



Transportation Electrification



Grid Impacts of Plug-In Electric Vehicles



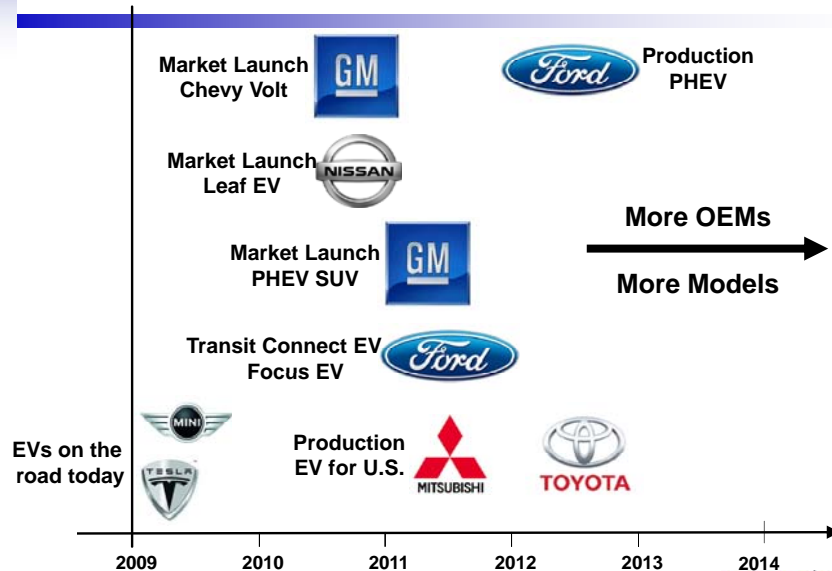
Mark Duvall

Director, Electric Transportation and
Energy Storage



March 15, 2010

Major Automaker Production Plans Current Status



Benefits of Electric Transportation

- Air Quality
 - Greenhouse Gas Emissions
 - Petroleum Reduction
 - Economic Output
-
- Realizing these benefits also requires minimizing the cost of widespread adoption
 - Community readiness is a key driver of both adoption and benefits



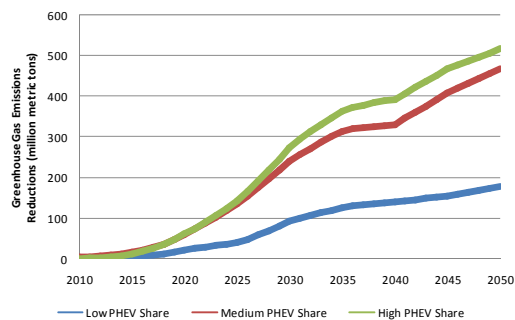
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Environmental Benefits of Plug-In Vehicles Key Challenges

- Electricity is a low-carbon fuel
 - Potential 400-500 mton reduction
- Nationwide air quality benefits—even under worst case scenarios
- 3-4 million barrels/day petroleum reduction
- Significant increase to regional economic output, jobs, household income



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

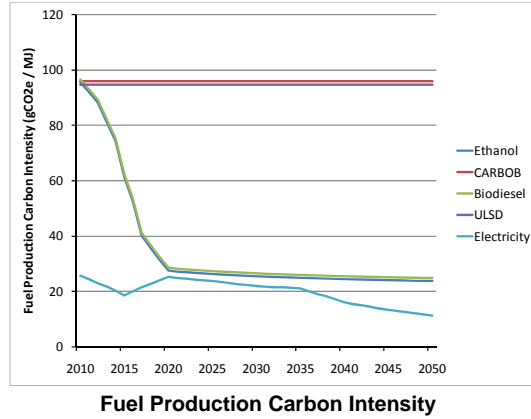
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Electricity as a Low Carbon Fuel in CA

- Marginal electricity supply is low GHG for ET
- Vehicle penetration is dominant factor
- EV range, electricity source not as significant

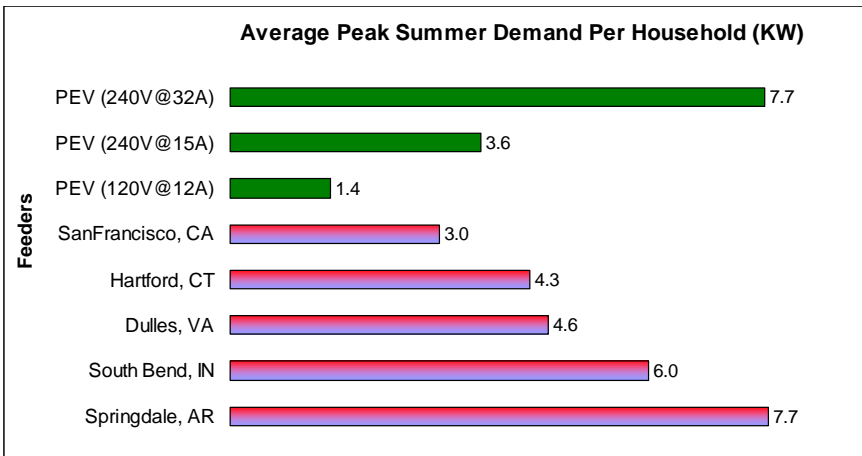


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The Grid Can Handle PEVs . . . But There Are Impacts



