

Joan M. Dukes
Vice-Chair
Oregon

Bruce A. Measure
Montana

James A. Yost
Idaho

W. Bill Booth
Idaho



Rhonda Whiting
Vice-Chair
Montana

Bill Bradbury
Oregon

Tom Karier
Washington

Phil Rockefeller
Washington

March 29, 2012

MEMORANDUM

TO: Power Committee


FROM: Massoud Jourabchi

SUBJECT: Update on plug-in hybrid electric vehicles (PHEV)

In the Sixth Power Plan, staff included a sensitivity analysis on the potential effects of plug-in hybrid vehicles on the power system. That analysis showed that the addition of these vehicles would have a modest impact on the power system, increasing off-peak loads by between 200 and 1000 MWa and increase annual loads by 100-500 average megawatts. A subsequent presentation to the Council showed that no new generation resources would be needed to meet the demand from these vehicles given the assumption that most charging would occur in off-peak hours.

The purpose of this report is to update the Council on a number of developments at the federal and state level that have encouraged the adoption of PHEVs. In addition, information on the actual electricity consumption of PHEV vehicles is becoming more available. Auto manufacturers as well as battery manufacturers are introducing more electric vehicle options and regional and national charging infrastructure investments have increased substantially.


In this presentation, we will cover the events since our last update. We will evaluate the effect of these events on the market acceptance of these vehicles, and present refined analytics on impact of PHEVs on the demand for electricity in the region. We will also discuss the planned enhancement of the transportation analysis in the 7th plan.



Analysis of Potential effects of plug-in Electric Vehicles on electricity demand in The Northwest
An update

April 10th 2012
Massoud Jourabchi

Photo illustration by George Lange, with Michael Miller (Plug) –Popular Mechanics



Results from Our Last Analysis

Figure C-23: Assumed Market Penetration Rates for New PHEV




Figure C-24: Projected Load from Plug-in Hybrid Vehicles

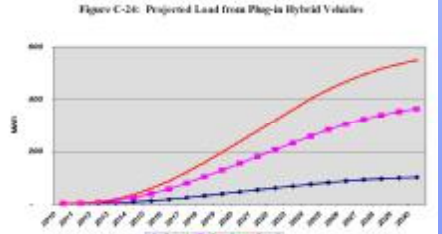
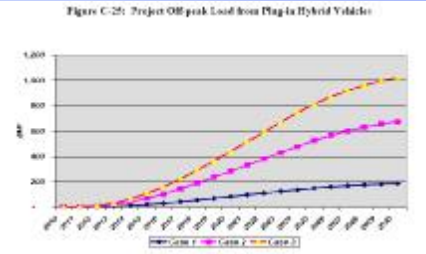


Figure C-25: Project Off-peak Load from Plug-in Hybrid Vehicles




Growth path for PHEVs are uncertain, we used a simplified range to estimate market shares.

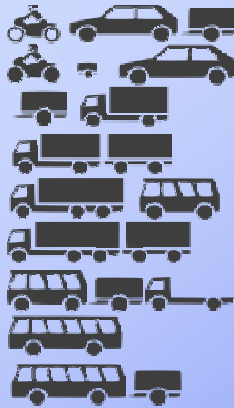
Our expectation for 2010-2011 was between 1000 to 8000 new PHEVs
 Actually registered by 2011 – 2000 vehicles
 Market share ~10% to 40% of new vehicles by 2030

Impact by 2030
 Annual Energy impact 100-550 MWa (~1.8% of load)
 Off peak impact 200-1000 MWa (~5% of off peak load)

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Snapshot of U.S Ground Transportation 2009

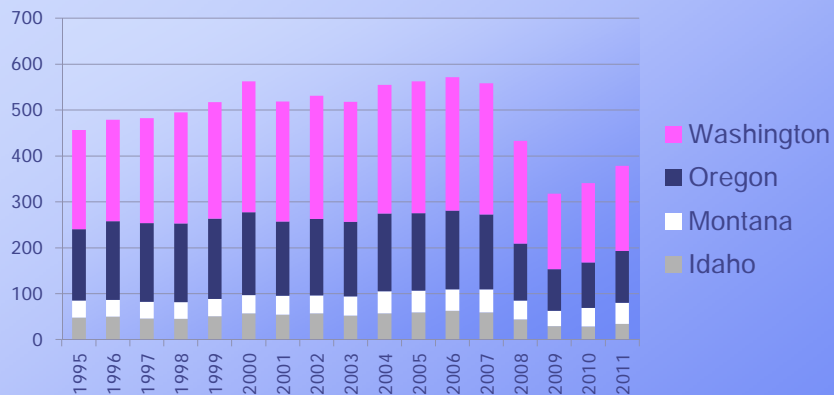


	Number Millions	Traveled miles Billions
Passenger Vehicles	251	2,013
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New Vehicles purchased annually	16	

New vehicle sales have been down for the last few years.
 Length of new car ownership has increased to a record 71 months.



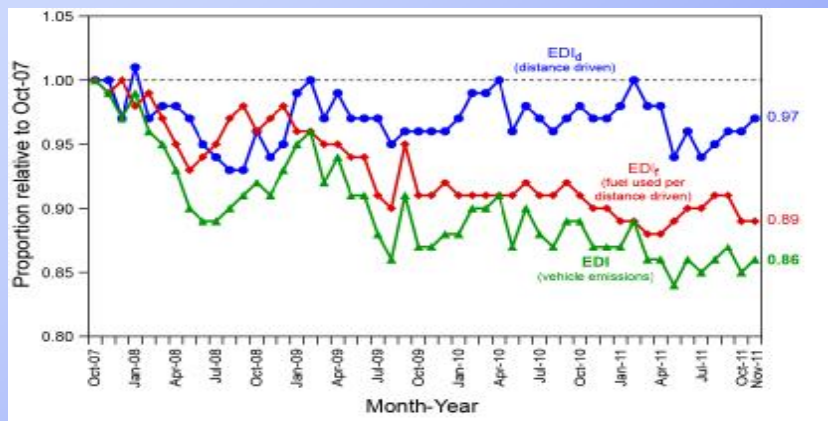
In the NW- Typically 500,000 New Light duty Vehicles are Purchased Each Year



However, since 2008 new vehicle purchases have dropped to about 350,000 vehicles. People are holding on to their vehicles longer. These factors contributed to fewer PHEV purchases than expected in 2009.



Since the start of the recession
new vehicle sales have increased efficiency
and lowered emissions



- New Vehicle Miles Traveled (VMT) dropped by 3%
- Fuel efficiency increased by 11%

Source: University of Michigan Eco-Driving Index (EDI)



What is an Electric Vehicle

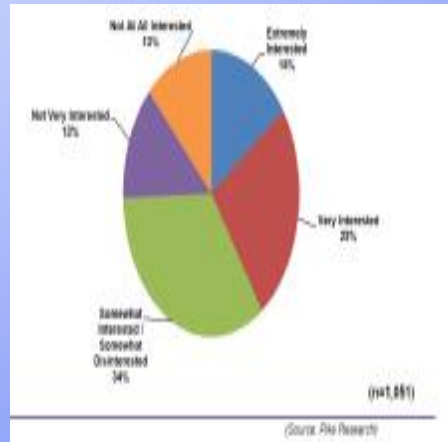
	Gasoline Engine	Electric Motor	Recharge by Plug-in	Example
Hybrid Electric	Yes	Yes	No	Toyota Prius
Plug-in Hybrid	Yes	Yes	Yes	Chevy Volt
All Electric Vehicle	No	Yes	Yes	Nissan Leaf

This report focuses on vehicles that plug-in to the grid, which include plug-in hybrids and all electric vehicles.



Consumer interest in Electric Vehicles is strong but can fluctuate

- Accenture Research's 2011 survey finds on average 46% were in favor of PHEV
- Pike Research 2011 survey found 40% of respondents were very interested in PHEV
 Customers want:
 100 miles range
 New vehicle Price of ~\$30,000



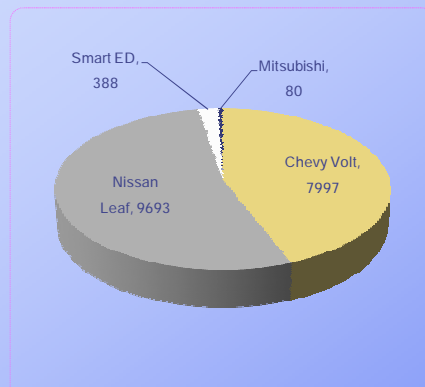
- 2012 Pike Research Energy & Environmental Consumer Survey finds that favorable rating of PHEV has gone down from 62% in 2009 to 55% in 2011.

7

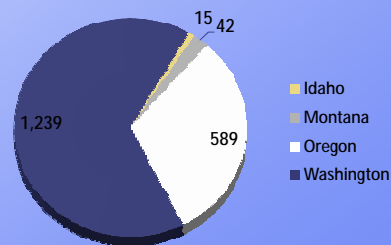


By the end of 2011 there were over 18,000 Plug-in Electric Vehicles on the road; in the US over 1800 were in the Northwest

Nation



Registered Volt and Leafs in the NW



- Nationally PHEVs market share of new vehicles was ~ 0.03%
- In the Northwest market share was twice as much.

8



Current Charging Options

	Voltage	AMP	Power Level	Charge time	Comparable Load
Level 1	120	12-16 Amp	1.4-1.9 KW	5-8 Hours	
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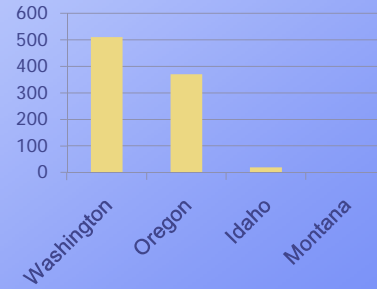
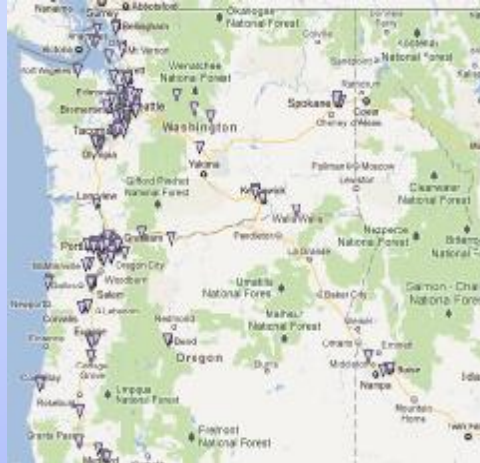


Large numbers of people who purchased Volts and Leafs participated in the EV project

- Ø Project objective (deploying charge infrastructure in major cities)
- Ø 60+ Partners
- Ø Over 14000 Participants
- Ø ~14000 Level 2 (240 charges)
- Ø 400 DC fast Charger ports
- Ø 8300 Grid Connected vehicles
- Ø 1200 Jobs created or retained by 2012
- Ø 18 Major cities and Metro areas in 6 states and DC.
- Ø Through this project information on vehicle charging is gathered



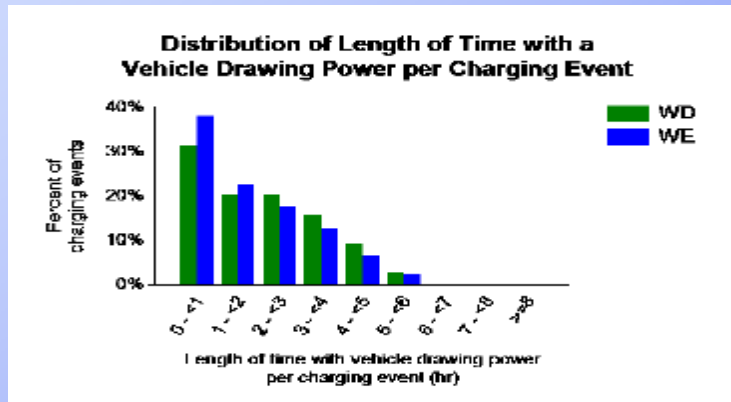
Regional Charging Stations



As of Feb 1, 2012 there were about 900 electric charging stations in the region, excluding home chargers



Over 50 percent of charging events are 2 hours or less in duration

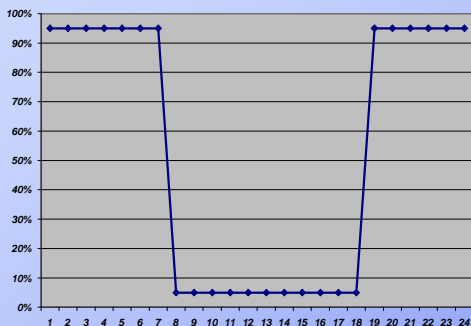


There were concerns about impact of PHEVs on distribution system. Data so far suggests good diversity in timing of charges.



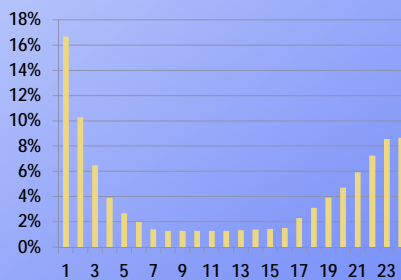
Majority of recharging occurs between 10 PM and 4 AM with little variation across the days

6th plan assumption



EV project results

Home Charging Profile Weekday



We had assumed every vehicle would be recharged every day.

