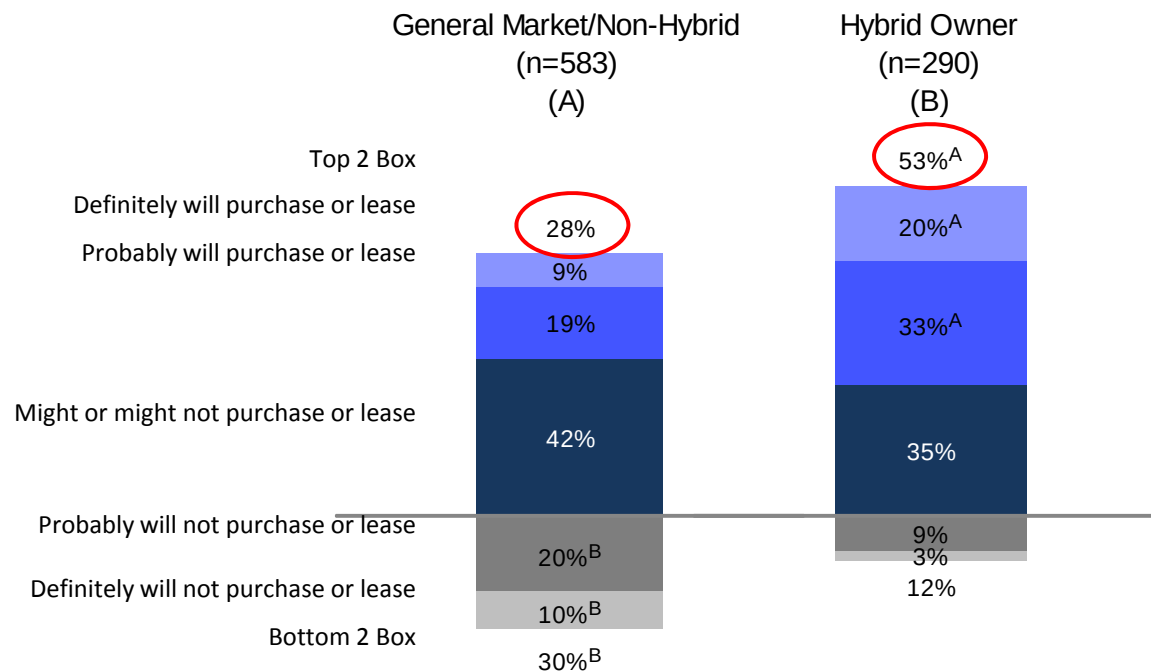


PHEV Purchase Interest

Hybrid and Non-Hybrid Owners

PHEV Purchase Interest

Base: Among Those Who Currently Own A Standard Vehicle



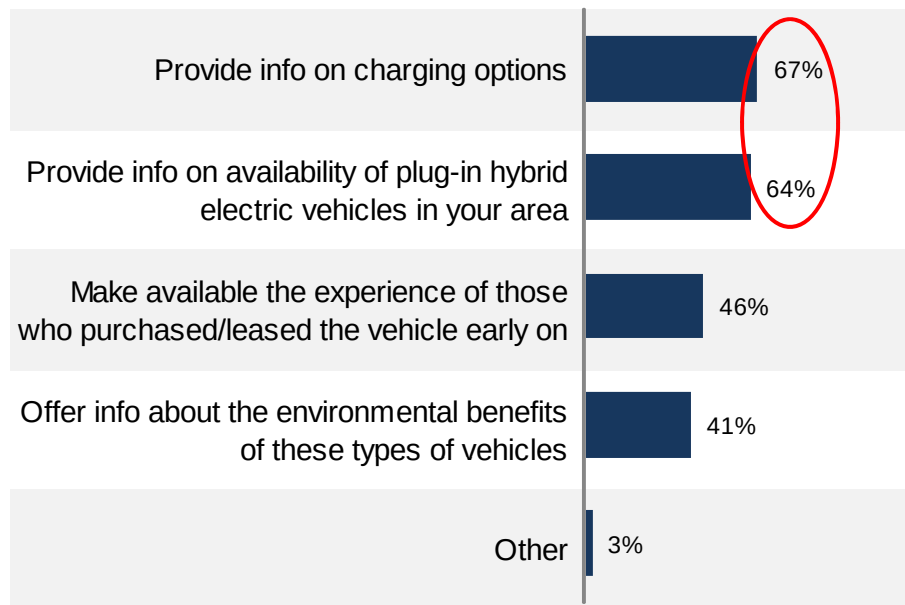
NOTE: Capital letters represent statistical differences at a 95% confidence level.
 Q. 15 How likely are you to purchase or lease this vehicle as a plug-in hybrid electric vehicle the next 5 years?

