

EPRI

ELECTRIC POWER
RESEARCH INSTITUTE

Plug-In Vehicles:

A New Way of Thinking about the Electric Grid

EMEP Conference

October 15th, 2009

John Halliwell

Plug-In Vehicles are Coming



PEV Development Timeline

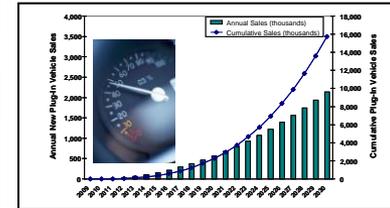
First Announcements
of Production-Intent
PHEV Programs



1st PHEV Introduction



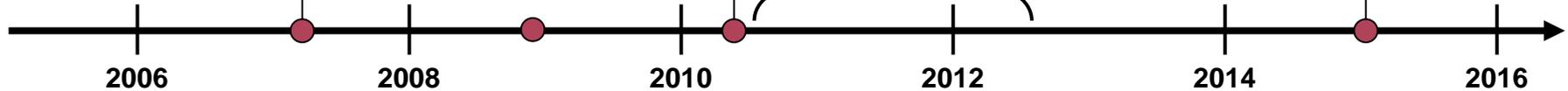
Other OEM
PHEVs, EVs
Enter Market



Production Ramp Up



Launch of 1st
Gen 2 Programs



PEV Development Timeline

First Announcements of Production-Intent PHEV Programs



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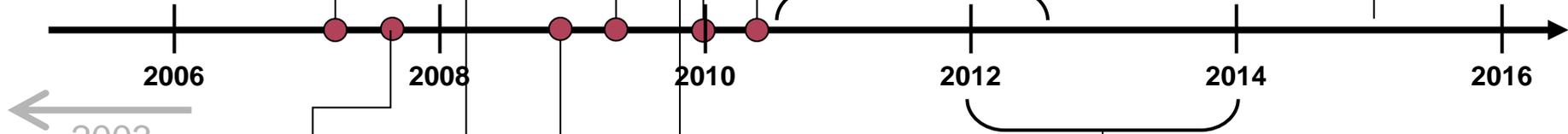
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Production Ramp Up



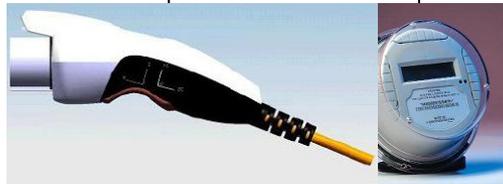
Launch of 1st Gen 2 Programs



2003
First EPRI – Auto PHEV Program (PHEV Sprinter)



Begin Ford PHEV Demonstration



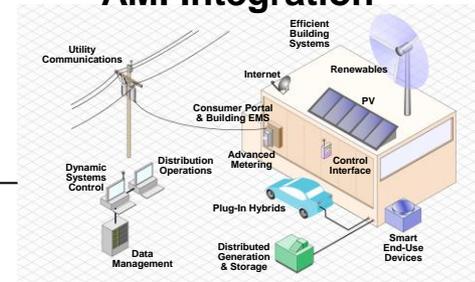
Finalize Connector (J1772)

Finalize Communications (J2836)



EPRI – GM PHEV and Smart Charging Development

Production Implementation of Smart Charging and AMI Integration



Utility Challenges and Opportunities

Opportunities

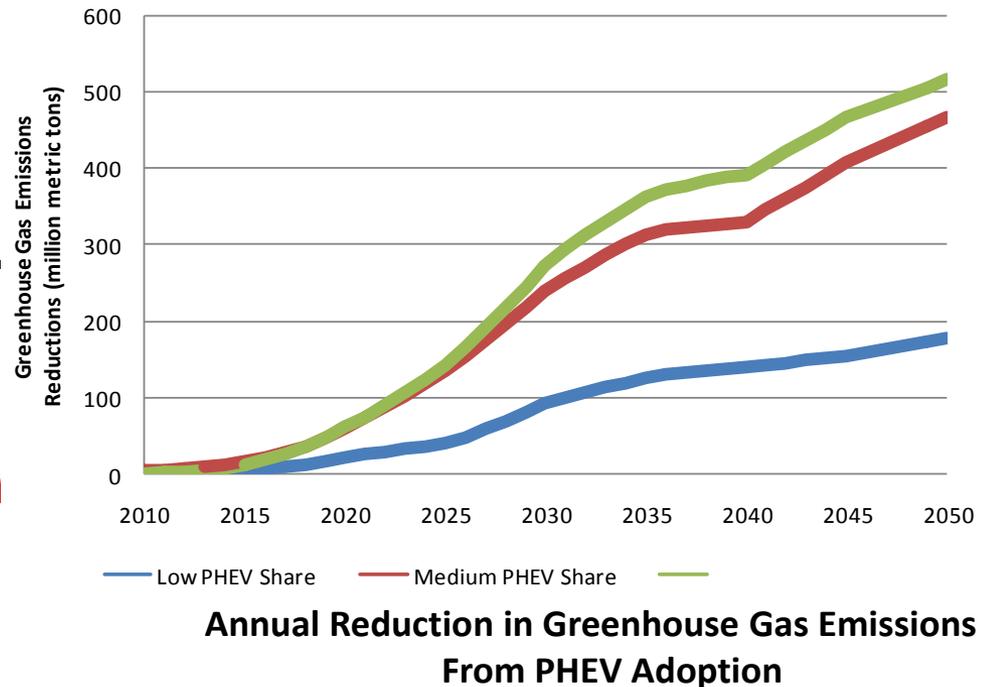
- Beneficial electrification
- Cost-effective emissions reductions
 - CO₂
 - Criteria emissions
- ‘New’ customers on existing assets
- New potential business models