EV project finds:

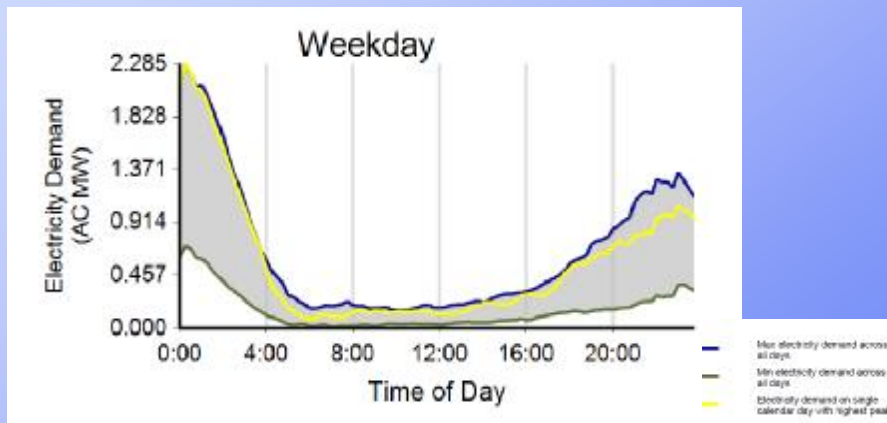
Vehicles need to be recharged less frequently

Public charging has not been used as expected

13



Load impact on the system varies by time of day

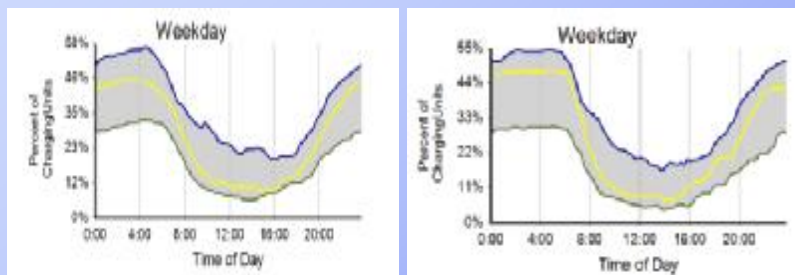


EV charging profile shows good fit to absorb excess generation and improve system load factor.

14



Slight regional difference in charging behavior



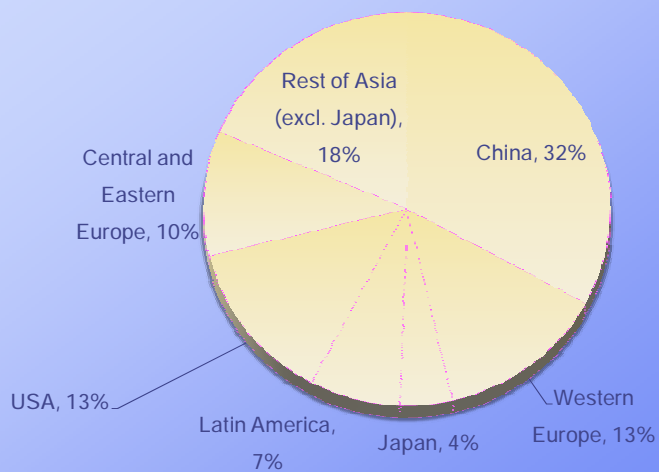
Load from 440 EVs monitored in Washington drops between 4-5 AM
 In Oregon, load from 254 EVs drops between 5-6 AM.

During BPA's system peak* EV load amounted to about 0.3 MW (0.2 MW in Washington and 0.1 MW in Oregon).

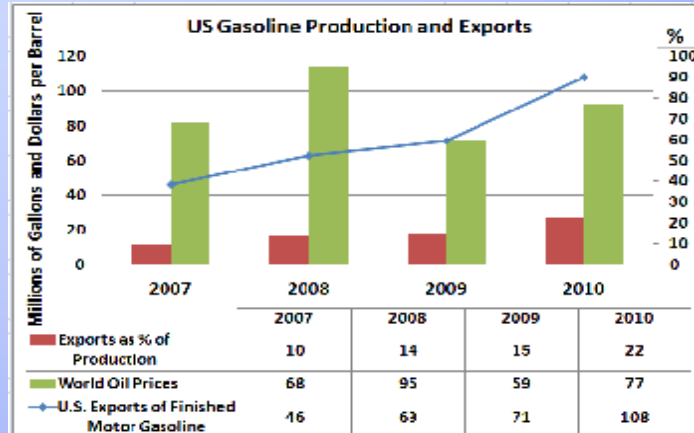
* - September 7, 2011 Hour 18



Long-term forecasts for EV (PHEV market is Global)



Gasoline is a global commodity,
 one reason for higher gasoline prices in the US
 can be higher market opportunities outside the US



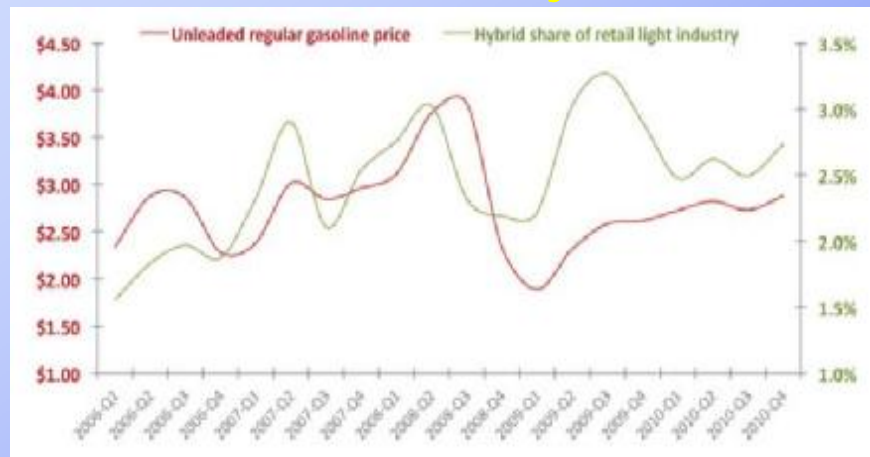
As oil prices increase, so do exports of gasoline out of the US
 In 2010, 22% of the US gasoline production was exported.

Source: EIA

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Gasoline prices influence the
 market share of hybrids



People's decision to purchase hybrid vehicles is in lockstep with price of gasoline.
 Demand for PHEVs will depend on price of gasoline.

Source of graph: R.L. Polk & Company

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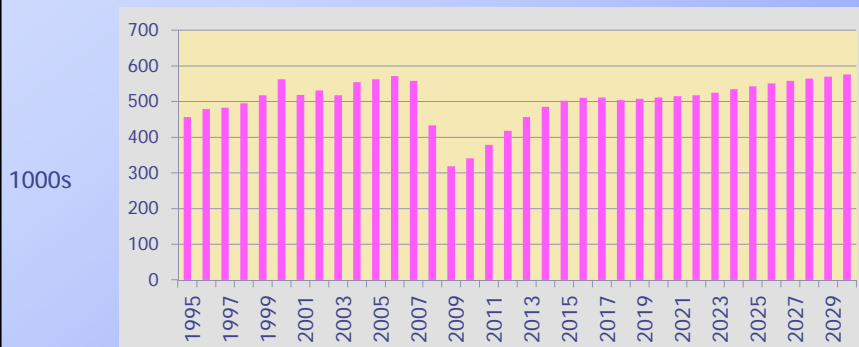
Modified "What If" model

- Ø Revised forecast of passenger and light trucks
- Ø Modified Market share fractions
 - § reflecting actual data for 2010 and 2011
 - § Modified long-term market shares for Idaho and Montana
- Ø Decreased efficiency during winter to reflect impact of temperature on battery holding charge
- Ø Increased load by 10% to reflect interstate travel
 - § West Coast Green Highway I-5 EV electrification (DC fast chargers) reducing range anxiety
 - § Truck stop electrification

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Historical Forecast of New Vehicle Sales in the Region

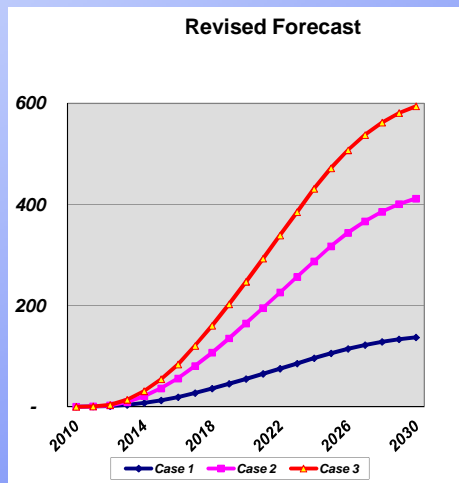
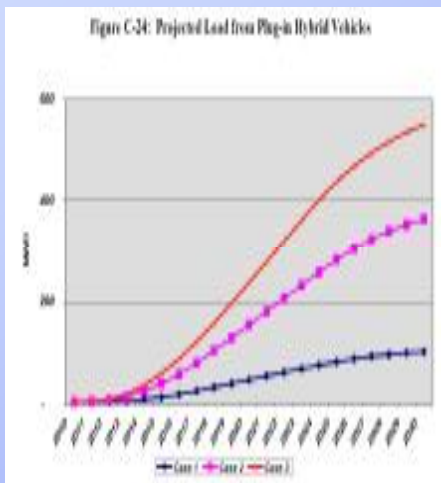


New car sales are expected to be depressed until 2015, and would not get to their recent levels until 2025.

20



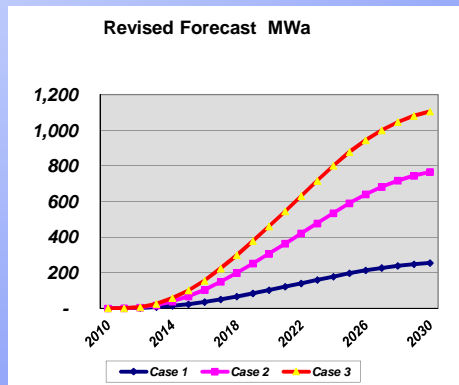
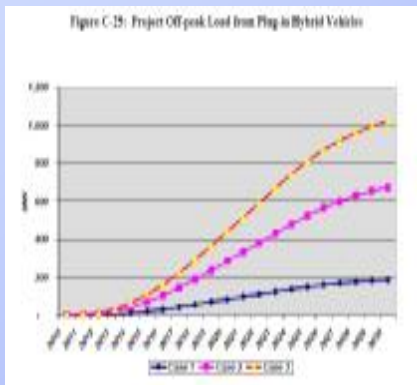
Impact on Annual Energy (MWA)



21



Impact on Off-peak Energy



22



Revised Analysis Findings

- Ø Market share of PHEVs for 2010 and 2011 are in line with the Case 2 (Medium growth) scenario
- Ø Revised plug-in hybrids' impact on annual and off peak load is slightly higher than the earlier forecast

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Improvements for the 7th Plan

- Ø Impact of PHEVs will be analyzed using the transportation module of Energy2020
- Ø Incorporating competition between fuels (gasoline, natural gas, electricity)
- Ø Incorporation of commercial fleet in the analysis

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New opportunities for Electric Vehicles and Fleet vehicles



Commercial Fleets can provide ancillary services to the Grid
Potential for V2G is greater for fleet vehicles due to larger battery size
And higher geographic concentration of vehicles.

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Ø Questions?

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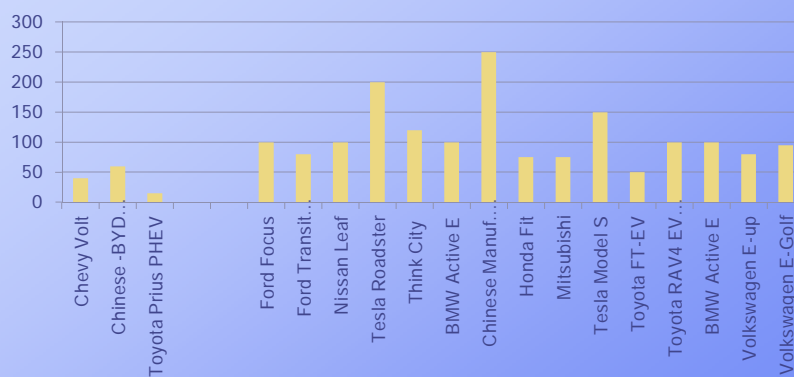
Additional slides

27



There are large number of new market entries expected for 2012

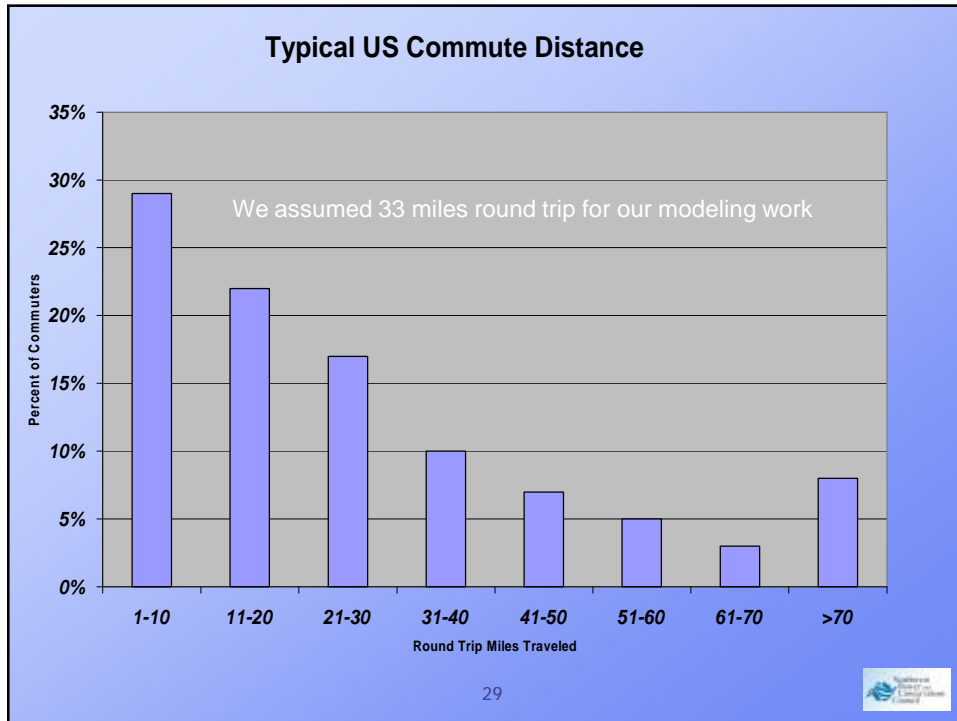
Manufacturers Claimed Range on single recharge (miles)



Many of the entries could meet customer requirement on range and price.

