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ECONOMIC ASSESSMENT OF ELECTRIC-DRIVE VEHICLE OPERATION IN CALIFORNIA AND THE UNITED STATES

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With Tim Lipman, PhD and Susan Shaheen, PhD

Motivation

- How much fuel cost savings if switch to electric drive vehicles (EDV)?
- Help to gain consumer market insights for CA and US policy
- Analysis considers:
  - Utility rates designed for EDVs
  - Regional gasoline prices
  - How they combine to provide (or not) economic incentive to switch to EDVs

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Current Incentives/Literature

- Federal $7500 tax credit for “qualified plug-in electric” vehicles, through 2014
- California Clean Vehicle Rebate Project
  - Up to $5,000 per vehicle starting in 2010
  - Applies to new zero emission and PHEV
- Cost effective GHG reductions from PHEVs requires significant drop in cost of batteries
- If batteries cost < $500 per kWh, then cost effective for GHG reductions
- If batteries cost approximately $200 per kWh may be economically viable for consumers

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Methodology - Data Collected

- Current electricity rates for U.S. utility companies known to offer special EV rates
  - Several offered time-of-use (TOU) rates
  - Several tiered rate structures
  - Several flat rate structures
  - Several had winter versus summer rates
- Prices of gasoline for same regions (AAA) of July 2009, prior year, and in between
  - 7/15/08, 1/15/09, and 7/15/09 (high, low, med)

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Methodology - Assumptions

- Assume a driver of 10,000 “electric” miles per year (16,100 km per year)
- Assume uniform driving over entire year
- Assume EDV will use 300 Wh/mi
- Assume compared to 23 mpg (10.2 liters/100km, U.S. Bureau of Trans. Statistics 1980 to 2006)
- Savings = Cost of Gasoline - Cost of Electricity
  - Does not include maintenance or other op-costs
- Sensitivity analysis for mpg, $/gal, % off-peak
- Quick look at regional picture

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Results Annual Savings

- For 10,000 miles a year (26,000 km a year)
- 23 mpg (10.2 liters/100km)
- 300 Wh/mi

Power Co.	Region (If Applicable)	Additional Info (If Applicable)	Gasoline Price Date 7/14/08	1/14/09	7/14/09
Pacific Gas & Electric			$1,793	$723	$1,101
Southern California Edison			$1,482	$395	$773
San Diego Gas and Electric			$1,656	$569	$948
Sacramento Muni. Util District			$1,584	$515	$893
LA Dept. of Water & Power			$1,697	$610	$967
Detroit Edison Energy			$1,615	$563	$858
Florida Power and Light Co.			$1,390	$451	$742
National Grid USA	Massachusetts		$1,091	$99	$421
	Nantucket		$1,126	$135	$456
	New Hampshire		$1,208	$229	$551
	Rhode Island		$1,310	$310	$675
	New York	Adirondack	$1,163	$150	$494
		Capital	$1,143	$130	$474
		Central	$1,164	$151	$494
		Frontier	$1,173	$160	$504
		Genesee	$1,172	$158	$502
		Utica	$1,162	$149	$492
Hawaii Electric Company	HEC	Single phase	$1,419	$510	$897
	HELC		$1,612	$704	$1,091
	MEC	Maui	$1,634	$725	$1,112
		Lanai	$1,634	$725	$1,112
		Molokai	$1,634	$725	$1,112
New York State Elect&Gas			$1,334	$321	$665
NSTAR Boston Edison			$1,161	$140	$501
Austin Energy			$1,354	$345	$671
Seattle City Light	Shoreline		$1,697	$623	$1,010
	Seattle		$1,707	$634	$1,021
	Tukwila		$1,691	$617	$1,004
	Suburban		$1,699	$625	$1,012
XCEL Energy	Colorado		$1,454	$445	$771
	Michigan		$1,563	$580	$828
	Minnesota	Overhead	$1,504	$587	$804
		Underground	$1,480	$563	$780
	New Mexico		$1,413	$478	$748
	North Dakota	Overhead	$1,477	$530	$821
		Underground	$1,453	$506	$797
	South Dakota	Overhead	$1,553	$597	$888
		Underground	$1,529	$573	$864
	Texas		$1,461	$501	$766
	Wisconsin	Single phase	$1,532	$601	$832