Challenges

- Understand customer needs
- Understand and minimize system impacts
- Near-term rollout (2010) vs. long-term planning
- Staying abreast of a fast moving standards and practices landscape
- Being proactive, not reactive

Environmental Impact of Electric Transportation

- Results of detailed electric sector and air quality modeling
- **ET creates definitive well-to-wheels CO₂ reduction**
- **U.S. Potential: 400-500 million metric ton annual (on-road) 100+ million mton (non-road)**
- ‘Credit’ for these reductions still undetermined
- Nationwide improvement in air quality—all gen sources



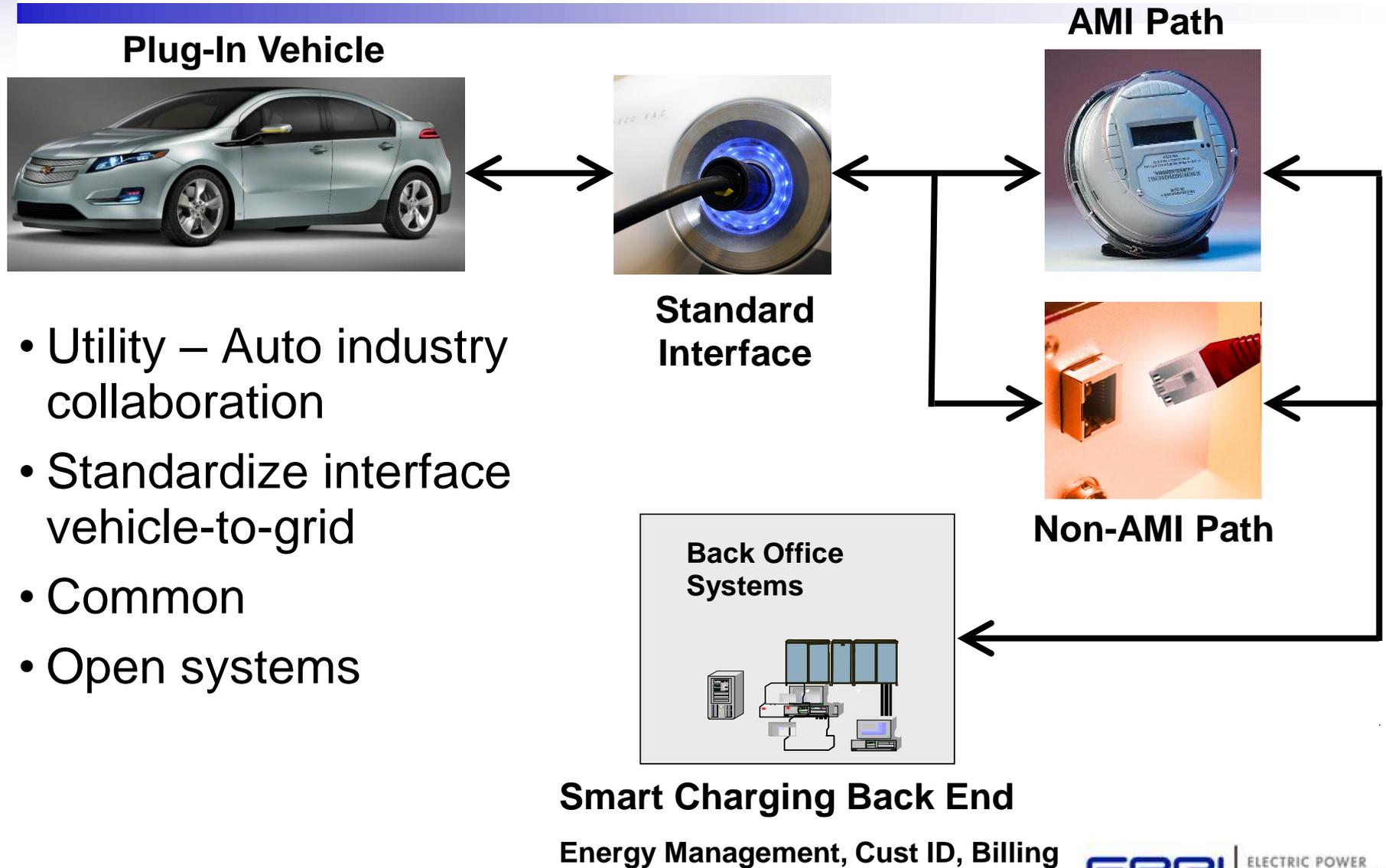
High PHEV Share

Community Economic Benefits

- Study of Cleveland Metro area
 - 2.9M residents
- EV adoption:
 - Increases electricity consumption
 - increases household income
 - 6k – 10k jobs/yr created