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Barriers for PHEVs

<h3>Demand</h3> <ul style="list-style-type: none"> Ø High purchase price Ø Range Anxiety Ø Recharging infrastructure 	<h3>Supply</h3> <ul style="list-style-type: none"> Lead times for new product line Ø High capital investment requirements Ø Limitations of critical supply components Ø Global market response
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2008 WSDOT Alternative Fuels Corridor Economic Feasibility Study:

"The primary challenge to Alternative Fuels commercialization is how to build a market – simultaneously – for new vehicle technologies, new fuels, and new infrastructure to support them."


Comparative Costs for Alternative Fueling Stations

	Land & Building	Fueling Equipment	Supply Chain
Gasoline	\$ 1,448,500	\$ 571,000	Established
Biodiesel	(Co-located?)	\$ 127,000*	Limitations
Hydrogen	(Co-located?)	\$ 318,000	Not Established
Electricity	Kiosk	\$ 50,000 - \$90,000**	Grid

* Number of pumps scaled for smaller initial demand
 ** Upper range includes utility connections and necessary upgrades

Washington State Department of Transportation

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Nissan LEAF Range and Vehicle Efficiency

Speed and Driving Conditions	Outside Temp (F)	Accessories	Estimated Range (mi)	Vehicle Efficiency (mi/kWh)*
Cruising 38 mph	68°	None	138	5.75
Fairly steady 24 mph City traffic	77°	None	105	4.38
Steady 55 mph Highway	95°	A/C on	70	2.91
Crawling 15 mph Stop-and-go	14°	Heater on	62	2.60
Average 6 mph Heavy stop-and-go	86°	A/C on	47	1.96

Nissan LEAF has a 24 kWh battery Source: "Nissan Agrees - EV Mileage Will Vary; Leaf Tests Show 93-Mile Variation." Green Car Advisor - adbrandz.com, June 15, 2010.

Washington State Department of Transportation

32



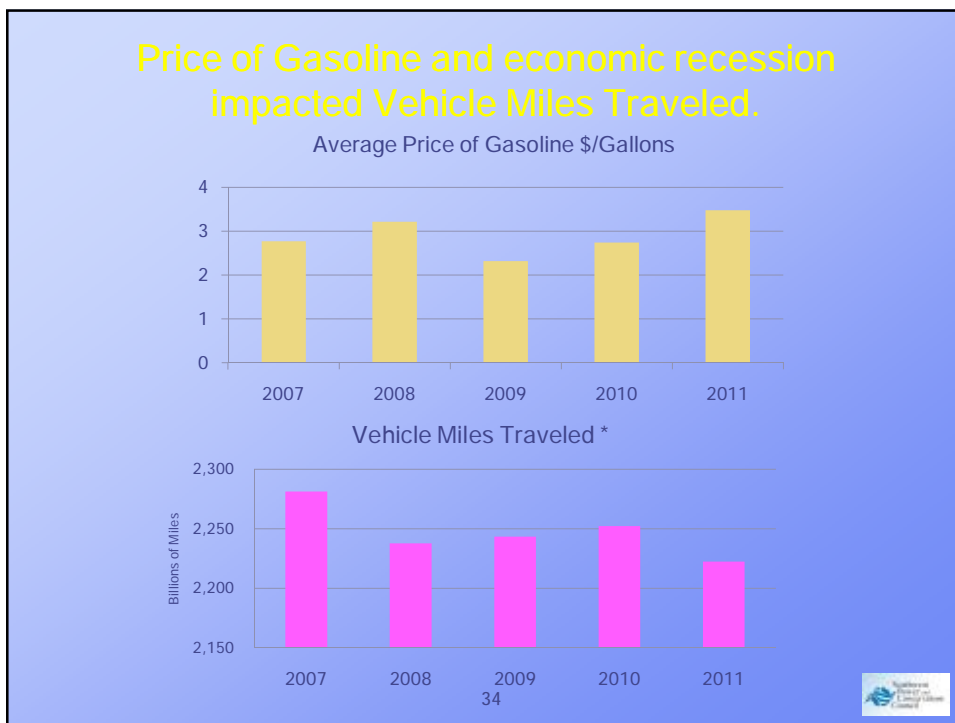
WEST COAST GREEN HIGHWAY

Electric Highways Project

- Funding:** \$1.32 m seed funding from US Dept. of Energy (via state energy program block grant)
- Minimum of DC Fast-charge stations:** 9 (7 along I-5; 2 along US-2 (E-W route over Cascade Mtns))

- Coordination:** with Oregon and B.C. to make PNW EV-ready
- Target completion date:** October 31, 2011

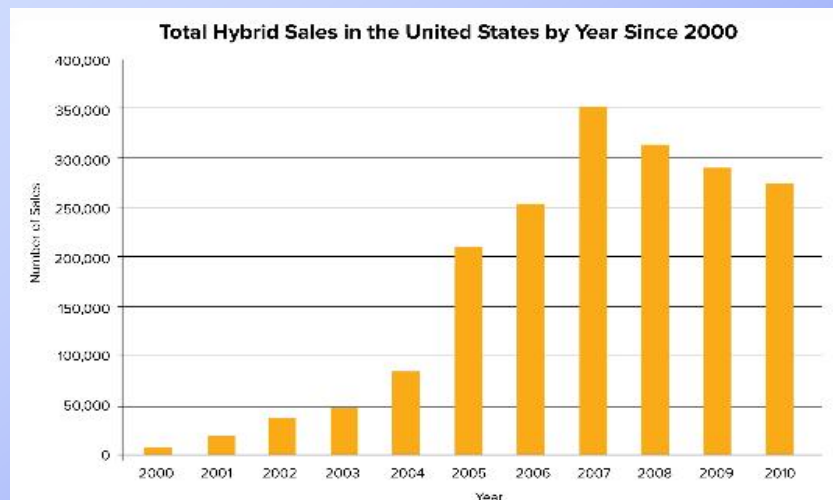
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So far

- Ø We discussed the recent experience:
 - § Sales and market share of PHEVs,
 - § Customer's perception,
 - § Charging behavior for PHEVs

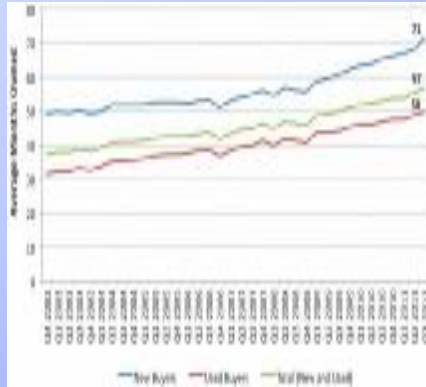
- Ø What the future could hold for PHEVs?
 - § In a global market, US is expected to have an small share of PHEVs.
 - § Gasoline prices are subject to global supply and demand.



Length of U.S. Vehicle Ownership has hit Record High

Increased Retention tied to Economic Slowdown

Impact on Automotive Industry




- Ø market part stores – more DIY.
- Ø OEM Dealership Service and Repair
- Ø New Vehicle Sales
- Ø Used Vehicle sales
- Ø Extended warranty providers

Source: R.L. Polk & Co.

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**Analysis of Potential effects of
plug-in Electric Vehicles
on electricity demand in
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An update**

**April 10th 2012
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Photo illustration by George Lange, with Michael Miller
(Plug) –Popular Mechanics

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Figure C-23: Assumed Market Penetration Rates for New PHEV

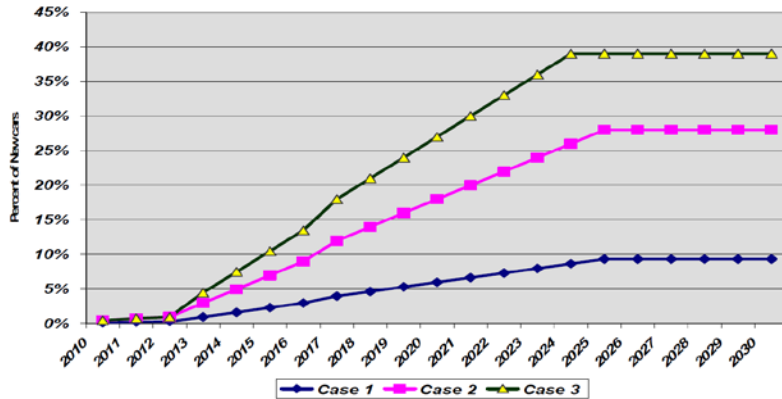


Figure C-24: Projected Load from Plug-in Hybrid Vehicles

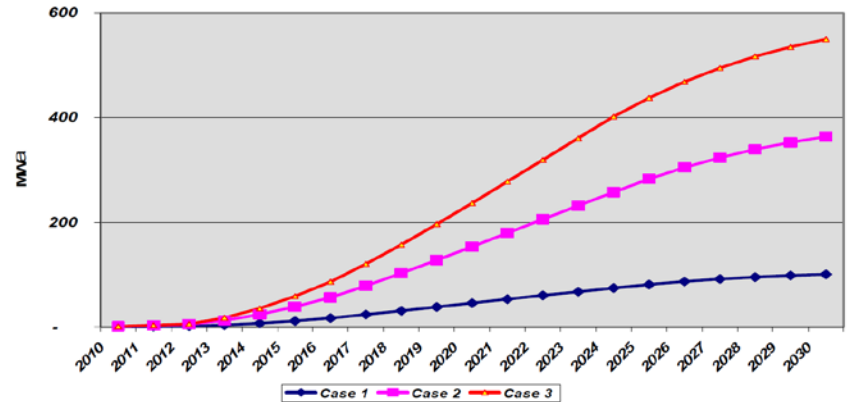
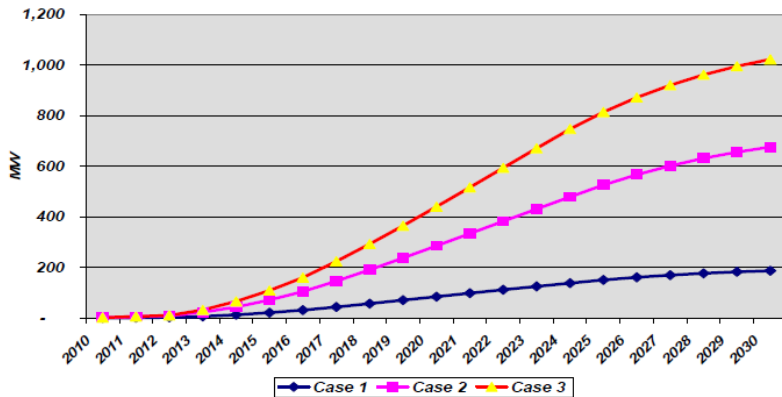