Customer Expectations of Their Utility

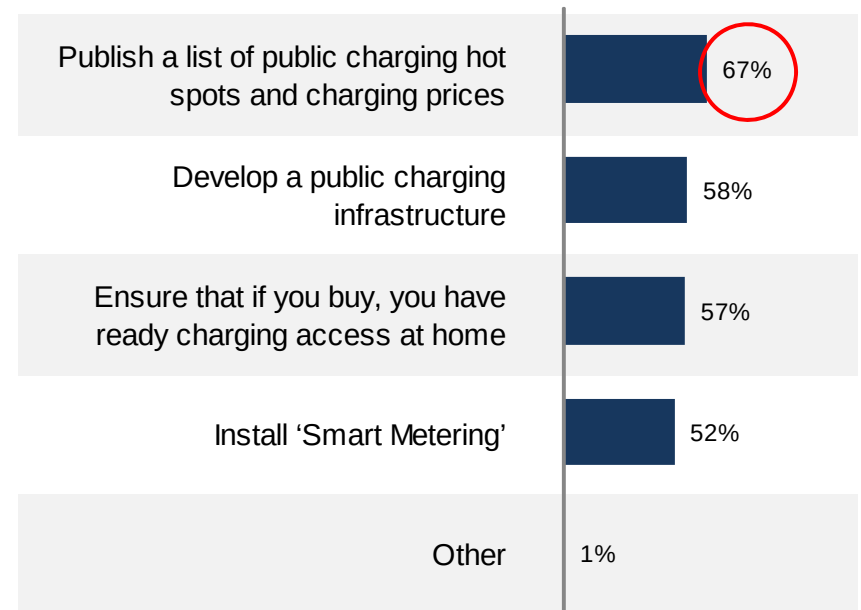
Expectations Of The Utility

Base: General Market (n=602)

How The Electric Company Can Help Keep Consumers Informed



Consumers' Desired Services From The Electric Company



Q. 40a How can your electric utility company best help you stay informed about plug-in hybrid electric vehicles?

Q.40b If you were planning on purchasing or leasing a plug-in hybrid electric vehicle, which of the following services would you want from your electric company?