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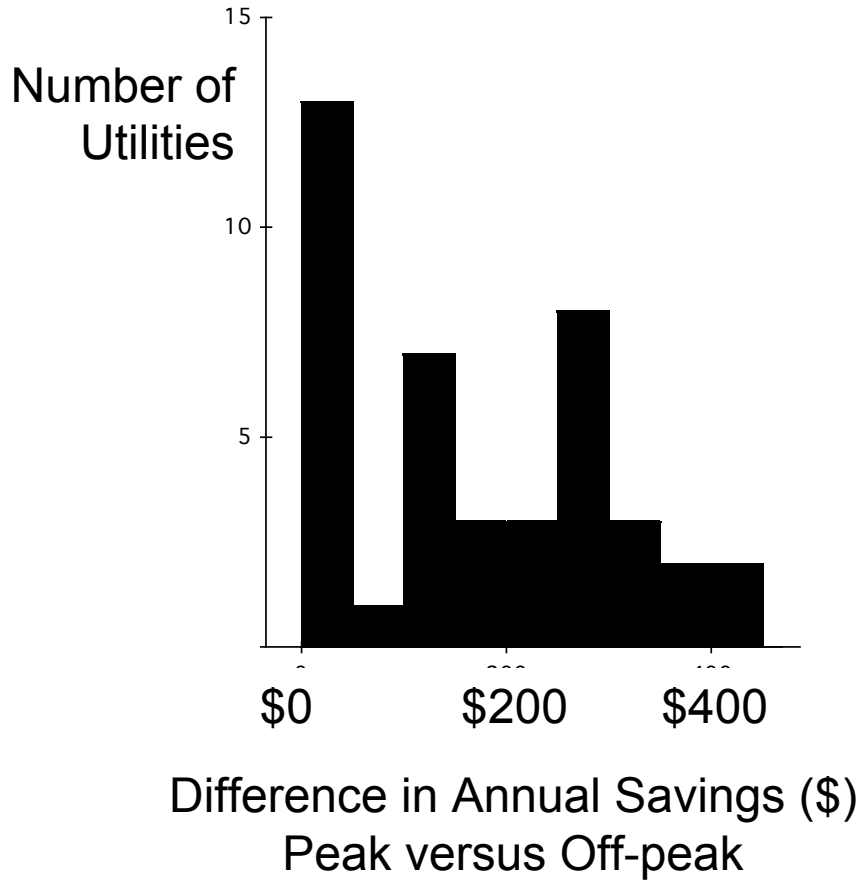
Results - Time of Use Savings

- For 10,000 miles a year (16,100 km/yr)
- 23 mpg (10.2 liters/100km)
- 300 Wh/mi

- Notice Max is ~$400 per year
- Average <$1 per day



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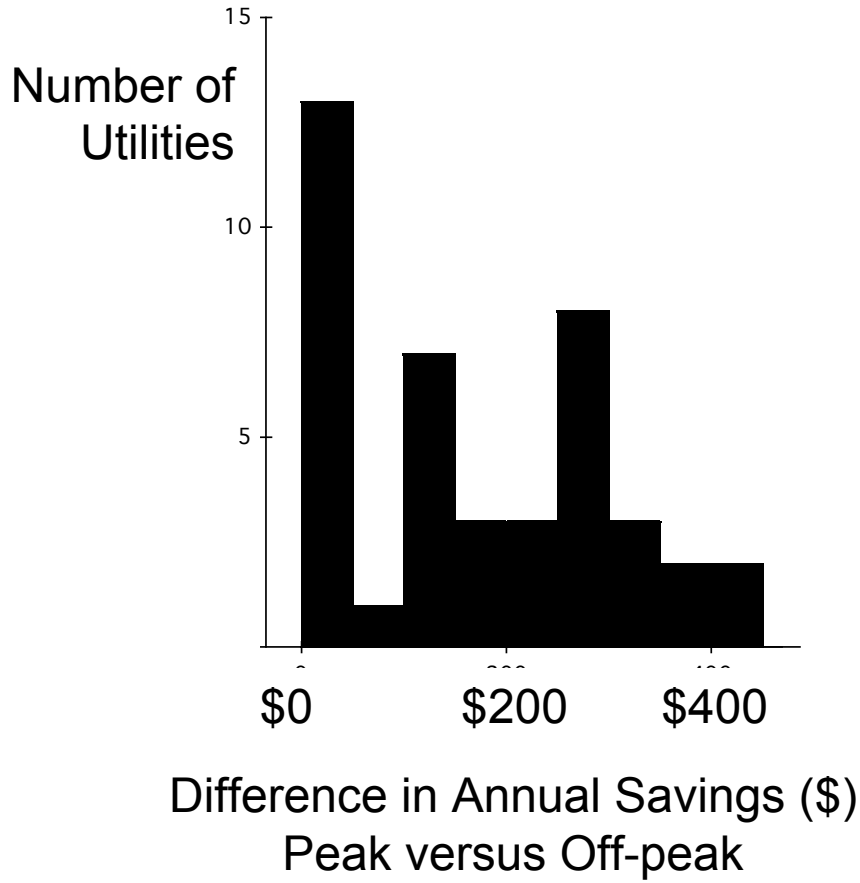