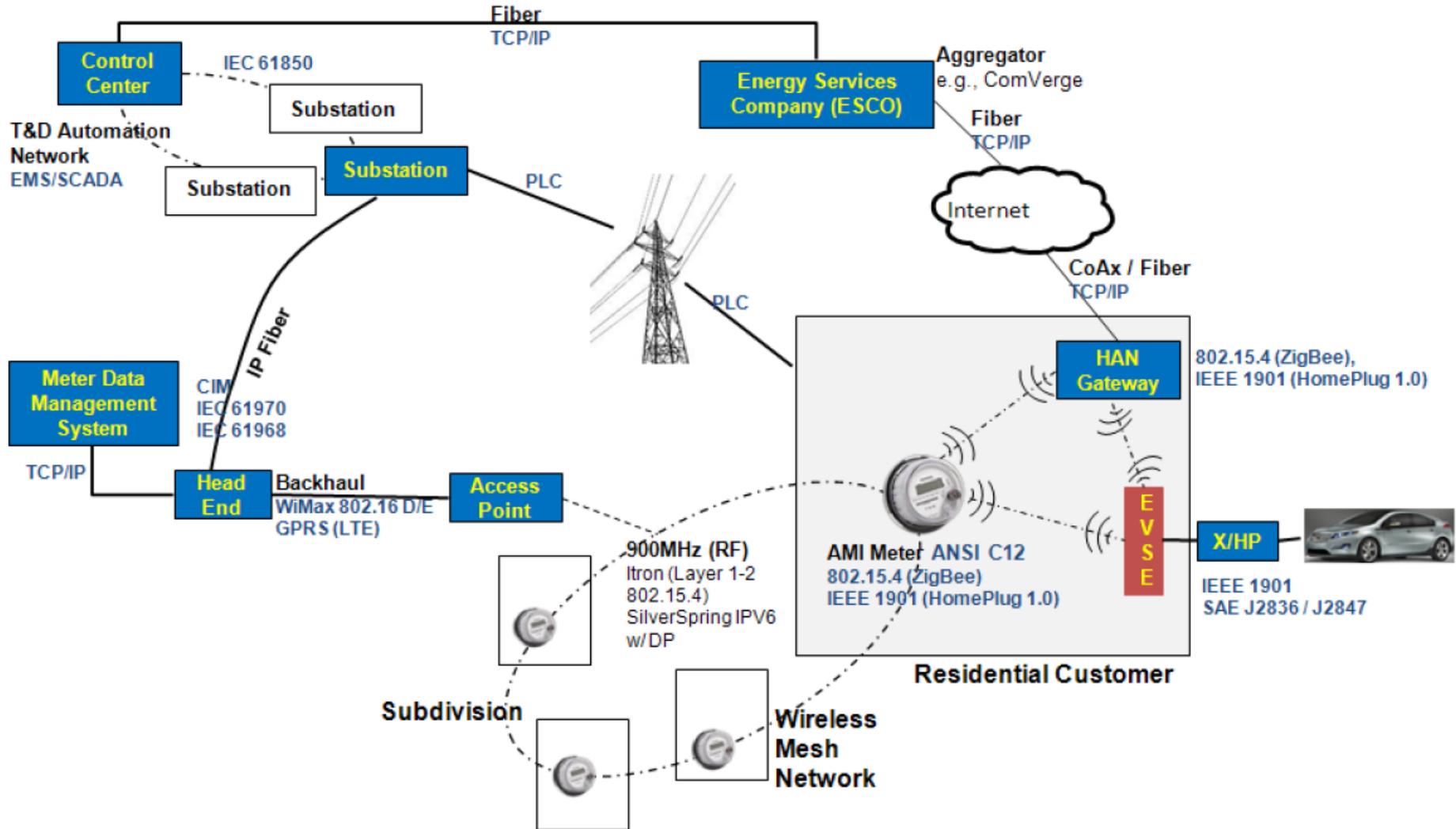
	Electricity 0.090/kWh	Electricity 0.093/kWh
2020 Impact	Gas 2.51/gal	Gas 3.51/gal
<i>Light Duty Vehicles</i>		
Reduced Petroleum Demand	-1,010.2	-1,413.0
Increased Electricity Demand	266.9	275.8
Increased HH Income	743.3	1,137.2
<i>Heavy Duty Vehicles</i>		
Reduced Petroleum Demand	-84.9	-121.8
Increased Electricity Demand	23.0	23.7
Increased HH Income	62.0	98.1