Figure C-25: Project Off-peak Load from Plug-in Hybrid Vehicles



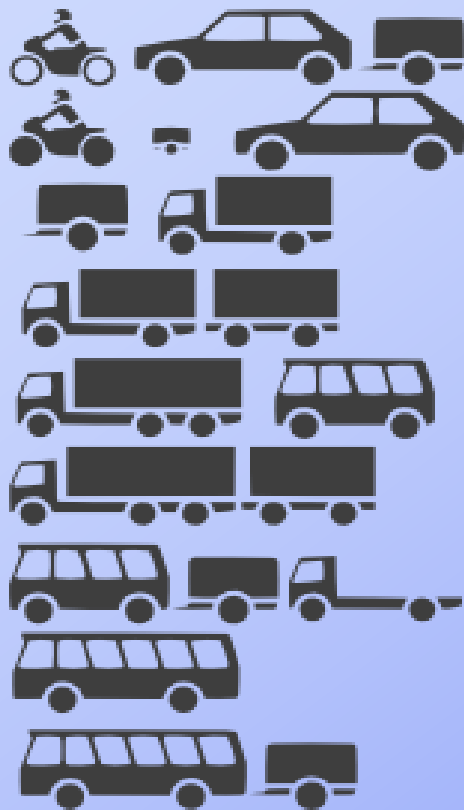
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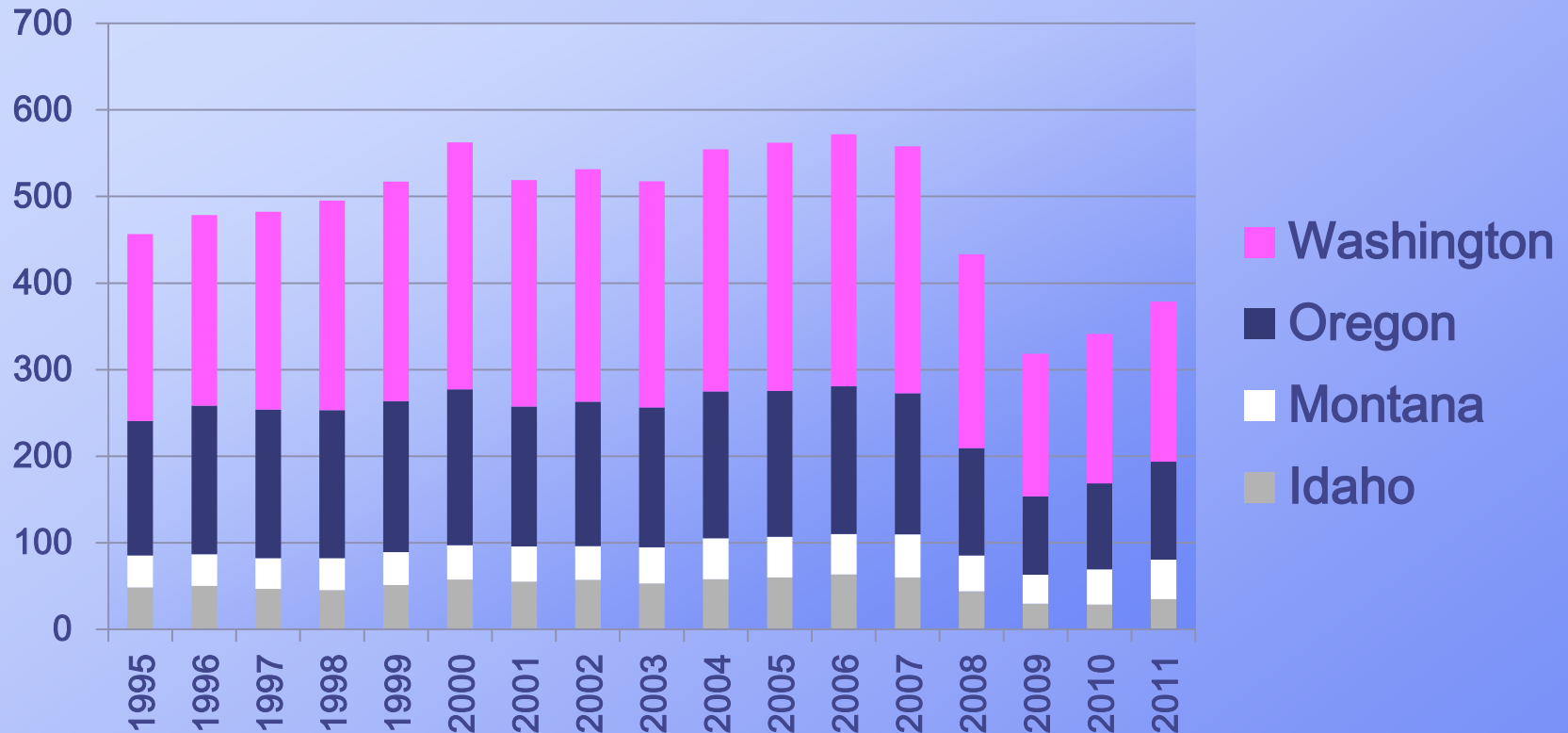
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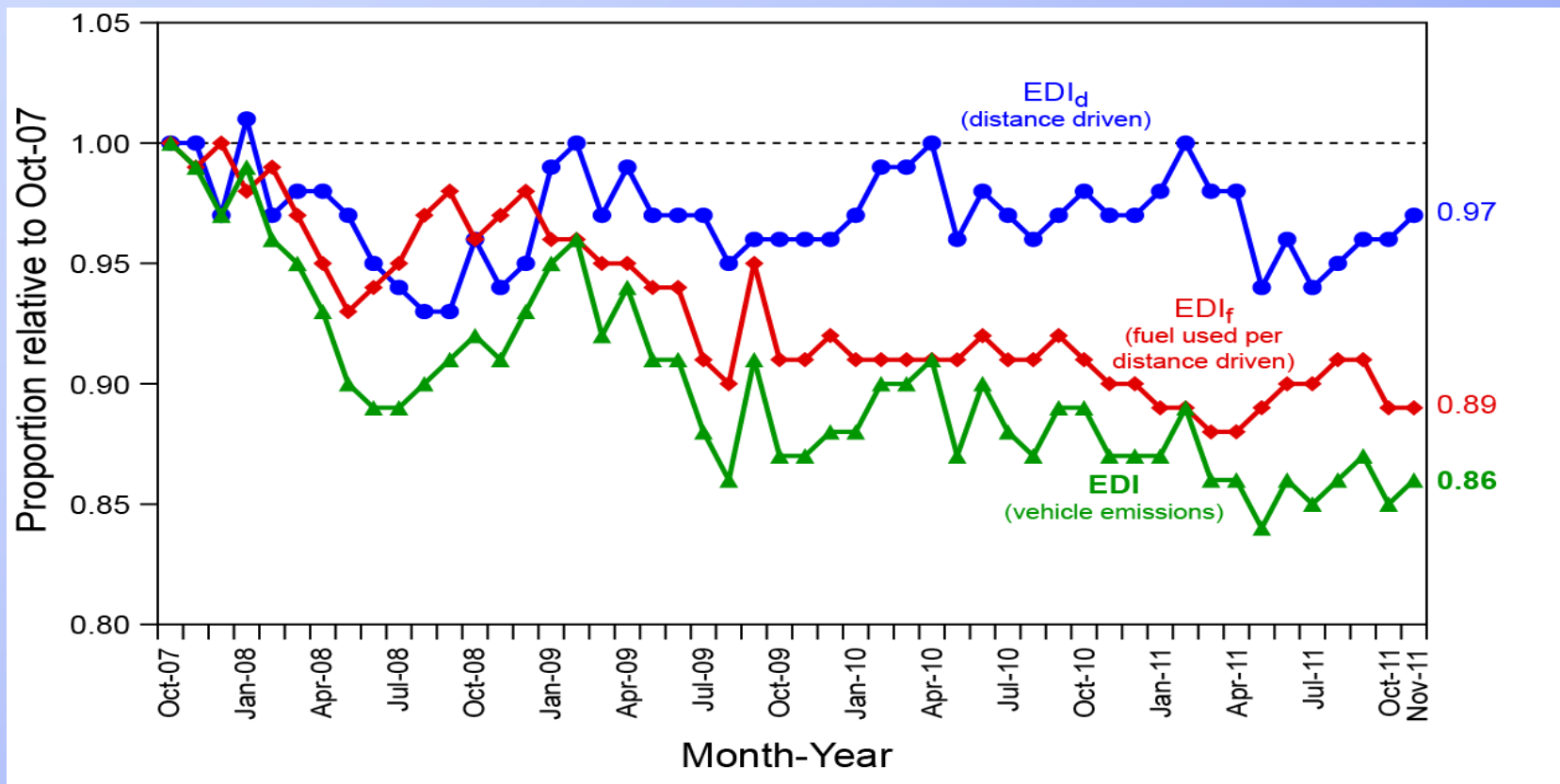
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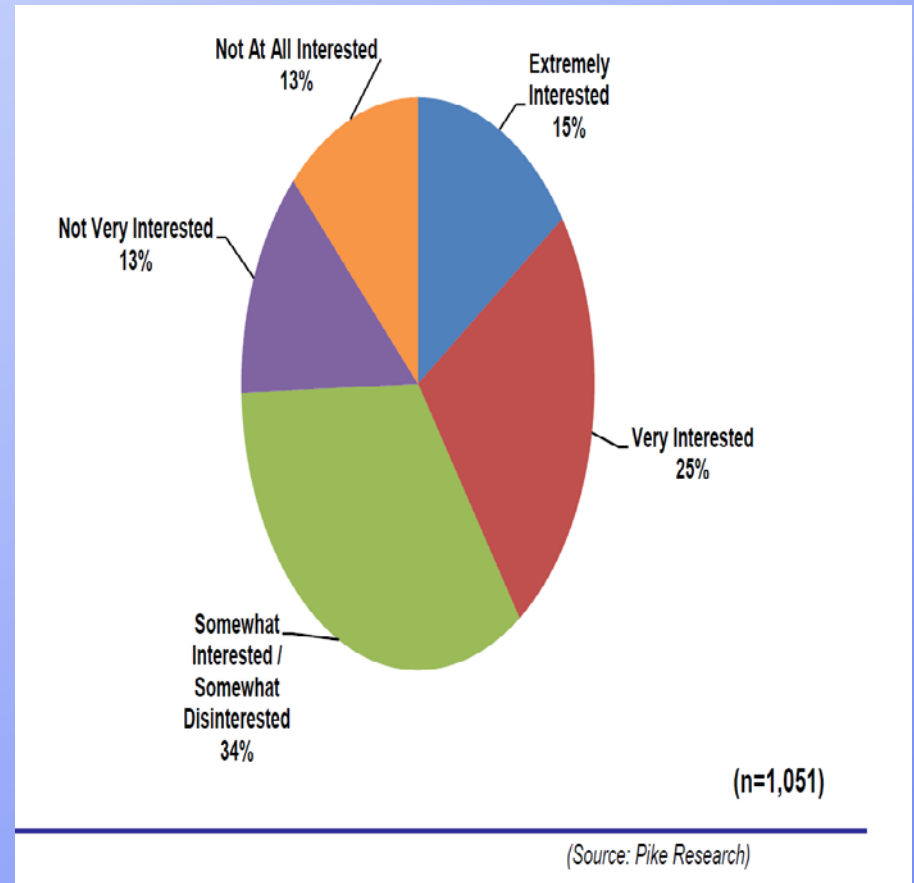
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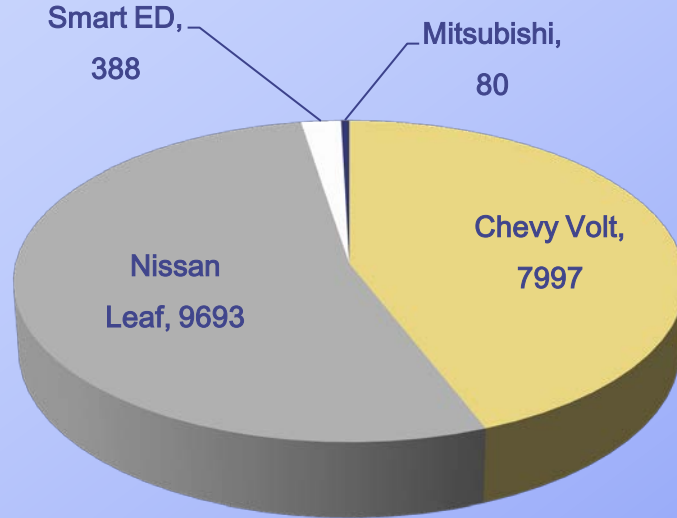
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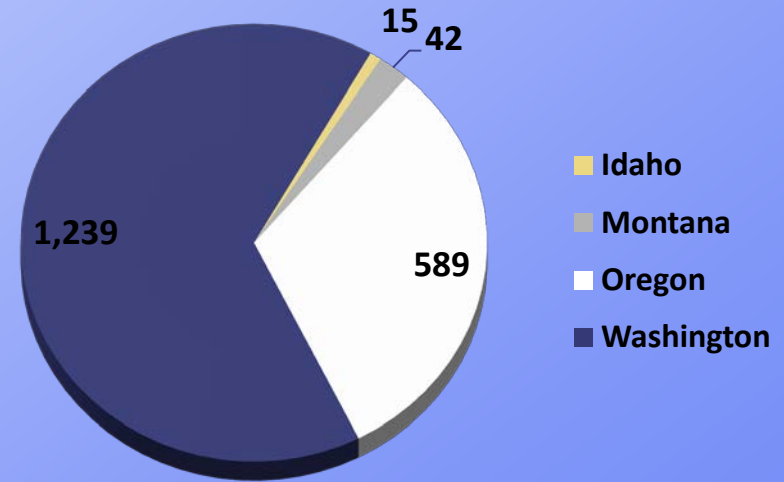
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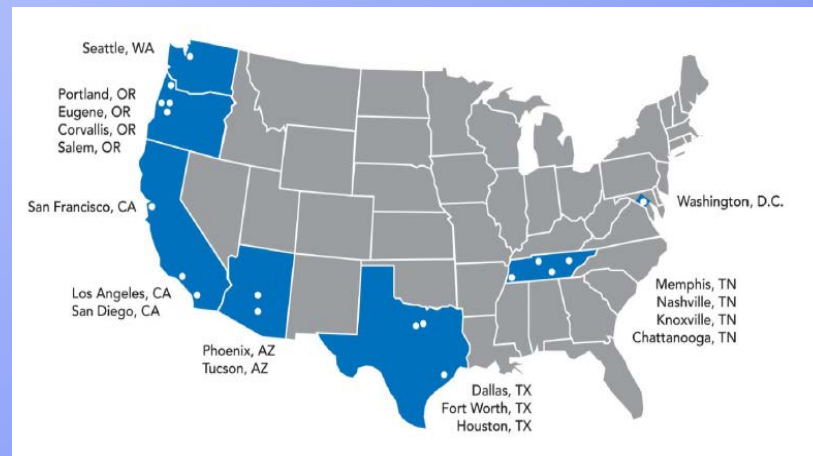
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Current Charging Options