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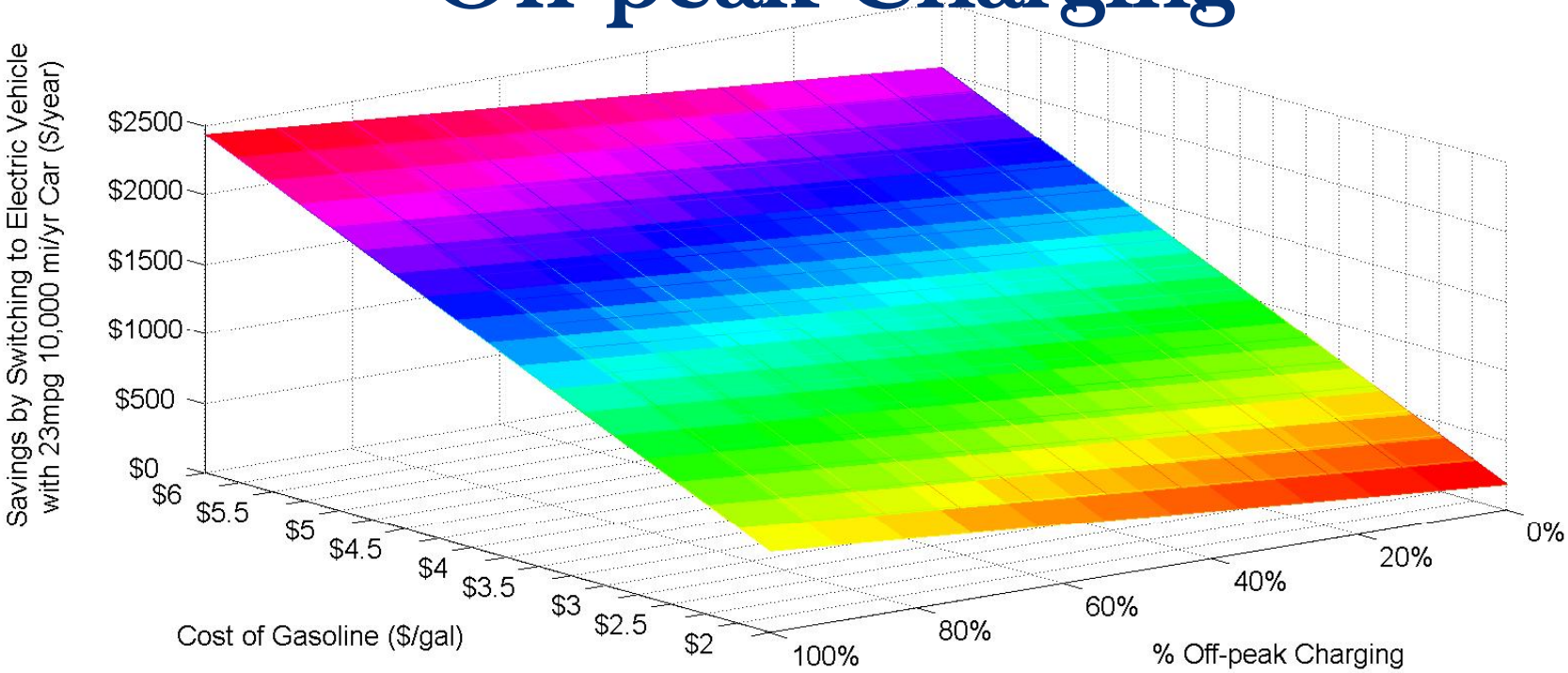
Sensitivity Analysis on $/gal and % Off-peak Charging



- PG&E as example
- Charge peak or off-peak makes little difference
- Price of gasoline makes large difference
- Gasoline price relation is linear