Components of Grid Integration



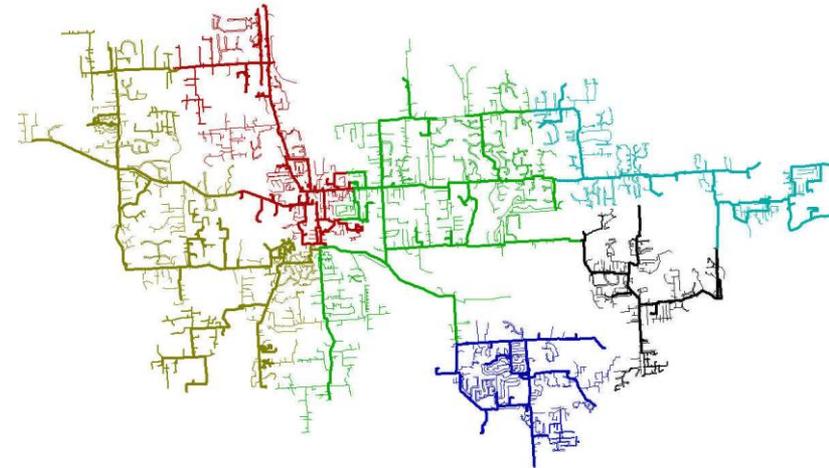
- Utility – Auto industry collaboration
- Standardize interface vehicle-to-grid
- Common
- Open systems

PEVs in the Smart Grid



Distribution System Impacts

- Evaluate localized impacts of PHEVs to utility distribution systems
- Participants – 14 Utilities; Con-Ed was the lead



Distribution Impacts

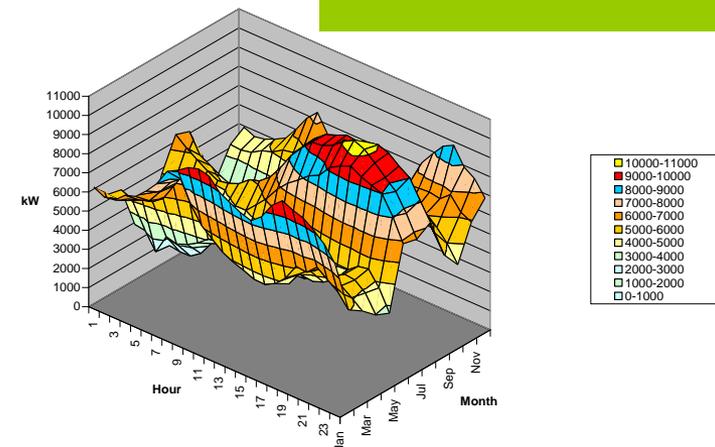
- Thermal Loading
- Losses
- Voltage
- Imbalance
- Harmonics
- Protection System Impacts
- Advanced Metering
- EE devices

Plug-In Characteristics

- Plug-in vehicle type and range
- PEV market share and distribution
- Charge profile and power level
- Charger behavior