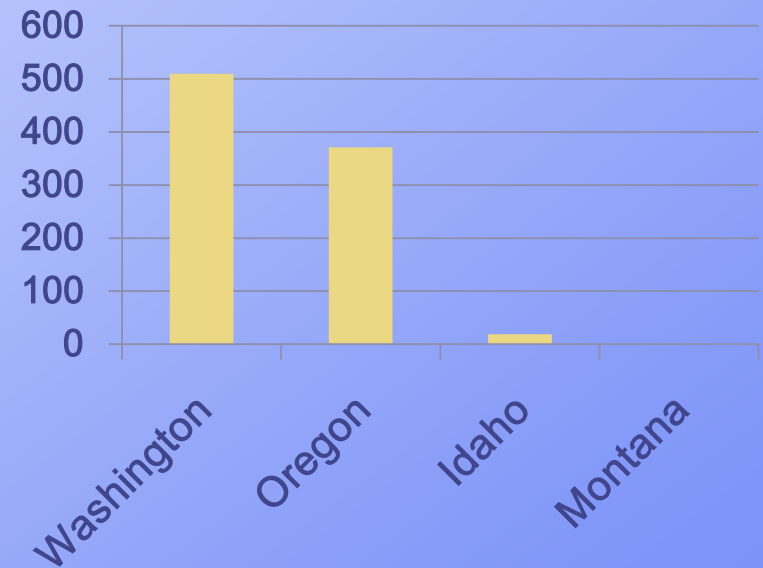
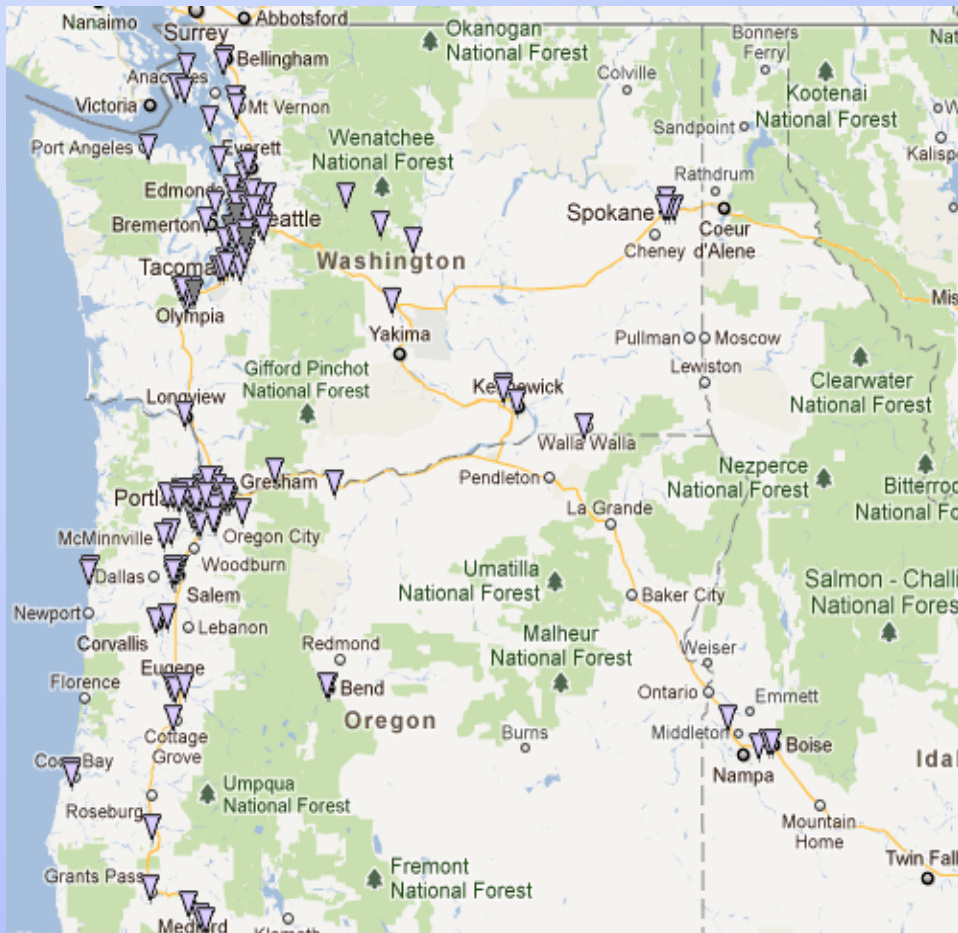
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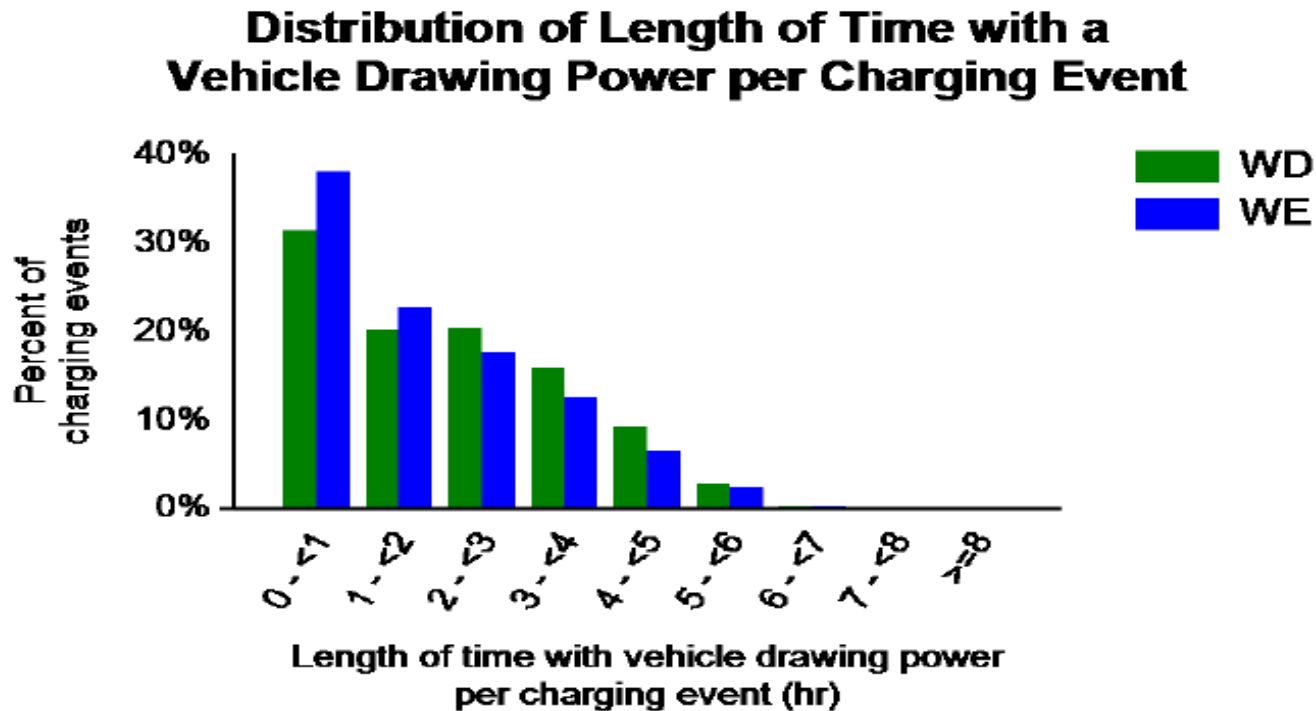


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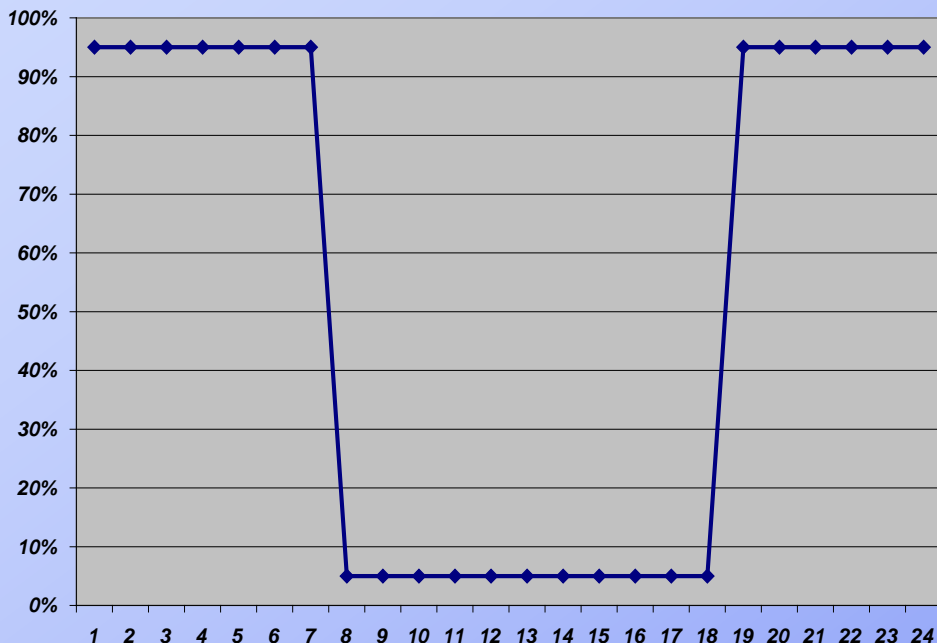
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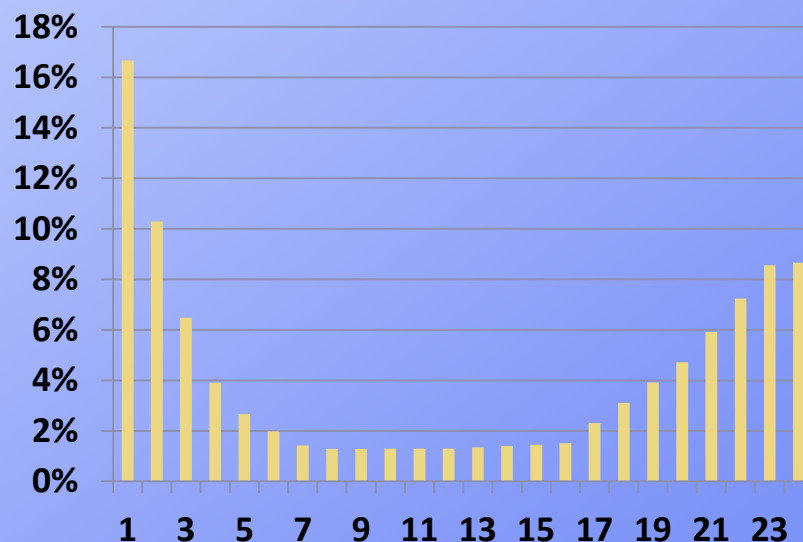
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6th plan assumption



EV project results

Home Charging Profile Weekday



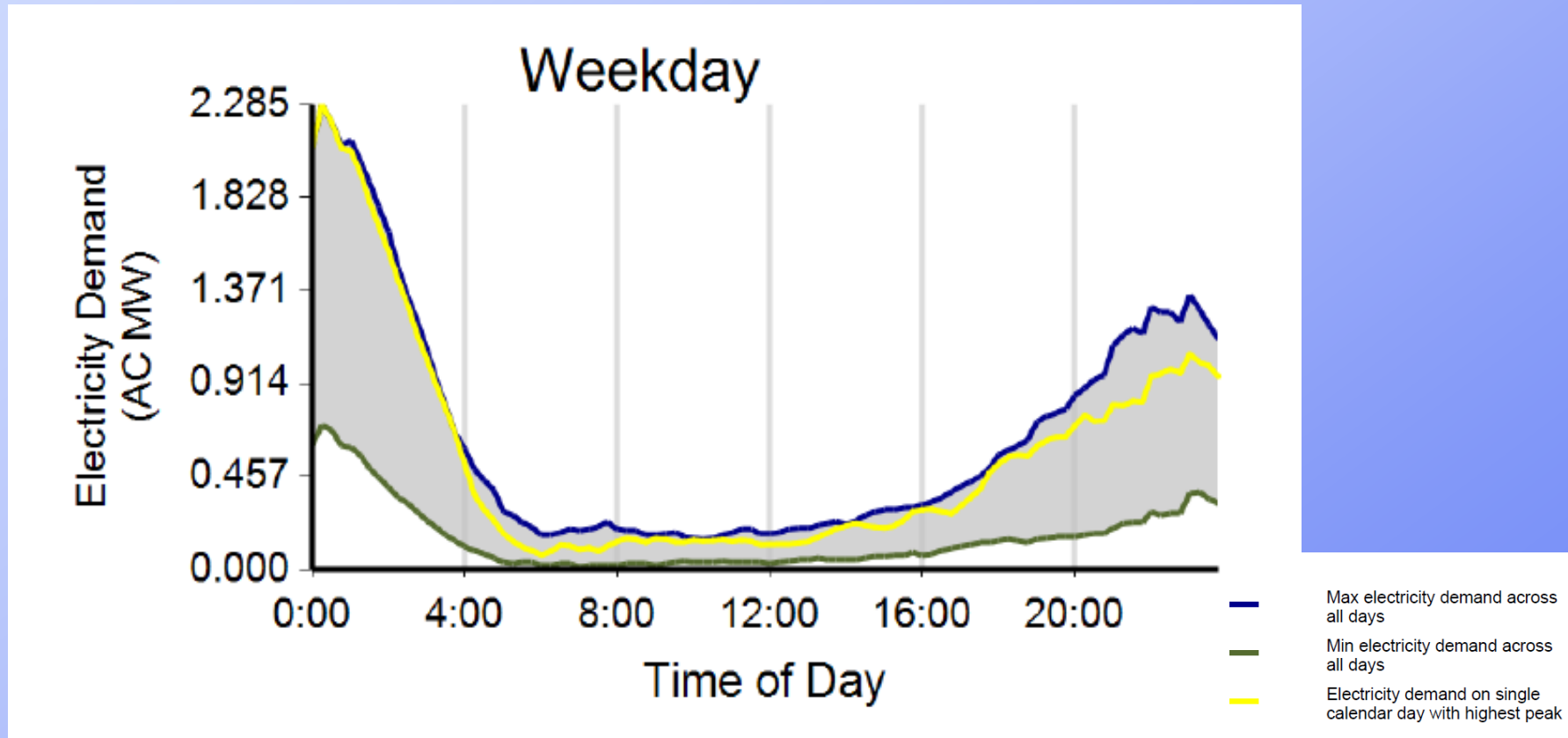
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EV project finds:

