Plug-In Electric Vehicles
An Overview

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Mainstream Commercialization of Electric Vehicles Began December 2010

Chevrolet Volt
- Extended Range Electric Vehicle (EREV - A plug-in hybrid with a guaranteed electric range).
- 25-50 mile advertised range
- Charging: 8-10 hours at 120V, 12A
  3-4 hours at 240V, 15A

Nissan Leaf
- Battery Electric Vehicle
- 100-mile advertised range
- Charging: 20 hours at 120V, 12A
  8 hours at 240V, 15A
  30 min at 400V, 150A
For comparison, between 1999 and 2004, there were three hybrids introduced to the U.S. market (Prius, Insight, Civic Hybrid).
Battery Electric Vehicles

• Plug-in vehicle with rechargeable battery only
• Driving range limited by battery size – industry norm for range ~ 100 miles
  – Tesla is exception, offering longer range
• Nominal recharge time of about eight hours (fully depleted battery)
• The majority of PEV launches through 2012 are BEVs

Mitsubishi ‘i’ battery electric vehicle. Photo courtesy of Mitsubishi.

Ford Focus Electric battery electric vehicle. Photo courtesy of Ford.
Plug-In Hybrid Electric Vehicles

• Plug-in vehicle with rechargeable battery
• Internal combustion engine allows for extended driving
• Typically based on hybrid vehicle technology (e.g. Prius Plug-In)
• 10 – 40 miles electric range
• Likely to blend electricity and gasoline at higher speeds, power

Toyota Prius Plug-In Hybrid. Photo courtesy of Toyota.

Ford C-MAX Energi plug-in hybrid. Photo courtesy of Ford.
Extended Range Electric Vehicle

• A type of PHEV—rechargeable battery plus a combustion engine
• EREVs drive like BEVs until battery is depleted then switch to hybrid mode
• Something of a ‘new’ category
  – Many consider to be distinct and separate category from PHEVs
• EREVs can also drive for extended distances between charges using engine
• Electric range typically longer, 25-50 miles

Chevrolet Volt Extended Range Electric Vehicle (EREV). Photo courtesy of General Motors
Most Daily Trips are Relatively Short
A Few Basic Points on Electric Vehicles

• They are not a ‘silver bullet’
  – However, won’t reach energy or environmental objectives without them
• Electric Vehicles will not happen ‘overnight’
  – Like all new technologies it will take time to realize the benefits
• There are no technological showstoppers
• They are not ‘too expensive’
  – Costs will and must be reduced significantly
• They are not detrimental to the electric grid
Charging Infrastructure
PEVs Generally Have Three Charging Options

120V – Level 1
Portable cordset
Use any 120V outlet
Up to 1.44 kW

240V – Level 2
Permanent charge station (EVSE)
Typ. 3.3 – 6.6 kW, but up to 19.2 kW

DC Fast Charging
Up to ~ 50 – 60 kW
Fast, expensive
Standard not yet in place
Understanding and Planning Charging Infrastructure

• **Build Today’s Infrastructure Today**
  
  - Infrastructure is expensive
    - ~ $1500 home, $2500+ public
  
  - Focus on Residential
    - 95% of vehicles end day at home
    - Costs can exceed $2200 - $2500
    - Cost and lead time minimization
  
  - Workplace
    - Fleet education and certainty of costs
  
  - Public Charging
    - Critical vs. convenience
    - Viable business models
    - Long-term sustaining of infrastructure
Workplace Charging has a Significant Role

• Likely 2nd most frequent charging location
• Can be expensive
• Employer uncertainty regarding costs, tax implications
• Commercial fleet electrification faces similar uncertainties on cost and deployment of infrastructure
• Employer and fleet outreach is critical
Cumulative PEV Sales from 2010 – 2015
Cumulative PEV Sales from 2010 – 2030
Electricity is an Inexpensive, Relatively Stable, Domestic Transportation Fuel

[Graph showing the real price of electricity and gasoline from January 1976 to January 2012, with key events such as the Iranian Revolution, '80 Recession, Crude Oil Price Collapse, Middle East Unrest, and US Invades Iraq labeled on the graph.]
Each PEV Adds about 700-800 watts to Electricity Demand
Non-Road Electric Transportation

• Non-road electric transportation is the electrification of lift trucks, cranes, yard tractors, and other equipment that operate at ports, airports, rail yards, warehouse, farms, etc.

• Non-road electrification results in significant emissions savings – NOx, SOx, particulate matter, and volatile organic compounds

• Operator cost savings can be significant

Shore power installation in Seattle, WA October 2006. Photo credit: Robert Hawkins