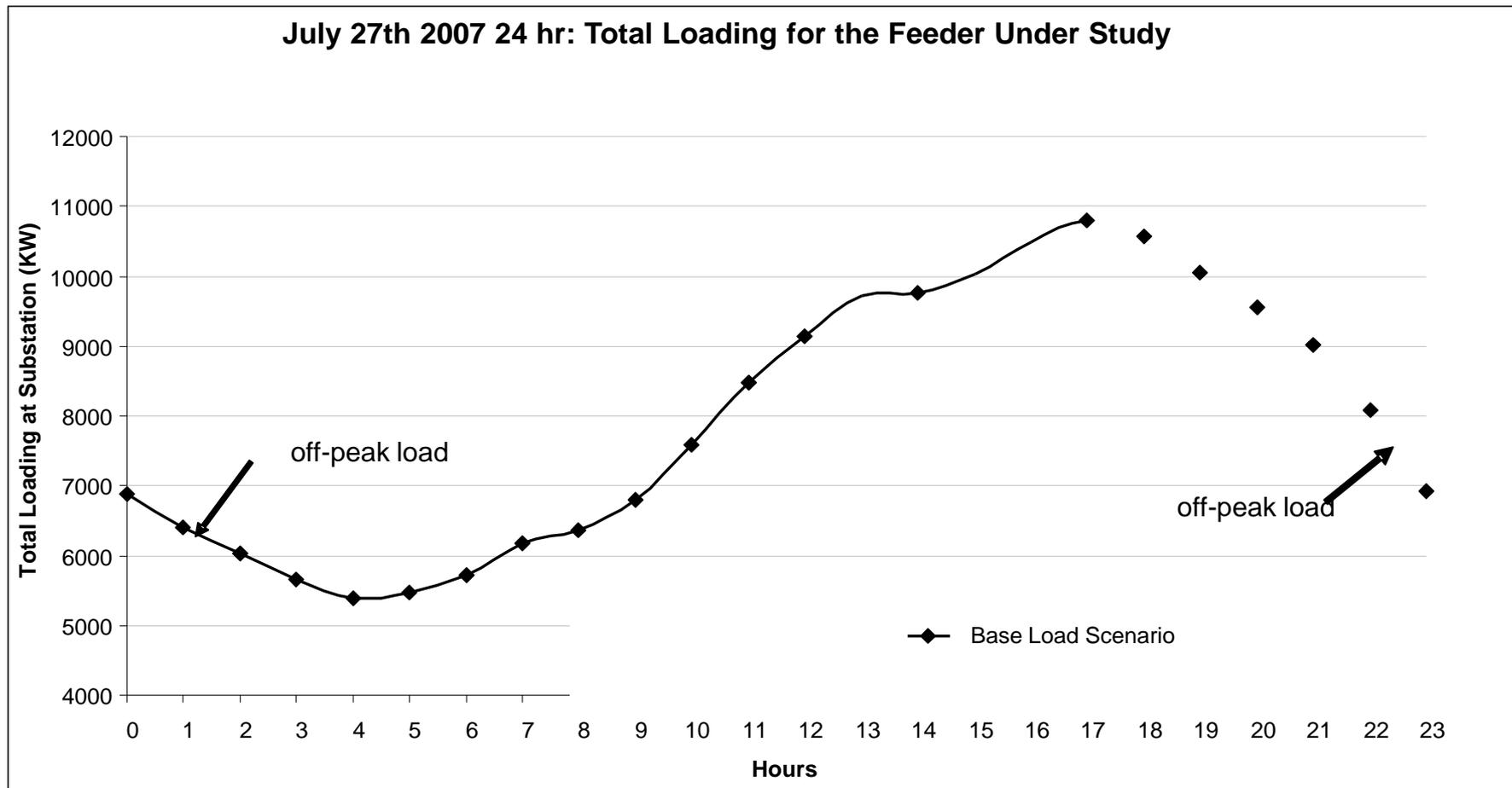
Total Loading on Feeder Under Study (2007) kW

Peak - Jan and July and August
Peak Period @ July/Aug - 1pm - 8pm
Peak Period @ Jan - 8am - 11am & 5pm-9pm
Peak - 10.4MW @ July 27th, 2007 @ 5pm