PEV Peak Demand Depends on Charging Capacity (Voltage/Amperage)

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Clarifying Infrastructure and Charging Requirements

Charging Requirements

| Type | Power Level | Vehicles |
|--------------------|------------------|--|
| Level 1 120 VAC | 1.2 – 2.0 kW | PHEVs (10-20 mi range) |
| Level 2 240 VAC | 2.8 – 6.6 kW | PHEVs, EREVs, EVs (20-40 mi range) |
| | Up to 19.2 kW | EVs (80+ mi range) |
| DC | 50 – 250kW | 5 minute recharge |



Note: Typical Household Load is 5 kW

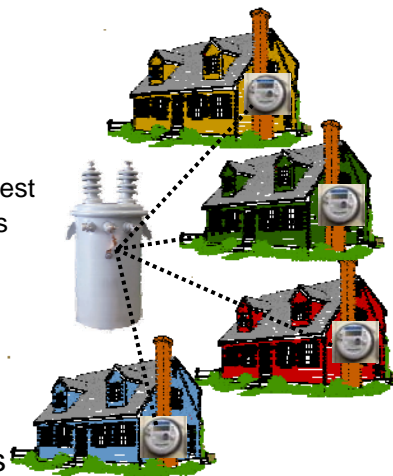
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Grid Impacts of Plug-In Vehicles

- Not all vehicles are 'created equal'
- Generation and transmission impacts likely minimal
 - Full light-duty fleet electrification at 7-8% of demand
 - Aggregate 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
 - Manage time and rate of charging
- EVs and PHEVs will not 'crash' the grid, but acting to reduce impacts is clearly beneficial



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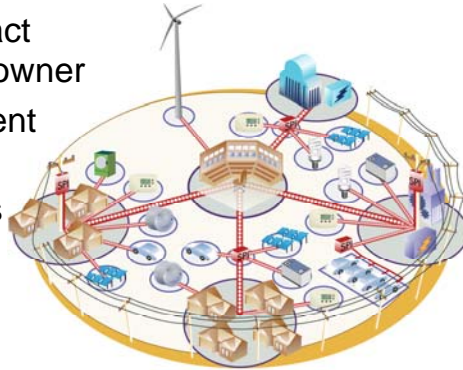
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Smart Charging is the Key to Reducing Grid Impacts

Vision – By 2015, all plug-in vehicles can communicate to the smart grid and charging is intelligently controlled

- ‘Smart charging’ is a compact between utility and vehicle owner
 - Low in cost and convenient for vehicle operator
 - Minimize system impacts
 - Optimize when time and rate of PEV charging on systemwide basis



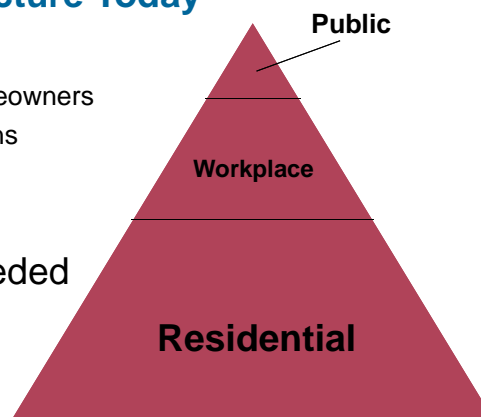
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To Electrify Transportation, You Must Get Electricity to the Vehicles

- **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
 - **Viable business models?**
- **Know what drivers need**

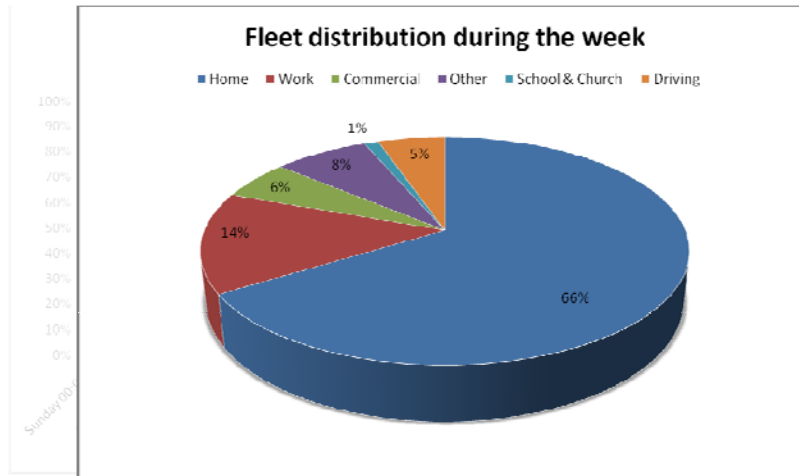


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Deliver Electricity, Charging Infrastructure to the Vehicle's Location