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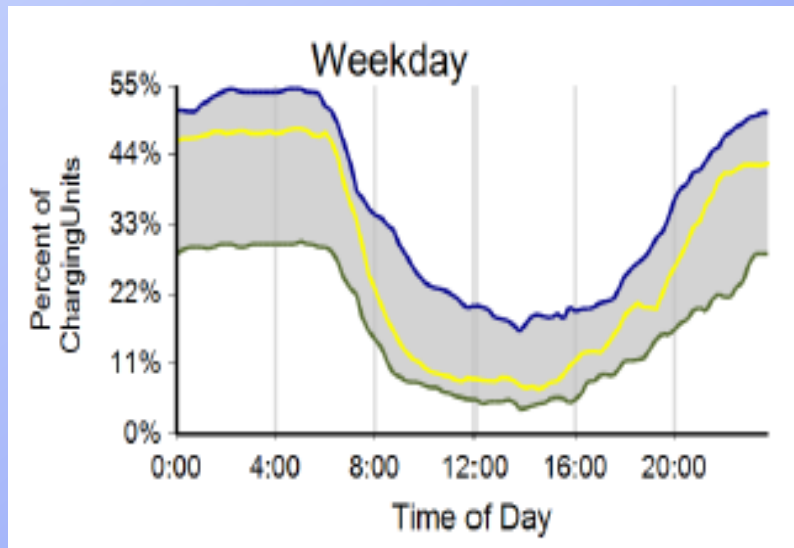
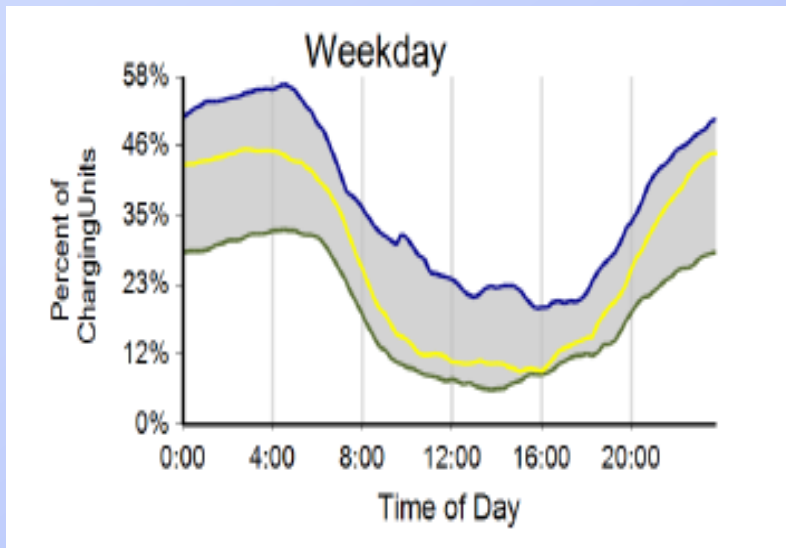
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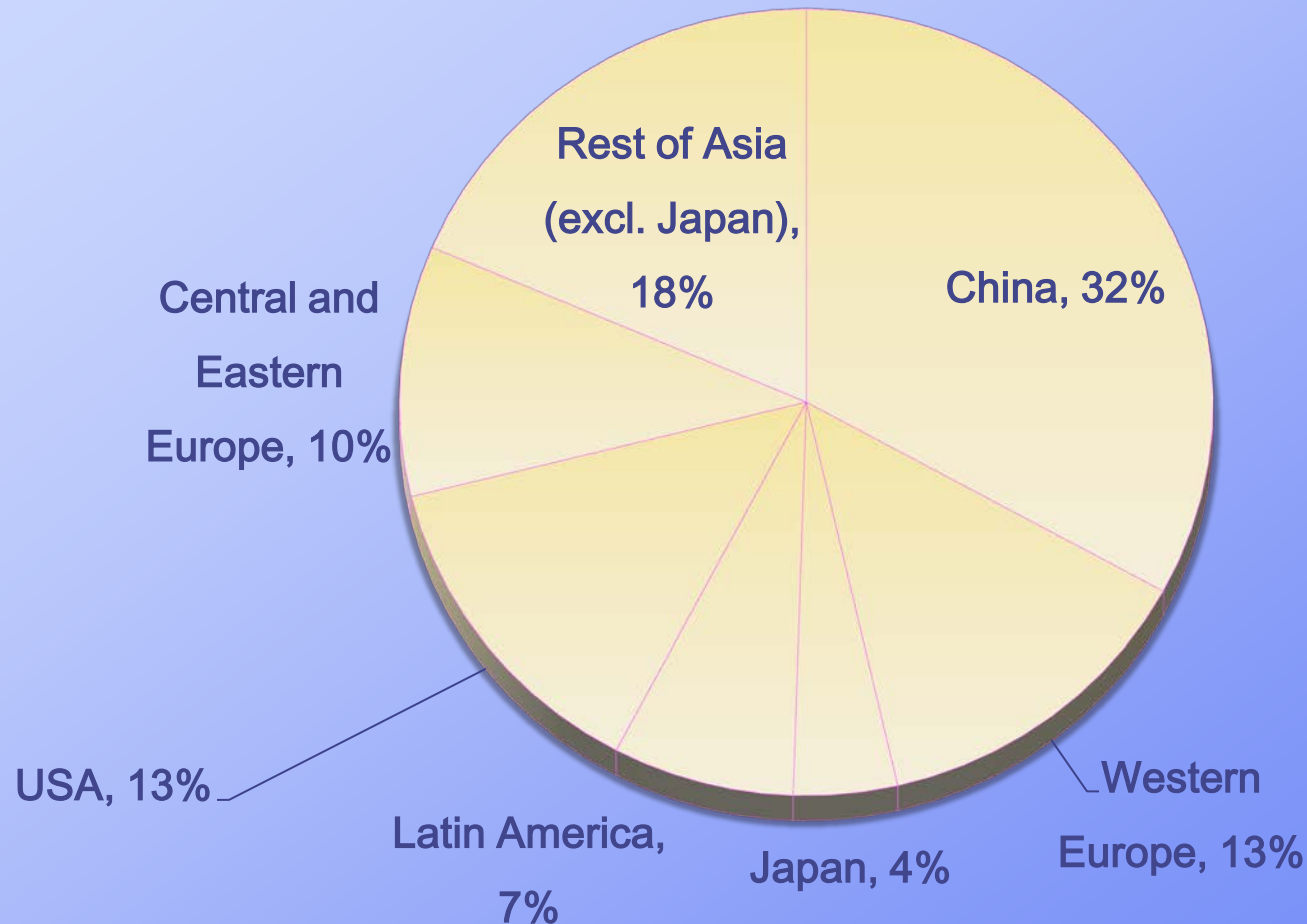


Load from 440 EVs monitored in Washington drops between 4-5 AM
In Oregon, load from 254 EVs drops between 5-6 AM.

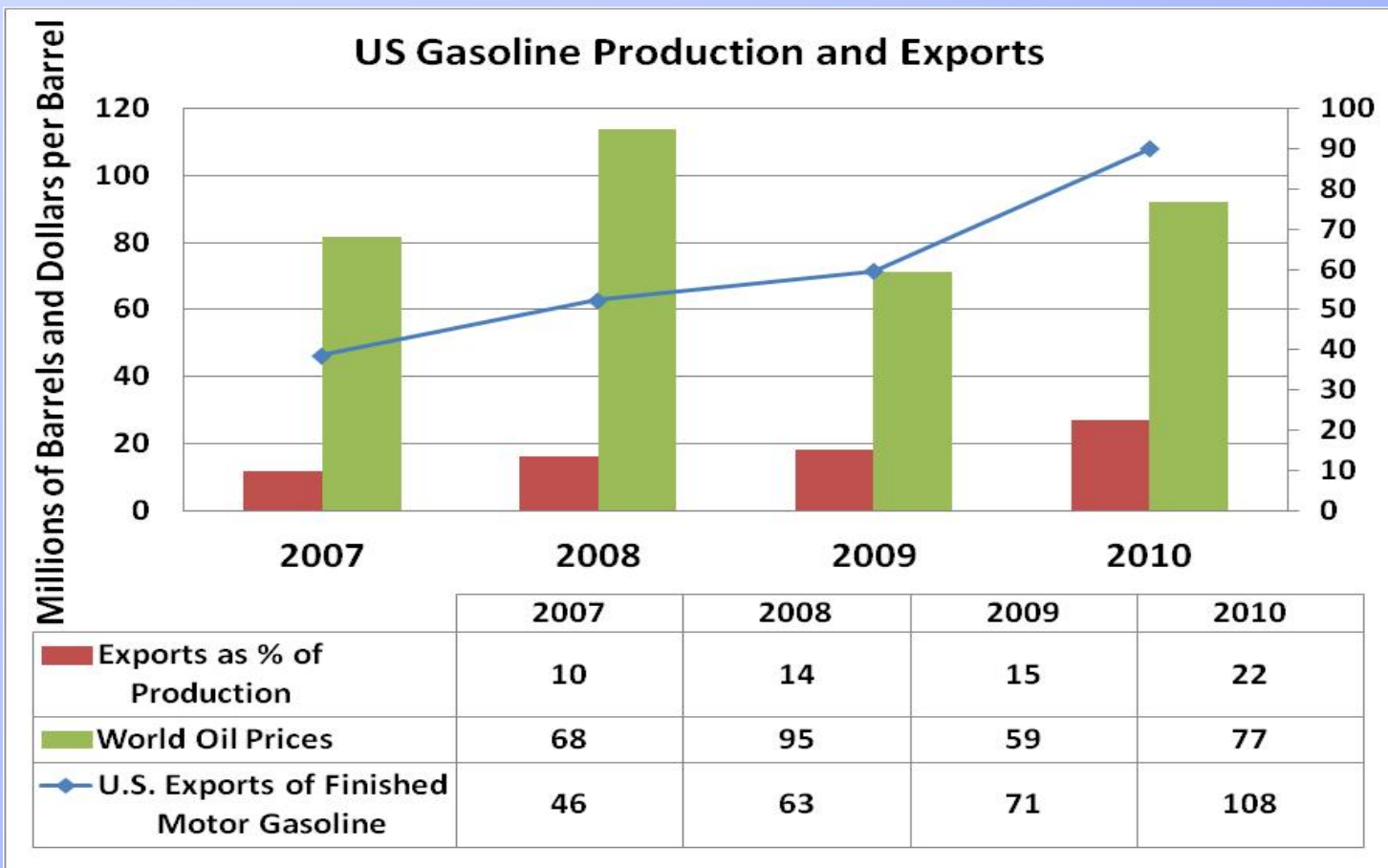
During BPA's system peak* EV load amounted to about 0.3 MW (0.2 MW in Washington and 0.1 MW in Oregon).

* - September 7, 2011 Hour 18

Long-term forecasts for EV (PHEV market is Global)



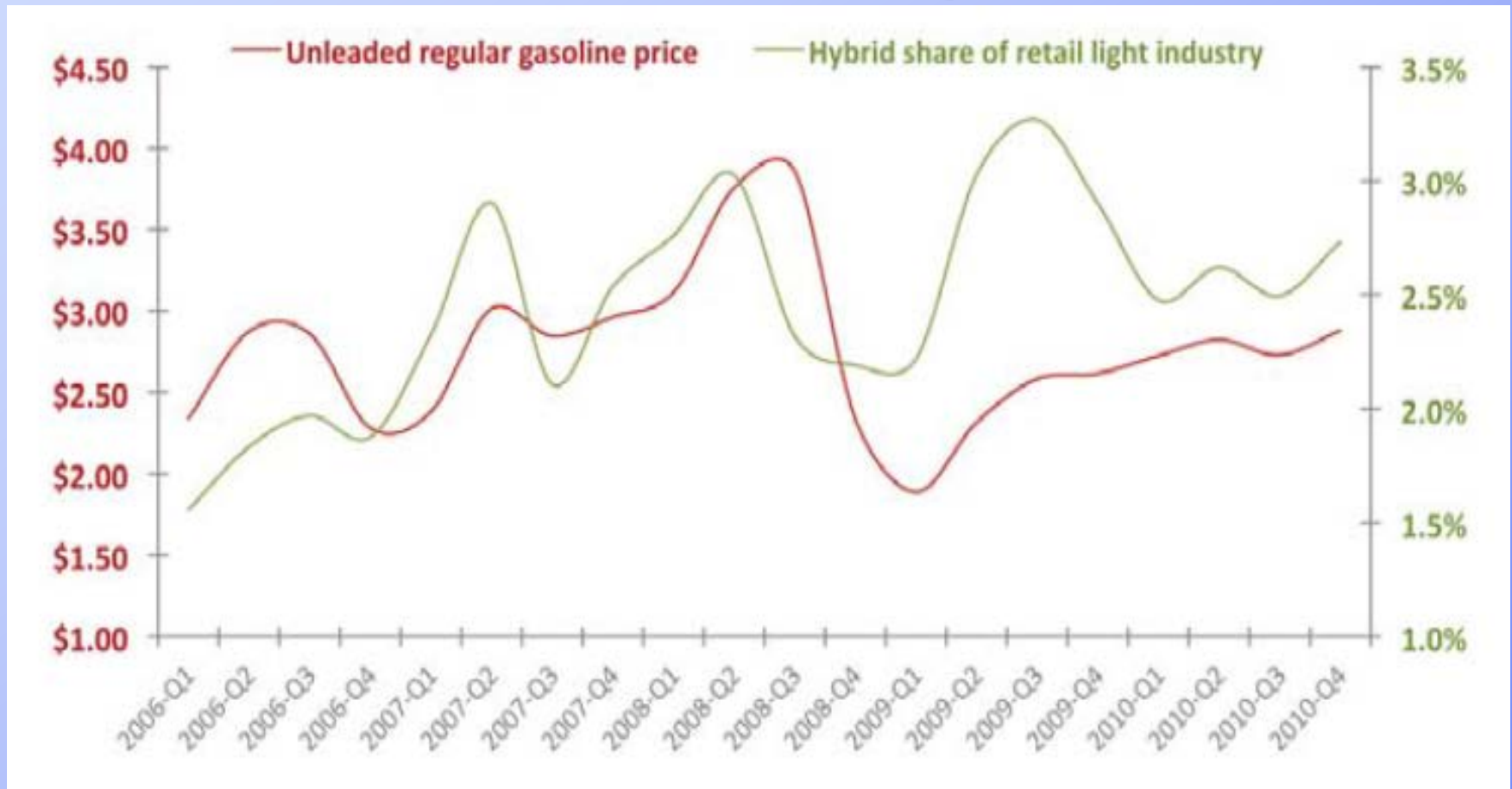
Gasoline is a global commodity, one reason for higher gasoline prices in the US can be higher market opportunities outside the US



As oil prices increase, so do exports of gasoline out of the US
In 2010, 22% of the US gasoline production was exported.