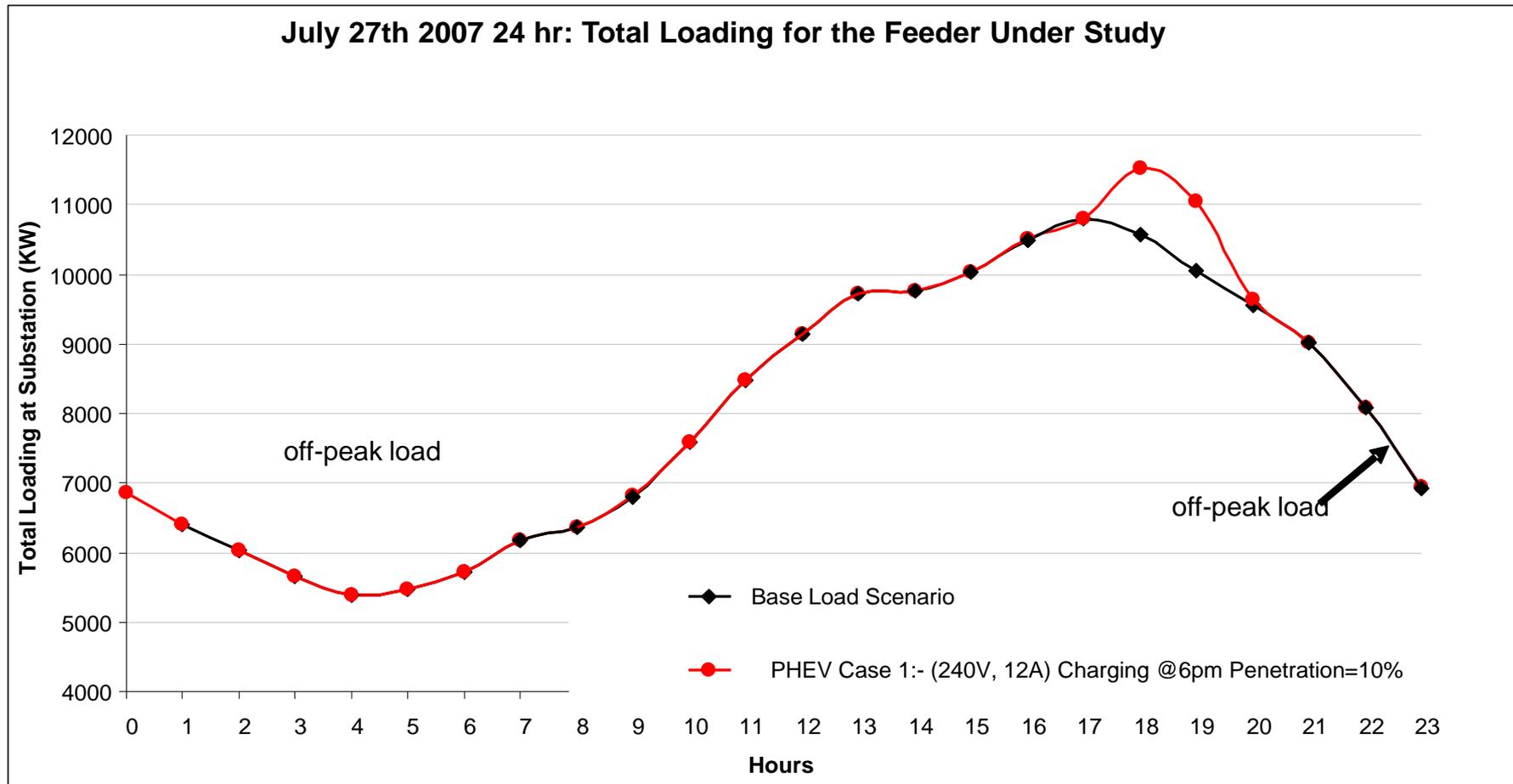
Distribution System Analysis

Smart Charging is a Key Technology to Reduce Impacts



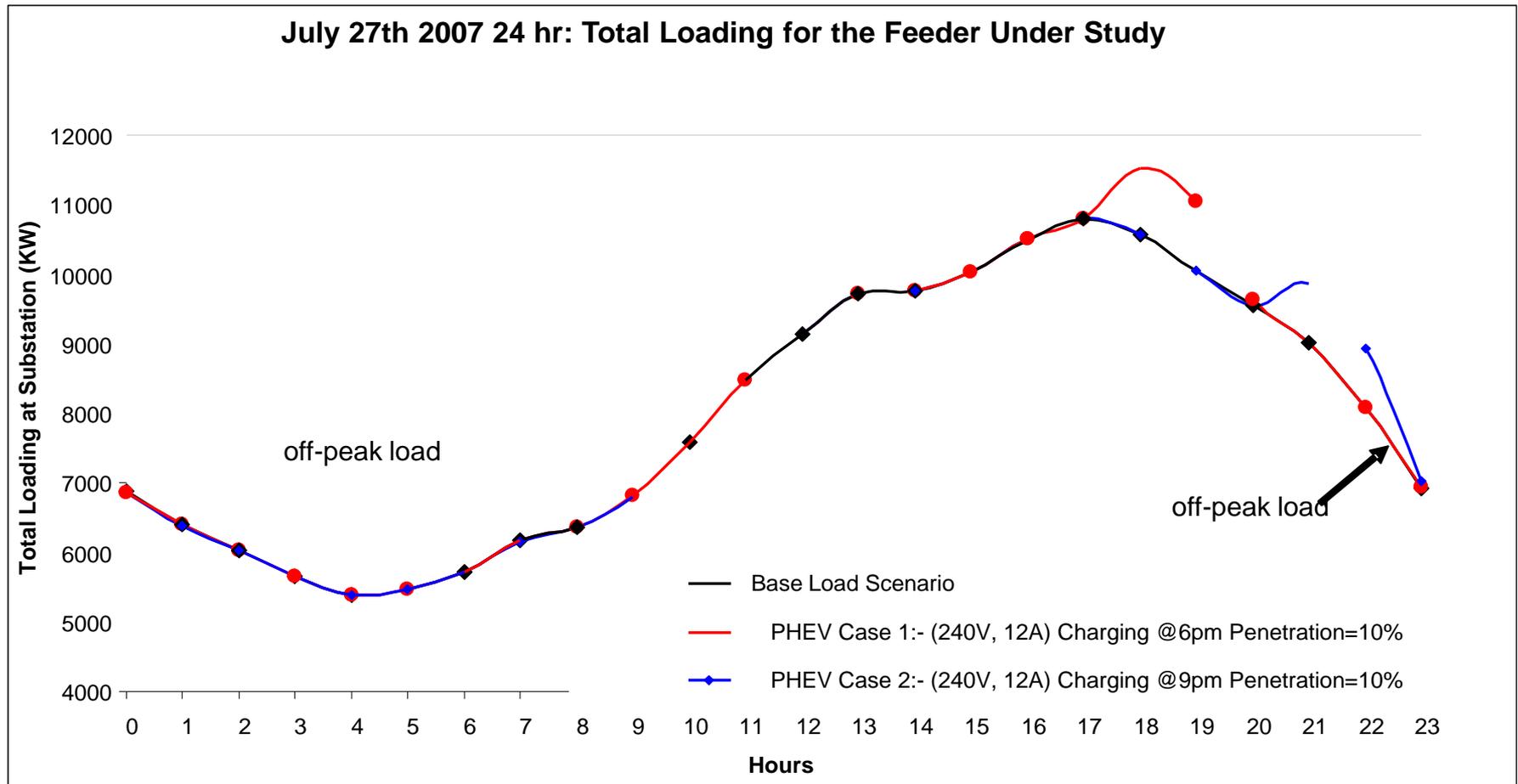