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Together...Shaping the Future of Electricity

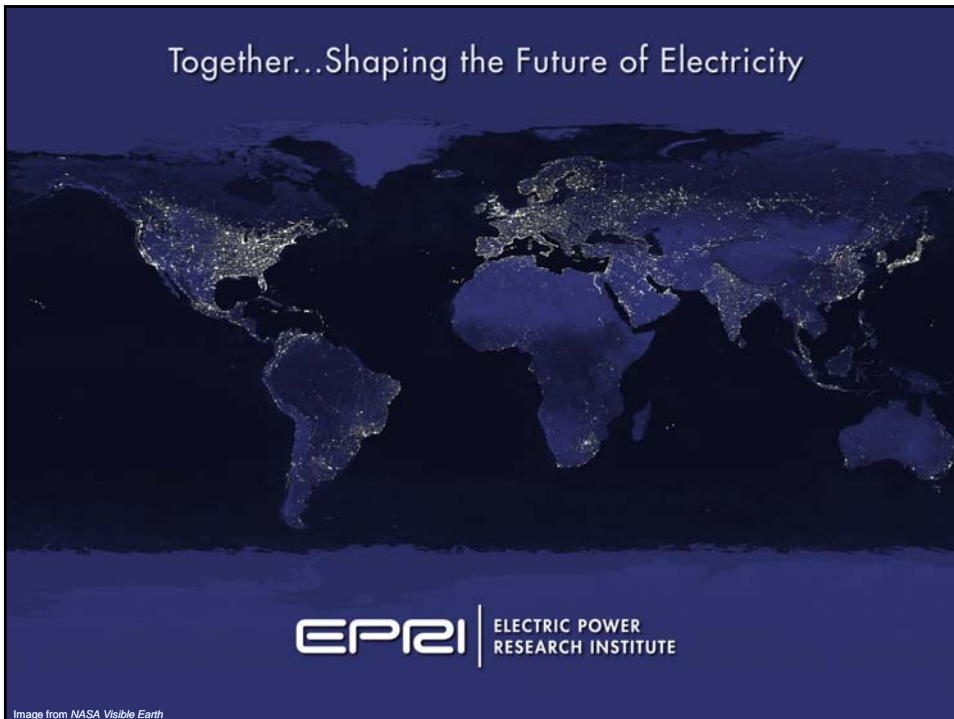
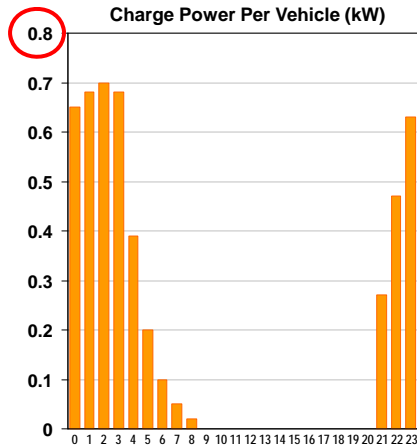


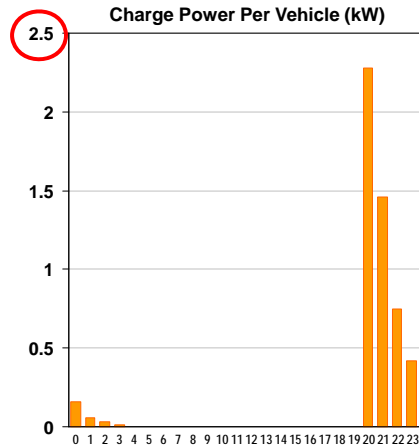
Image from NASA Visible Earth

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Smart Charging Helps – If Done Right Badly Managed Charging Worse than Uncontrolled



Shifts the charge load to nighttime, but spreads it out relatively evenly over 6 hours



Only shifting the time without evening out the profile can make the situation worse

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How Much Load is a 40 Mile Range EREV & 100 Mile Range Nissan Leaf?

PLASMA TV



Annual Energy
623 kWh

SET TOP BOX



Annual Energy
263 kWh

Annual Energy Consumption
= 865 kWh

CHEVY VOLT Extended Range Electric Vehicle



Average Annual Energy Consumption
= 1890 kWh

Nissan Leaf All Electric Vehicle



Average Annual Energy Consumption
= 2964 kWh

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