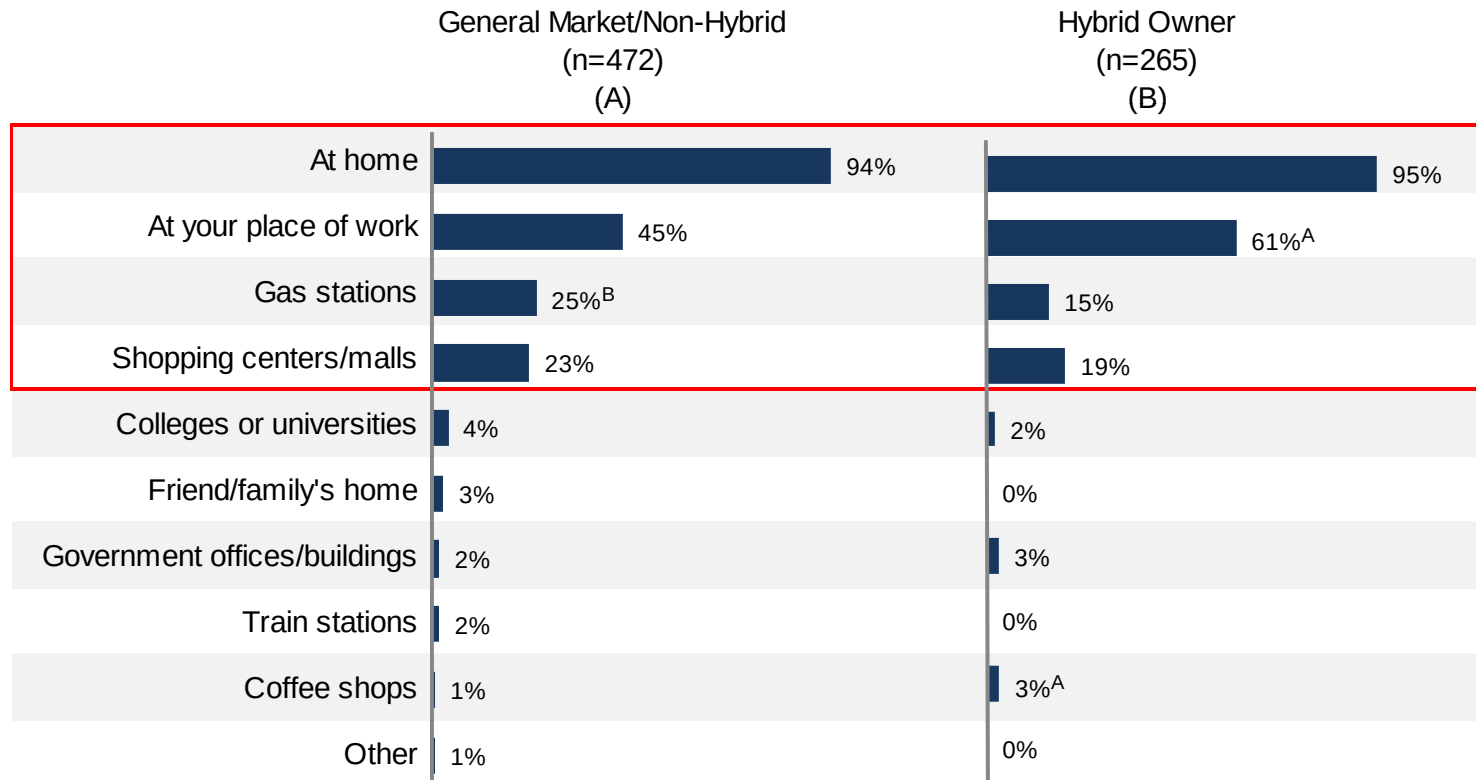
Preferred Charging Locations

Preferred Charging Location

Base: Among Those Who Mentioned A Preferred Station

50% of consumers expect a full charge to take 4-8 hours

Top 2 Preferred Charging Locations



NOTE: Capital letters represent statistical differences at a 95% confidence level.
 Q. 19 If you owned a plug-in hybrid electric vehicle, which locations do you think you would use the most to charge the vehicle?
 Q. 21 How much time do you expect it to take to fully recharge a plug-in hybrid electric vehicle, assuming that the battery was low?

Planned Use of Public Charge Stations

Planned Usage Of Public Charging Stations

Base: Total Respondents

Charging Stations Most Likely To Use

	General Market/Non-Hybrid (n=587) (A)	Hybrid Owner (n=292) (B)
A retail store	22%	20%
A typical gas station	21%B	13%
A charging station that offered free Wi-Fi	16%	18%
A club store	11%	16%
A city-owned station	10%	12%
A government-owned station	6%	4%
An electric utility company	6%	6%
A college or university	4%	3%
A coffee shop	4%	6%
Some other company	1%	2%

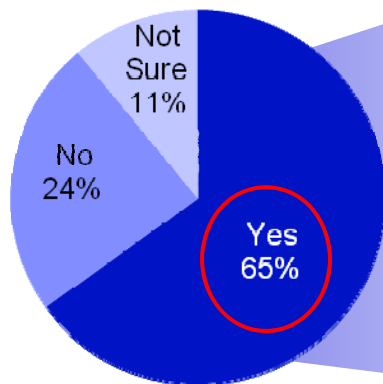
NOTE: Capital letters represent statistical differences at a 95% confidence level.
Q. 27 Assuming that each station were to offer recharging at the same price, which of the following types of stations would you use the most?