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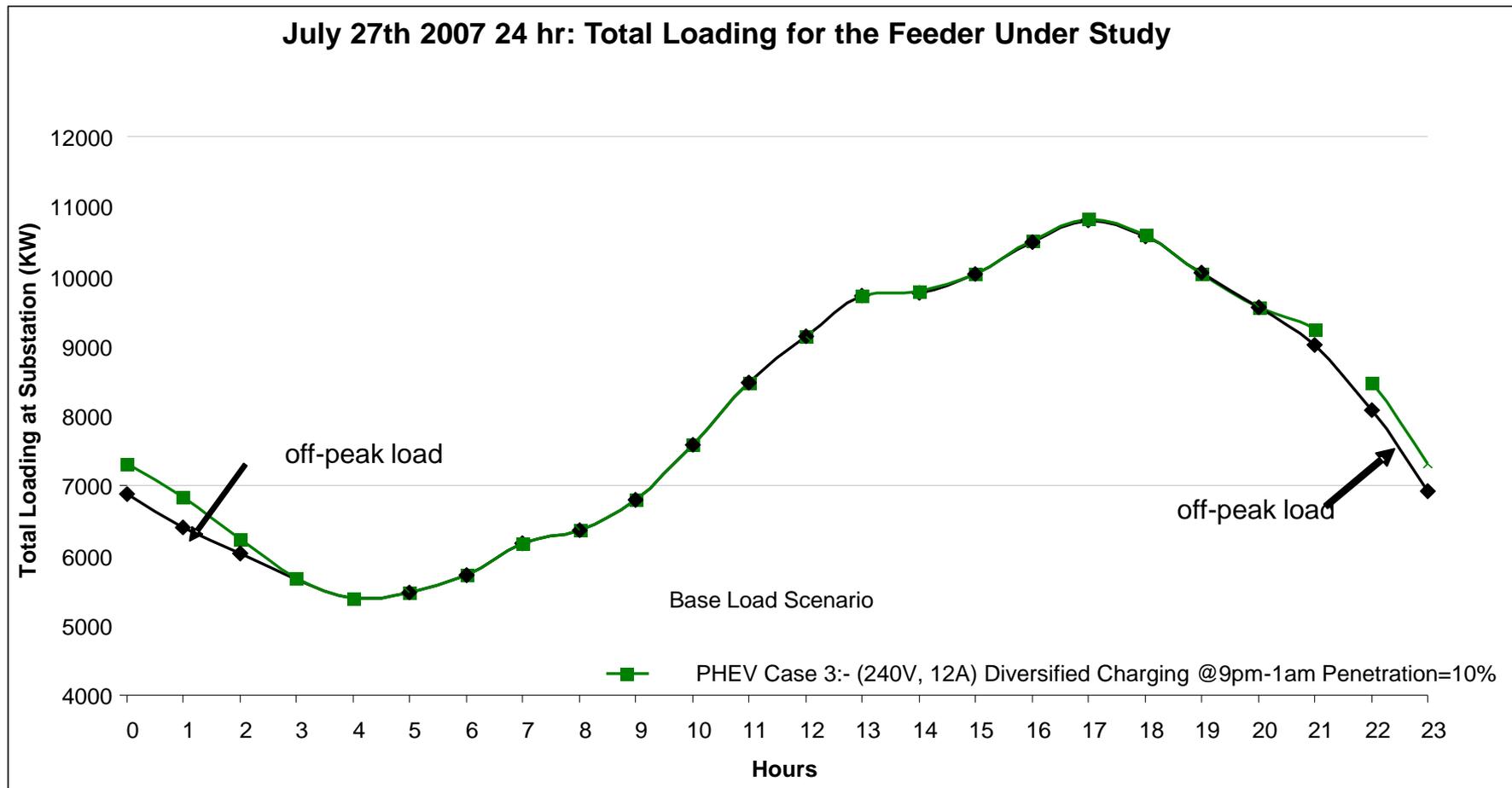
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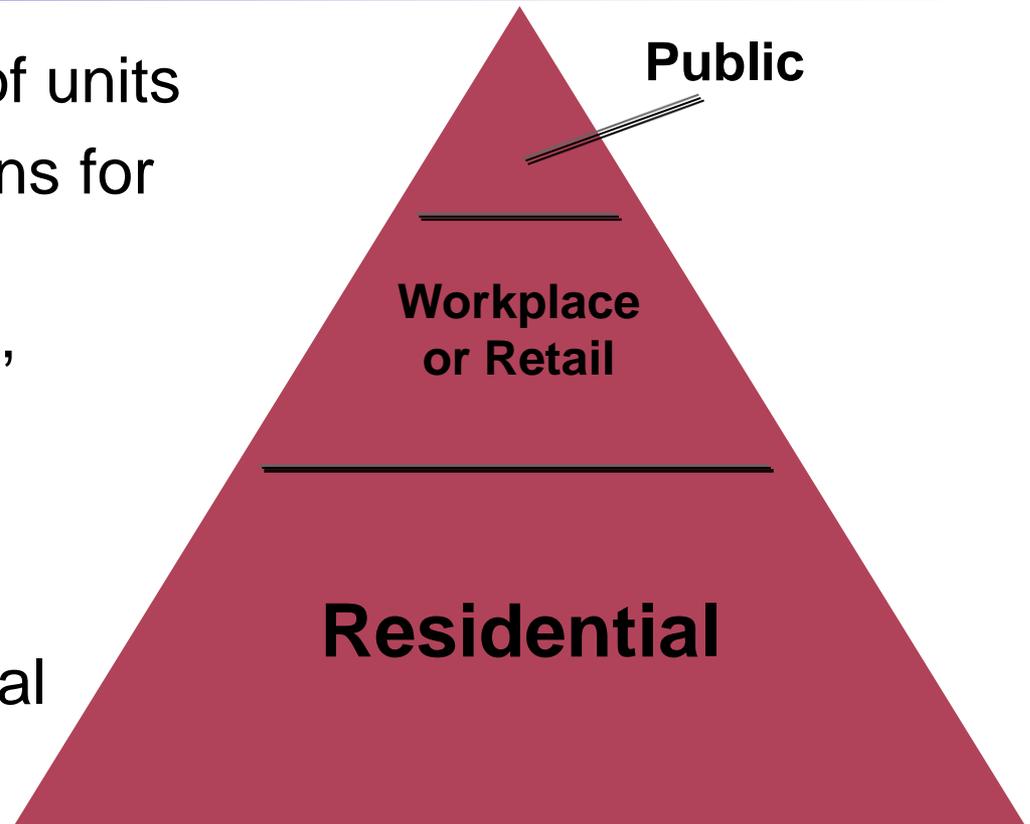
Distribution System Analysis