Source: EIA

Gasoline prices influence the market share of hybrids



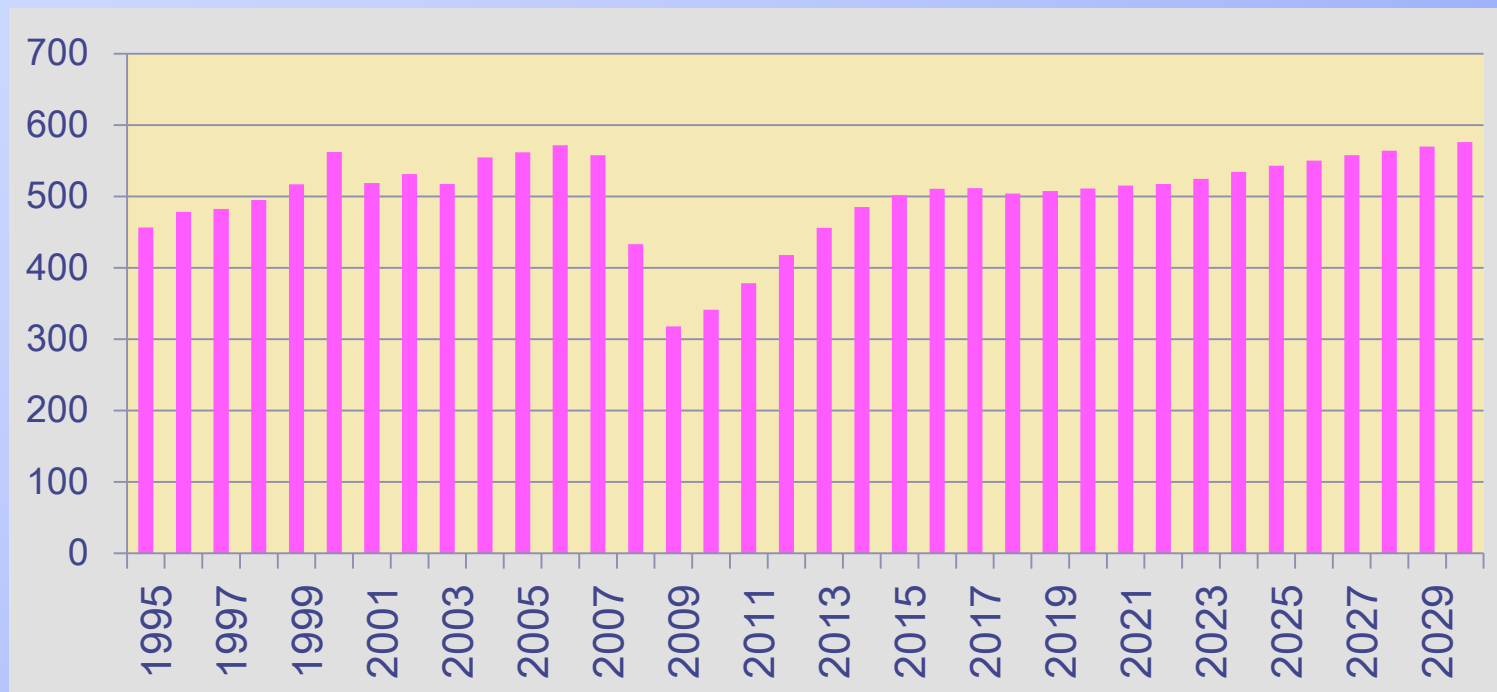
People's decision to purchase hybrid vehicles is in lockstep with price of gasoline. Demand for PHEVs will depend on price of gasoline.



Modified “ What If ” model

- Revised forecast of passenger and light trucks
- Modified Market share fractions
 - reflecting actual data for 2010 and 2011
 - Modified long-term market shares for Idaho and Montana
- Decreased efficiency during winter to reflect impact of temperature on battery holding charge
- Increased load by 10% to reflect interstate travel
 - West Coast Green Highway I-5 EV electrification (DC fast chargers) reducing range anxiety
 - Truck stop electrification

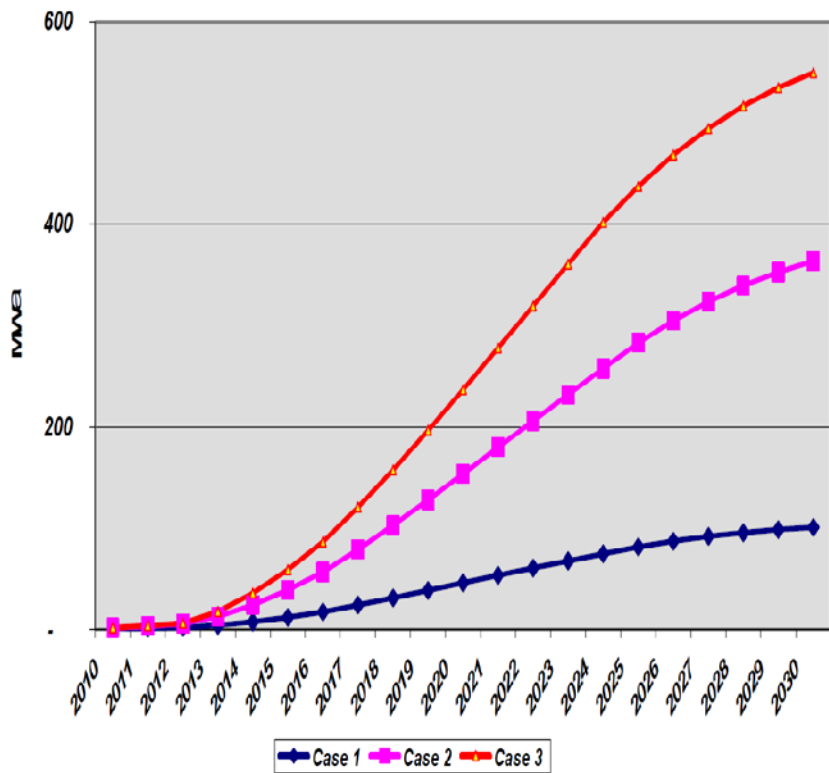
Historical Forecast of New Vehicle Sales in the Region



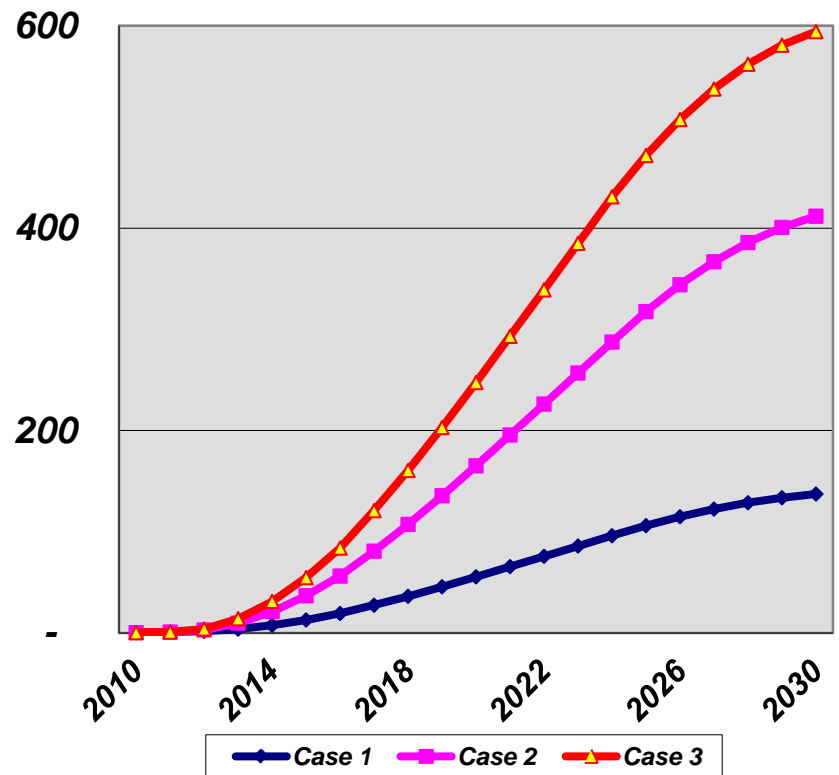
New car sales are expected to be depressed until 2015, and would not get to their recent levels until 2025.

Impact on Annual Energy (MWA)

Figure C-24: Projected Load from Plug-in Hybrid Vehicles

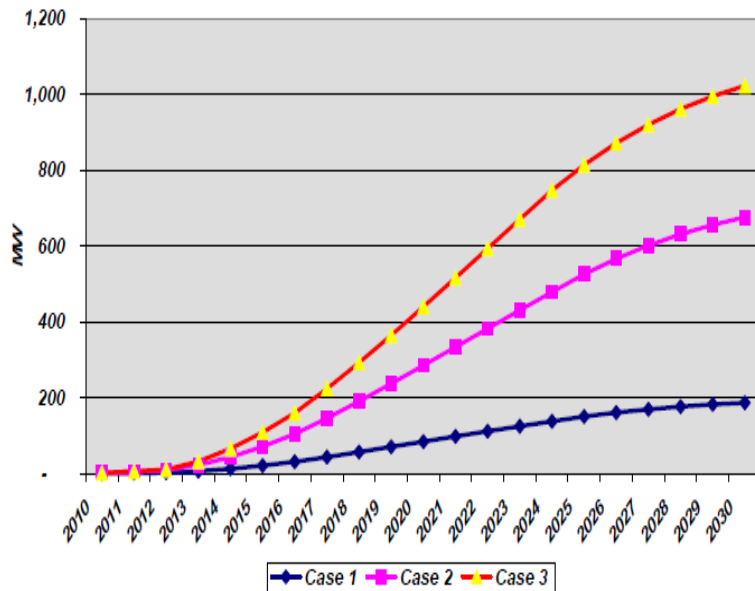


Revised Forecast

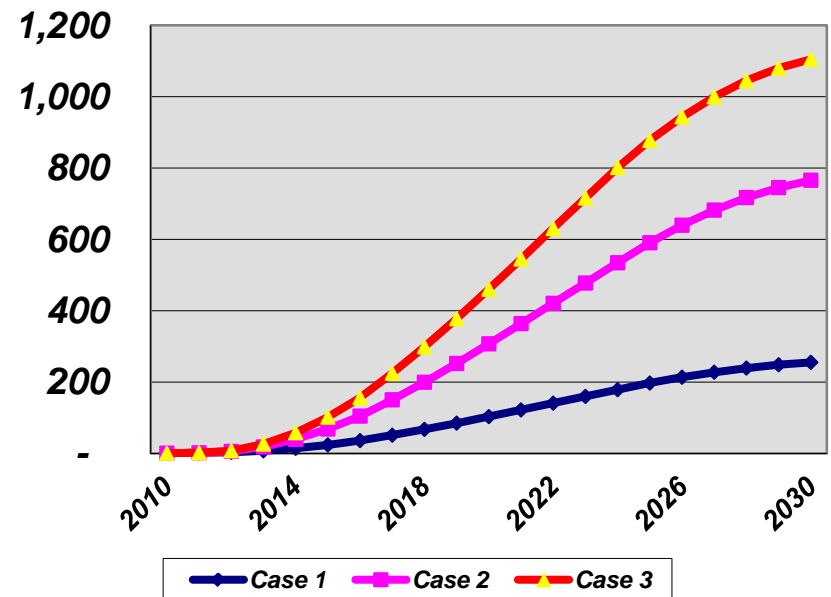


Impact on Off-peak Energy

Figure C-25: Project Off-peak Load from Plug-in Hybrid Vehicles



Revised Forecast MWh



Revised Analysis Findings

- Market share of PHEVs for 2010 and 2011 are in line with the Case 2 (Medium growth) scenario
- Revised plug-in hybrids' impact on annual and off peak load is slightly higher than the earlier forecast

Improvements for the 7th Plan

- Impact of PHEVs will be analyzed using the transportation module of Energy2020
- Incorporating competition between fuels (gasoline, natural gas, electricity)
- Incorporation of commercial fleet in the analysis

New opportunities for Electric Vehicles and Fleet vehicles



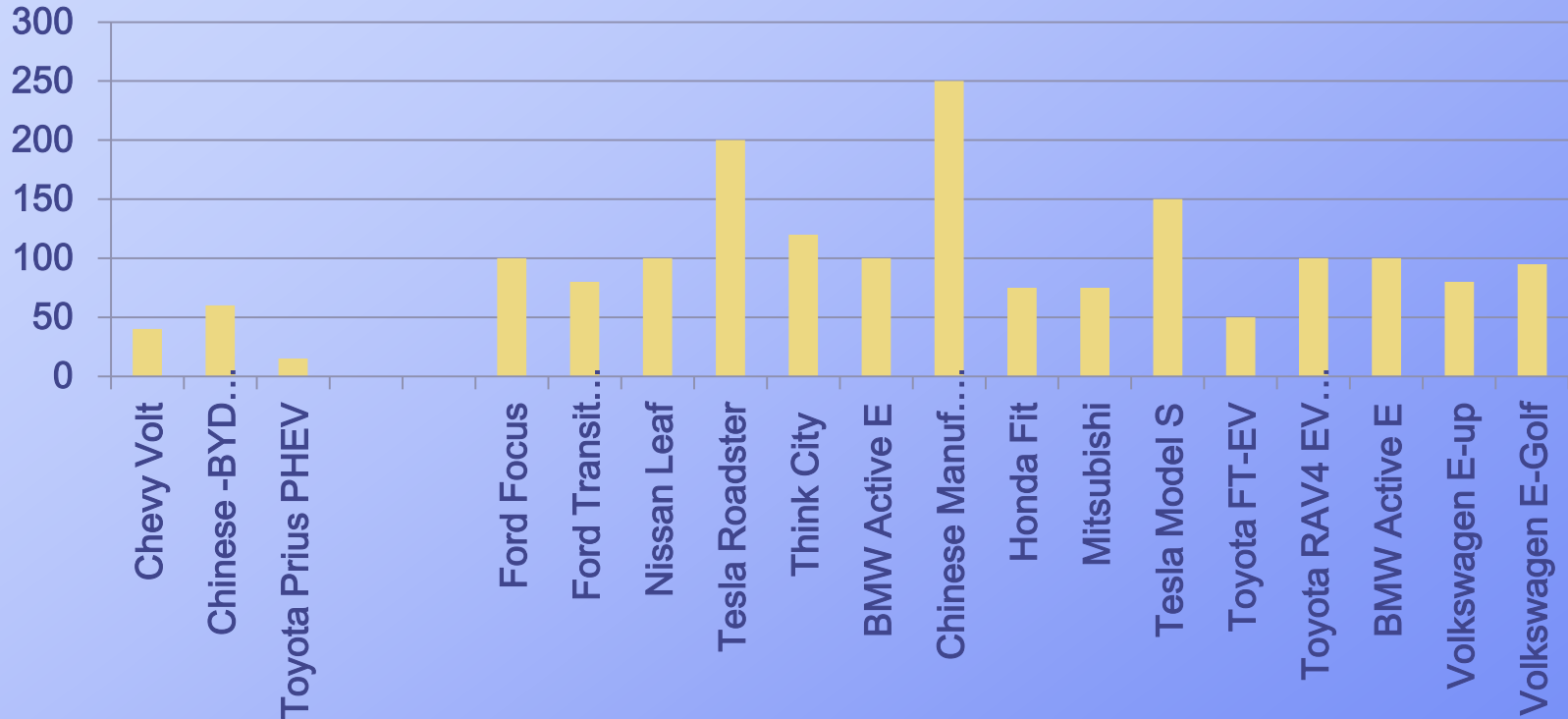
Commercial Fleets can provide ancillary services to the Grid.
Potential for V2G is greater for fleet vehicles due to larger battery size
And higher geographic concentration of vehicles.