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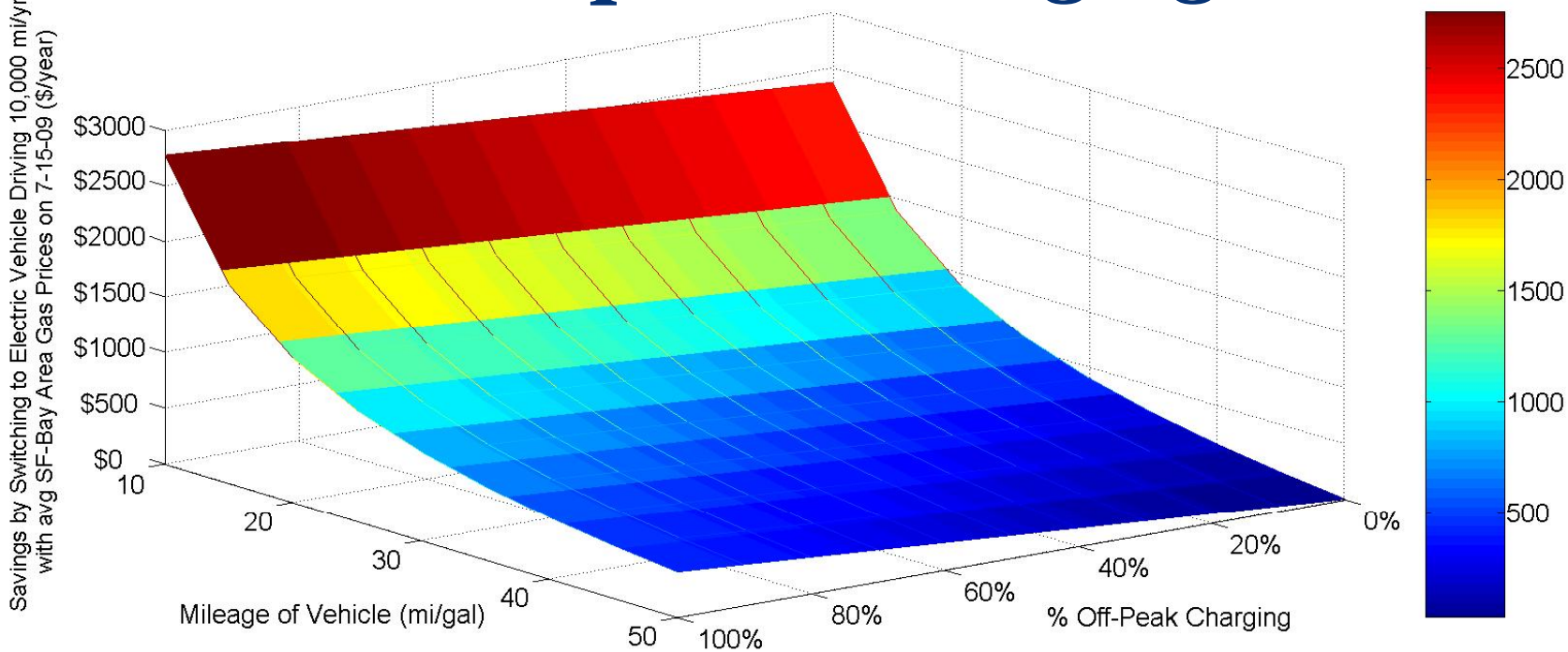
Sensitivity Analysis on MPG and % Off-peak Charging



- PG&E as example
- High mileage vehicle compared to 100% peak charging offers zero savings
- Comparison mpg is exponential
  - Most likely due to fixed 300 Wh/mi