Smart Charging is a Key Technology to Reduce Impacts



Charging Infrastructure

- Residential – majority of units
 - Seamless installations for homeowners
 - Permits, electricians, inspections
 - Rates and
- Workplace or Retail
 - Commercial/Industrial customers
- Public Charging
 - Support municipalities
 - Very expensive



EPRI Vision: Smart PEV Evolution

Technology	Time Horizon	Applications	Enablers
Smart Charging	Near-Term	Off-Peak Charging Demand Response and Load Control Critical Peak Pricing / Dynamic Pricing Down-regulation	Bidirectional Communications Standards Development OEM implementation Smart Grid implementation
Vehicle to Home	Mid-Term	Standby power Rooftop solar integration Household load shifting	Bidirectional power transfer Proven Value Proposition Standards development OEM and smart grid implementation
Vehicle to Grid	Long-Term	Voltage and Frequency Regulation Utility Peak Shaving	Bidirectional power transfer Proven Value Proposition Standards development OEM and smart grid implementation Proven Reliability and robustness Integration with grid operations
Renewables Integration	Longer-Term	Enabling more wind and solar capacity	Sufficiently high installed base Bidirectional Power Transfer Proven value proposition Standards development OEM / Smart Grid implementation Proven reliability and robustness Upstream integration with T&D and Generation

Ford PHEV Program

1st OEM—Utility Demo of PHEV Passenger Vehicles

- **Fleet demonstration of 21 PHEV Escape prototypes**
 - Ten new participants join SCE, Ford, and EPRI
 - Progress, DTE, NYPA, ConEd, Southern, NYSERDA, National Grid, AEP, Pepco, Hydro-Quebec
- **Vehicle deliveries completed this month**
- **3½ year test and demo program**



GM/EPRI/Utility Collaboration



PHEV 'Trouble Truck' Program

(Pending Contract Award)

- Migrate PHEV technology to high-volume applications
- Utility fleets act as early adopters
- Federal stimulus proposal
 - 328 vehicles to utility and public fleets in large multi-year demonstration
- Production-ready design and facilities



Non-Road Electric Transportation

- Airports & Sea Ports
 - Ground support equipment
 - Ground power
 - A/C & Refrigeration
- Material handling
 - Lift trucks
 - Trucks & support vehicles
- Benefits
 - Saves customers money
 - Beneficial electrification
 - Reduce emissions
 - Leverage existing customer relationship



Going Forward – Getting Ready

- Create internal team—fleet, system planning, customer service, etc
 - Emphasis on planning and education/training
- Understand community wants/needs
 - City governments, stakeholders
 - Support infrastructure planning
- EPRI supporting information
 - Public outreach and education materials
 - OEM collaborative and vehicle demo programs
 - Infrastructure planning information and tools
 - Fleet adoption info
 - Grid impacts and environmental analyses
- Develop a high-level plan—but pace the implementation

Together...Shaping the Future of Electricity