➤ Questions?

Additional slides

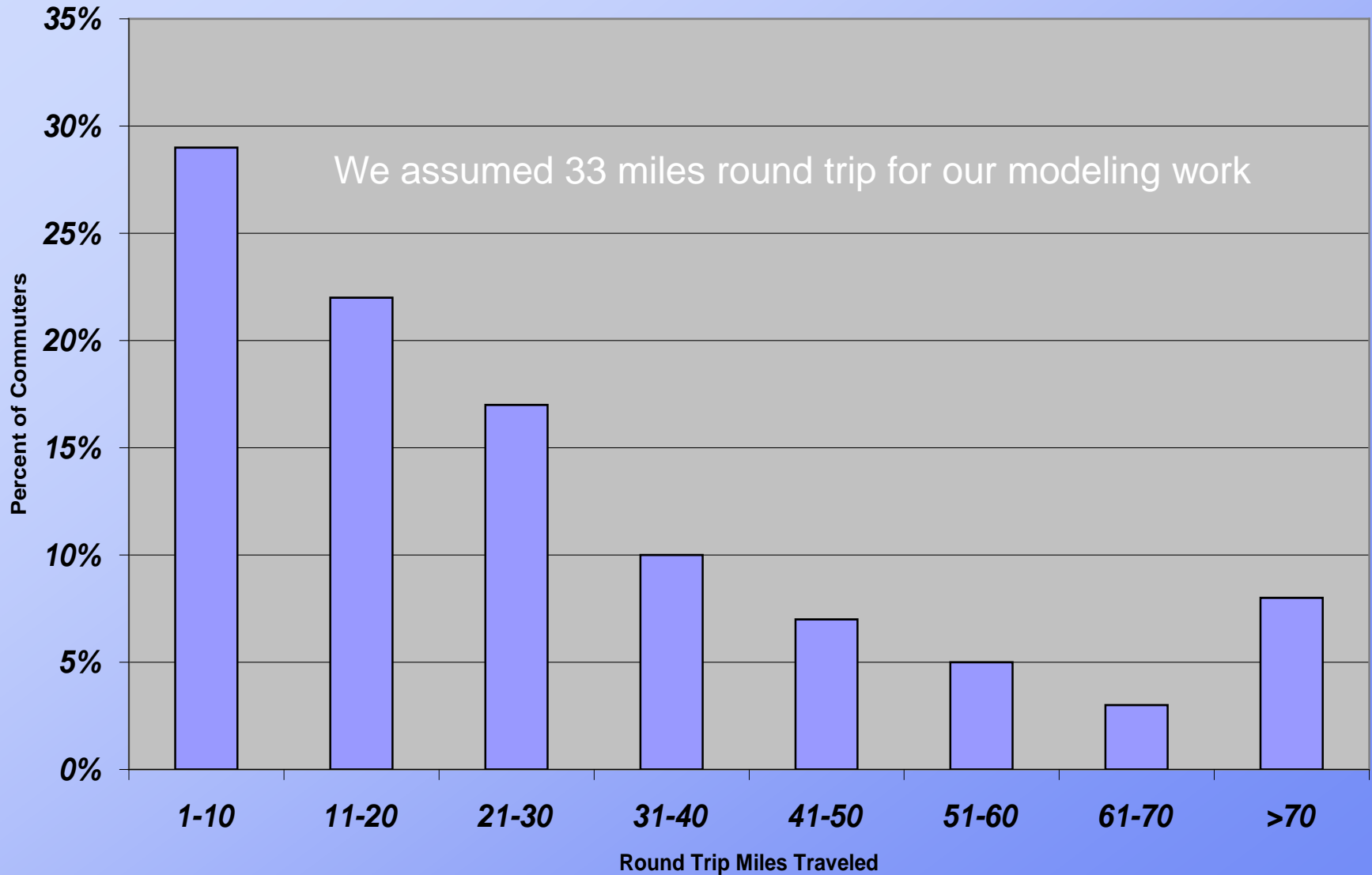
There are large number of new market entries expected for 2012

Manufacturers Claimed Range on single recharge (miles)



Many of the entries could meet customer requirement on range and price.

Typical US Commute Distance



Barriers for PHEVs

Demand

- High purchase price
- Range Anxiety
- Recharging infrastructure

Supply

- Lead times for new product line
- High capital investment requirements
- Limitations of critical supply components
- Global market response

2008 WSDOT Alternative Fuels Corridor Economic Feasibility Study:

“The primary challenge to Alternative Fuels commercialization is how to build a market – simultaneously – for *new vehicle technologies, new fuels, and new infrastructure* to support them.”

Comparative Costs for Alternative Fueling Stations

	Land & Building	Fueling Equipment	Supply Chain
Gasoline	\$ 1,348,500	\$ 571,000	Established
Biodiesel	(Co-located?)	\$ 127,000*	Limitations
Hydrogen	(Co-located?)	\$ 318,000	Not Established
Electricity	Kiosk	\$ 50,000 - \$90,000**	Grid

* Number of pumps scaled for smaller initial demand

** Upper range includes utility connections and necessary upgrades



Nissan LEAF Range and Vehicle Efficiency

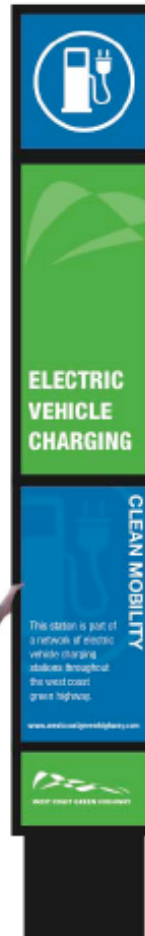
Speed and Driving Conditions	Outside Temp (F)	Accessories	Estimated Range (mi)	Vehicle Efficiency (mi/kWh)*
Cruising 38 mph	68°	None	138	5.75
Fairly steady 24 mph City traffic	77°	None	105	4.38
Steady 55 mph Highway	95°	A/C on	70	2.91
Crawling 15 mph Stop-and-go	14°	Heater on	62	2.60
Average 6 mph Heavy stop-and-go	86°	A/C on	47	1.96

Nissan LEAF has a 24 kWh battery Source: "Nissan Agrees - EV Mileage Will Vary; Leaf Tests Show 91-Mile Variation." Green Car Advisor – edmunds.com. June 15, 2010.



Electric Highways Project

- **Funding:** \$1.32 m seed funding from US Dept. of Energy (via state energy program block grant)
- **Coordination:** with Oregon and B.C. to make PNW EV-ready
- **Minimum of DC Fast-charge stations:** 9 (7 along I-5; 2 along US-2 (E-W route over Cascade Mtns))
- **Target completion date:** October 31, 2011



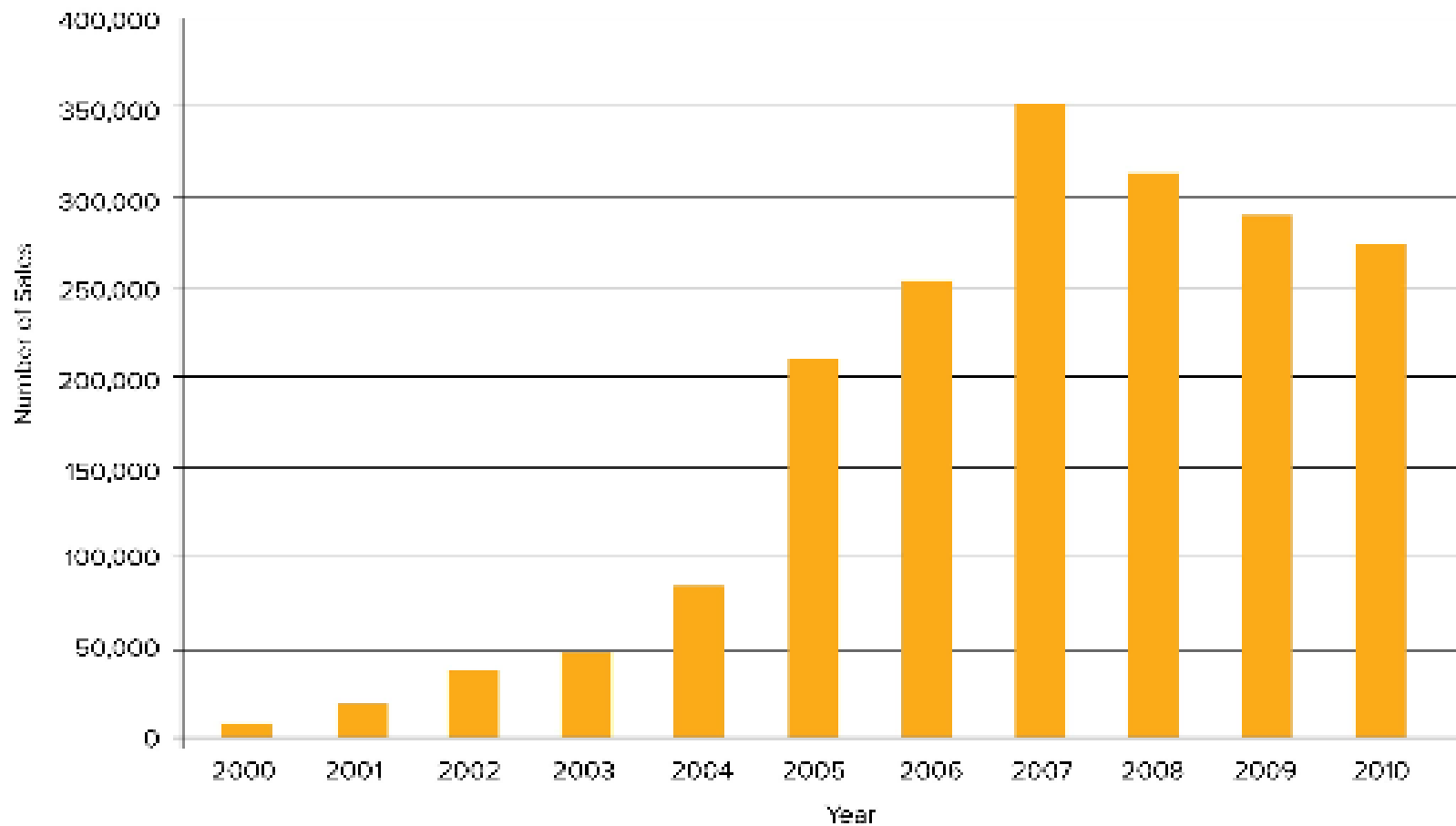
So far

- We discussed the recent experience:
 - Sales and market share of PHEVs,
 - Customer's perception,
 - Charging behavior for PHEVs

- What the future could hold for PHEVs?
 - In a global market, US is expected to have an small share of PHEVs.
 - Gasoline prices are subject to global supply and demand.



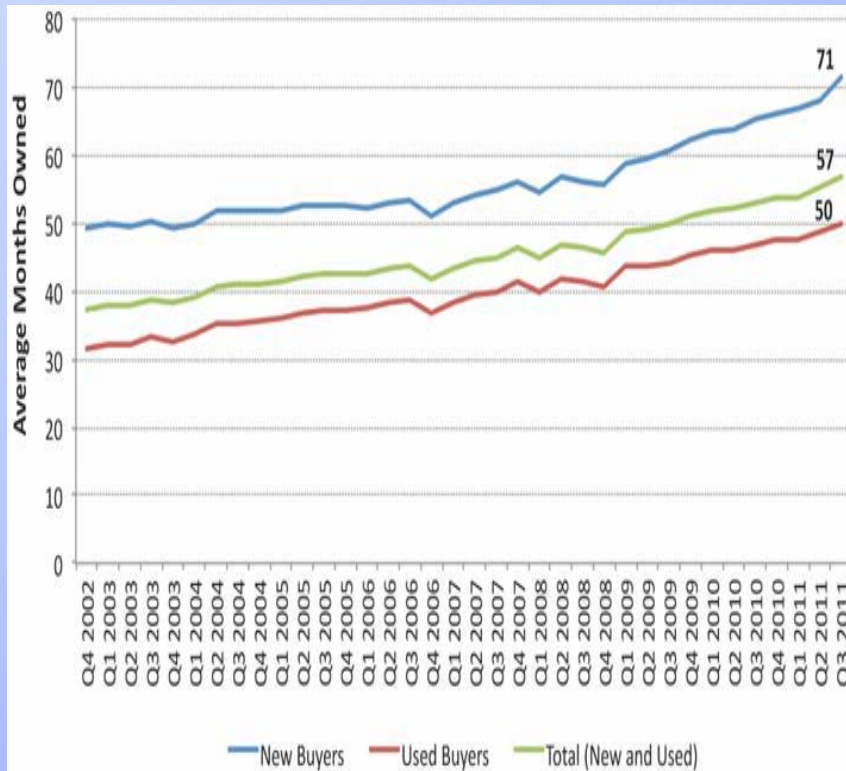
Total Hybrid Sales in the United States by Year Since 2000



Length of U.S. Vehicle Ownership has hit Record High

Increased Retention tied to Economic Slowdown

Impact on Automotive Industry



- market part stores – more DIY.
- OEM Dealership Service and Repair
- New Vehicle Sales
- Used Vehicle sales
- Extended warranty providers

Source: R.L. Polk & Co.