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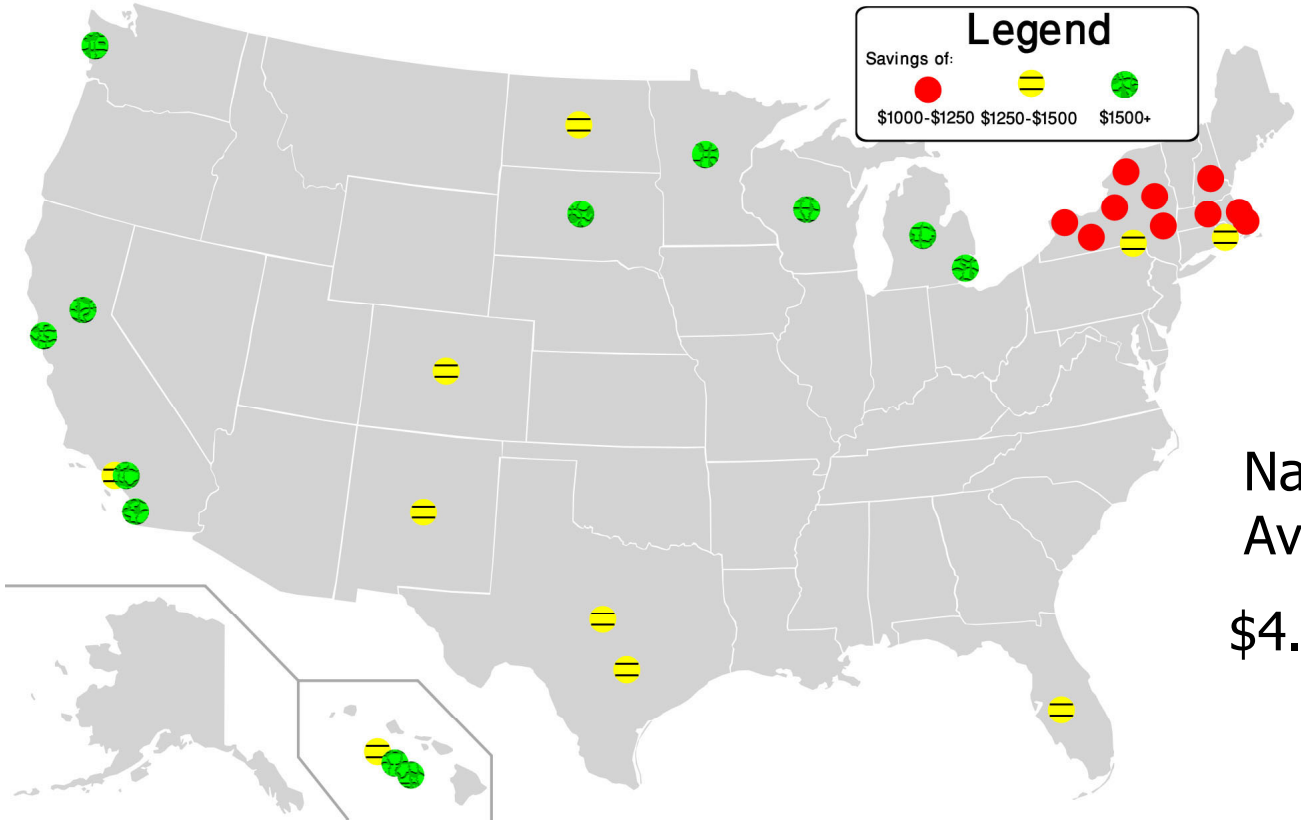
Regional Picture
Highest Gasoline Prices



National Average

$4.11/gal

Relative annual fuel cost savings from switching to EDV, based on estimated gasoline prices in July 2008 (10,000 mi/16,100 km per year and compared with 23 mpg/10.2 literes/100km)