240-Volt Accessibility

240 Volt Accessibility Near Parking Location

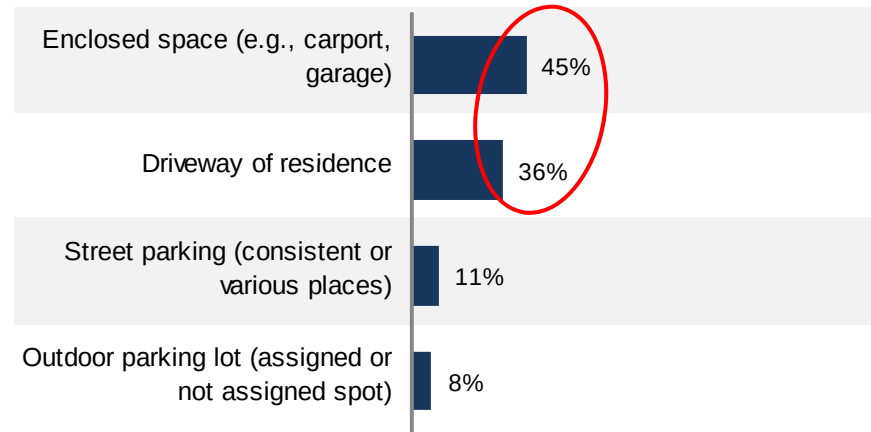
Base: General Market

**Available 3-Prong Outlet within
25 Feet of Parking Location**
(n=602)



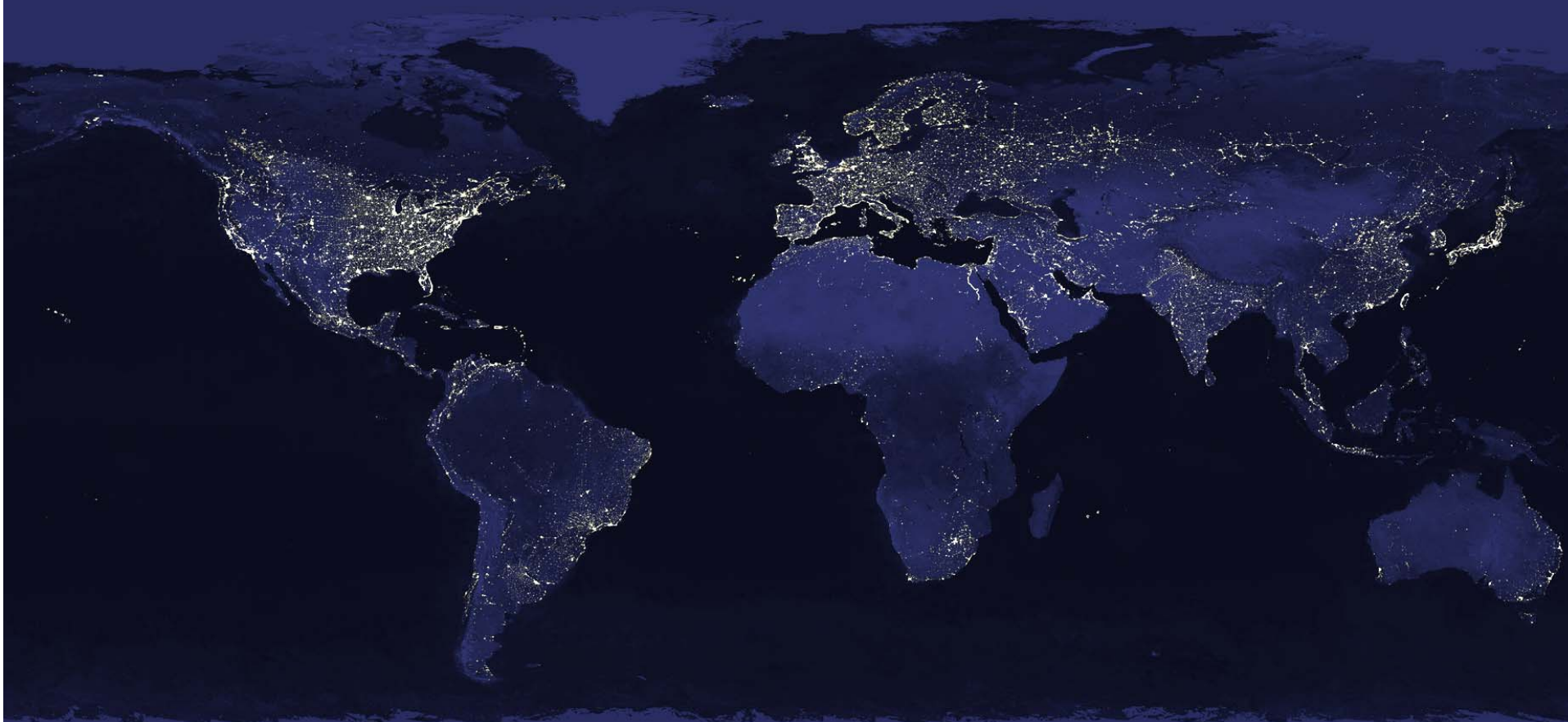
Current Parking Situation

Base: Among Those Who Have Access To 3-Prong Outlet Within 25 Feet Of
Parking Location And Are The Primary Driver of A Standard Vehicle
(n=360)



NOTE: Capital letters represent statistical differences at a 95% confidence level.
Q.22 In a typical week, which of the following best describes where you park your primary vehicle the most?
Q. 23 Do you currently have a conventional 3-prong electrical outlet within 25 feet of where you park your primary vehicle at your residence?
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Image from NASA Visible Earth

Potential Utility Roles

- Seamless customer experience
 - Outreach and education
 - Consumers and fleet
 - Facilitate residential, commercial infrastructure
 - Support public infrastructure
- Minimize Grid Impacts
 - Smart grid integration – smart charging
 - Distribution planning
 - Customer programs