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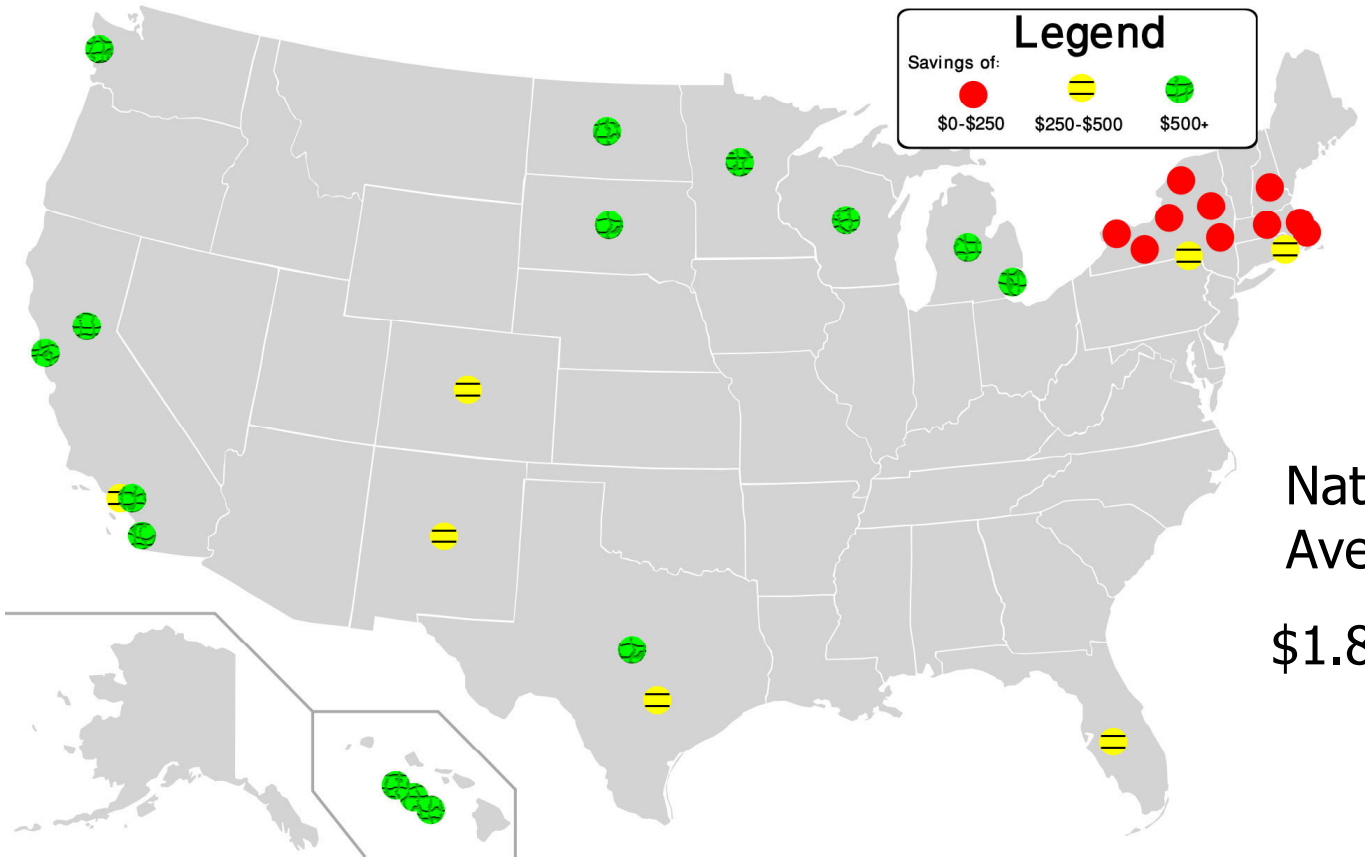
Regional Picture
Lowest Gasoline Prices



National Average

$1.81/gal

Relative annual fuel cost savings from switching to EDV, based on estimated gasoline prices in January 2009 (10,000 mi/16,100 km per year and compared with 23 mpg/10.2 literes/100km)

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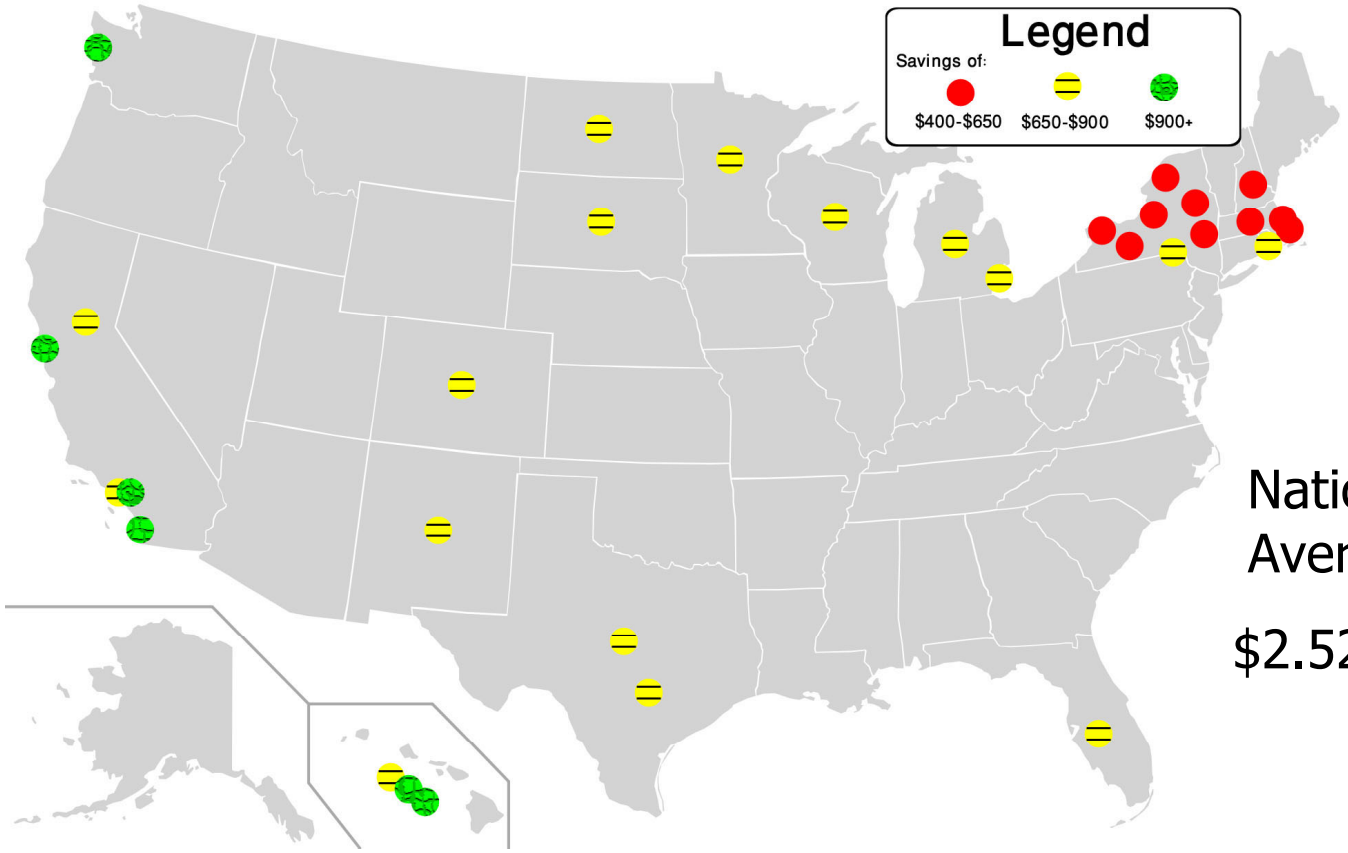
Regional Picture
Current Gasoline Prices



National Average

$2.52/gal

Relative annual fuel cost savings from switching to EDV, based on estimated gasoline prices in July 2009 (10,000 mi/16,100 km per year and compared with 23 mpg/10.2 literes/100km)

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Conclusions

- High gas price case (summer 2008) provides average savings of $1,447/yr ($7,235/5yr, $14,500/10yr)
  - Based on 10,000 mi/16,100 km per year, 23 mpg/10.2 liters/100km)
- Charging 100% off-peak saves < $1 a day (on average)
- Gasoline prices greatly affect EDV savings
- Switching from larger gasoline vehicle (low mpg) to smaller EDV provides exponentially increased savings
- High mileage gasoline vehicles compared to 100% peak charging offer virtually no savings
- Each 50 cent increase in gasoline prices (gas tax?) will provide an additional $200/yr in savings
- The West Coast, Hawaii, and Northern Midwest offer largest fuel cost savings

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Limitations/Future Research

- Limited scope of study: focuses only on consumer energy costs and not vehicle first costs (battery), other operating costs, etc.
- Utility companies are not a random sample, results are not to be used for inference
- No sensitivity analysis done for Wh/mi
- No commercial or fleet vehicles were considered
- Detailed driving patterns were not considered (PHEV vs. BEV, etc.)

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THANK YOU!

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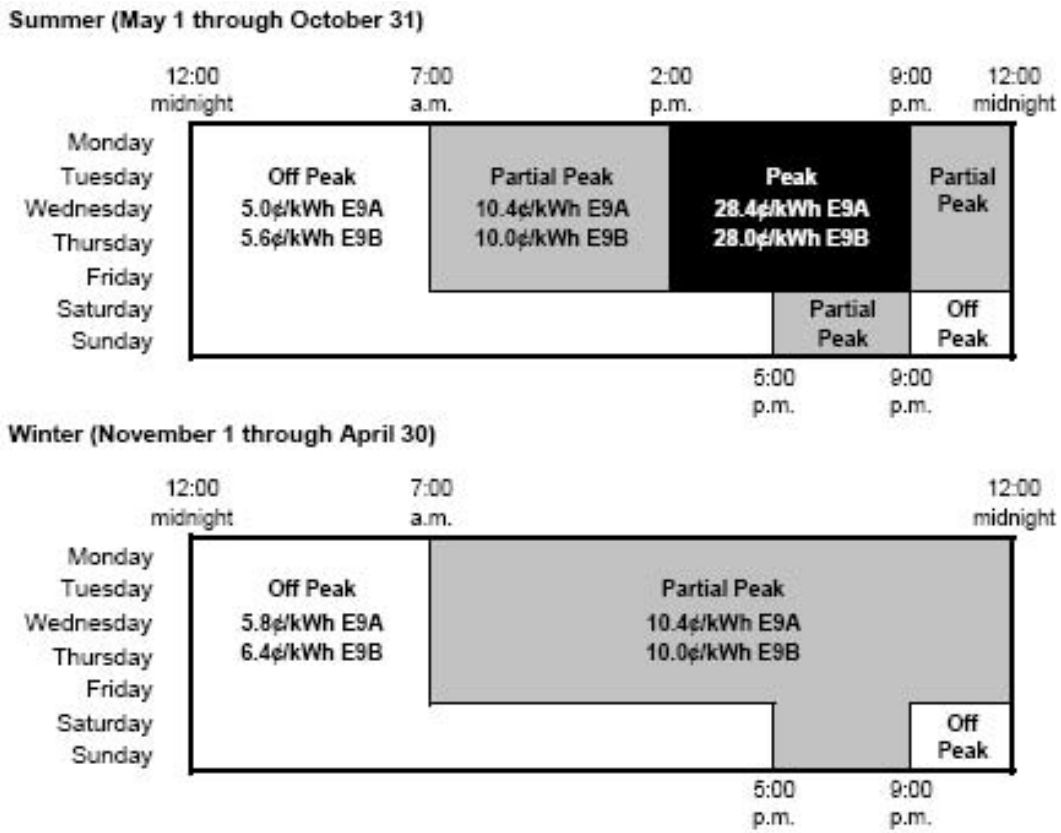
Example Time-of-Use Rate Schedule



Source: Pacific Gas & Electric July 2009

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Gas Prices

- 7/15/08 is highest
- 1/15/09 is lowest
- 7/15/09 is current
- Source: AAA http://www.fuelgaugereport.com/sbsavg.html

Region-Utility Company	7/15/08	1/15/09	7/15/09	Regions Used for Gas Price Estimates
SF-Bay Area (PG&E)	$4.54	$2.08	$2.95	SF, Oakland
Los Angeles (SoCal Edison)	$4.51	$2.01	$2.88	LA, Orange, Riverside, San Bernardino
San Diego (SDG&E)	$4.50	$2.00	$2.87	San Diego
Sacramento (SMUD)	$4.42	$1.96	$2.83	Sacramento
Los Angeles (LADW&P)	$4.51	$2.01	$2.88	LA, Orange, Riverside, San Bernardino
Detroit (Detroit Edison Energy)	$4.18	$1.76	$2.44	Detroit (MI)
Florida (FPLC)	$4.06	$1.90	$2.57	Florida
Massachusetts (Nat'l Grid USA)	$4.09	$1.81	$2.55	Massachusetts
Nantucket (Nat'l Grid USA)	$4.09	$1.81	$2.55	Massachusetts
New Hampshire (Nat'l Grid USA)	$4.04	$1.79	$2.53	New Hampshire
Rhode Island (Nat'l Grid USA)	$4.10	$1.80	$2.64	Rhode Island
New York (Nat'l Grid USA)	$4.31	$1.98	$2.77	New York
Hawaii (Hawaii Electric Co.)	$4.47	$2.38	$3.27	Hawaii
New York (NY State Elect & Gas)	$4.31	$1.98	$2.77	New York
Boston (NSTAR Boston Edison)	$4.08	$1.73	$2.56	Boston (MA)
Austin (Austin Energy)	$3.97	$1.65	$2.40	Austin (TX)
Seattle (Seattle City Light)	$4.35	$1.88	$2.77	Seattle (WA)
Colorado (XCEL CO)	$4.07	$1.75	$2.50	Colorado
Michigan (XCEL MI)	$4.18	$1.92	$2.49	Michigan
Minnesota (XCEL MN)	$3.97	$1.86	$2.36	Minnesota
New Mexico (XCEL NM)	$4.05	$1.90	$2.52	New Mexico
North Dakota (XCEL ND)	$4.06	$1.88	$2.55	North Dakota
South Dakota (XCEL SD)	$4.05	$1.85	$2.52	South Dakota
Texas (XCEL TX)	$3.97	$1.76	$2.37	Texas
Wisconsin (XCEL WI)	$4.09	$1.95	$2.48	Wisconsin

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