



A  Sempra Energy utility[®]

Plug-in Electric Vehicle Customer Charging Time Decisions

Prepared for the
Association of Energy Services Professionals

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Plug-in Electric Vehicle Terminology

Conventional



Hybrid
HEV



Plug-in Hybrid
PHEV



Plug-in Electric
Vehicle
PEV

Battery
Electric
BEV



New Plug-in Vehicles Coming To Market

New U.S. models – existing & new manufacturers
LDV, unless otherwise noted



PHEV

BEV

2011

2012

Source: Plug In America; California HVIP rebate program

SDG&E® Goals

Support growth of electric transportation while ensuring the safe, reliable & efficient integration with the grid

Create an Excellent Customer Experience and Build Consumer Confidence



Charging Technology & Infrastructure

Widespread & convenient

Charging Pricing

Attractive to charge off-peak

Utility System Integration

Efficient & "smart"

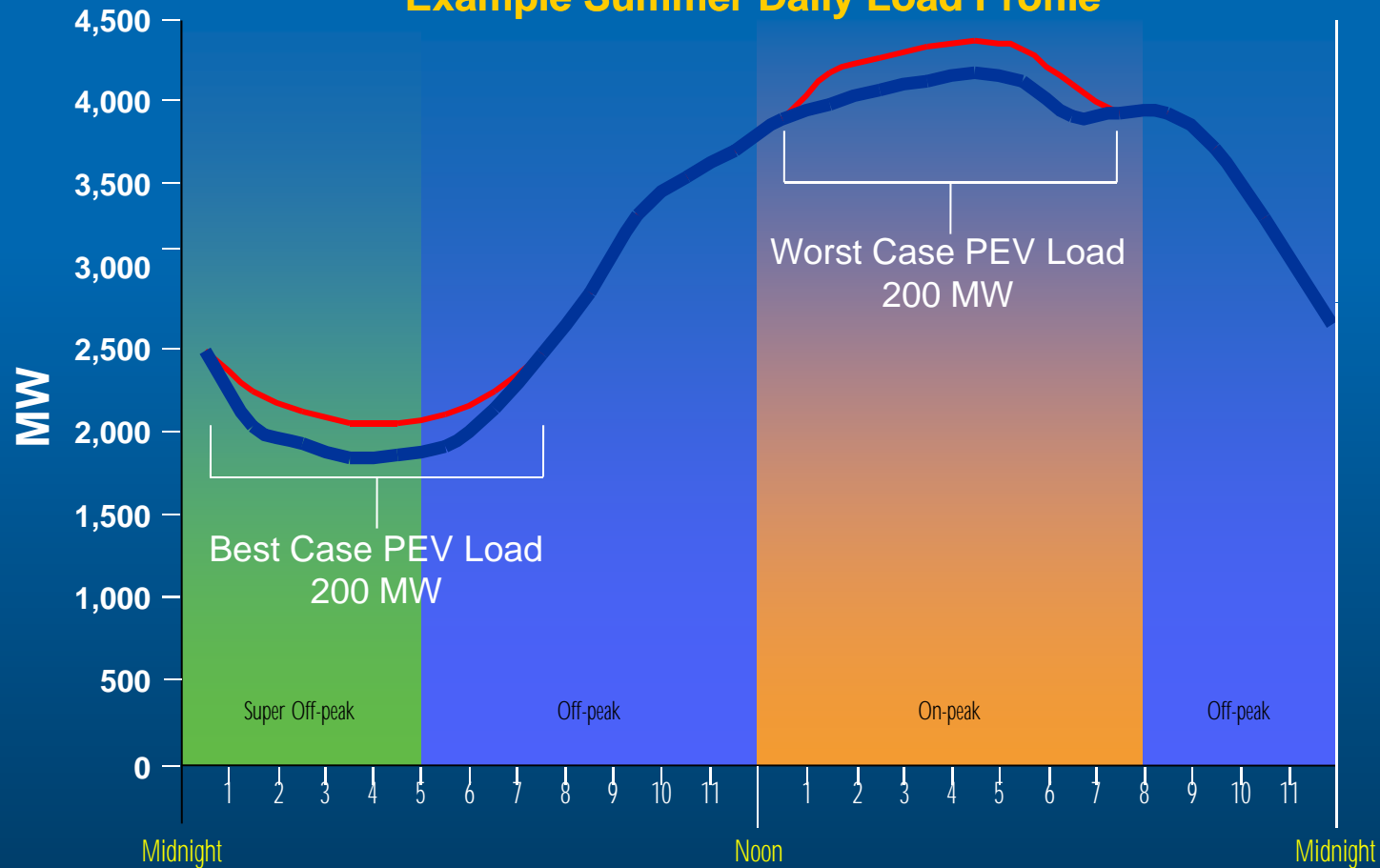
Market Development

Educate & support



Charging Time Impacts on the Grid

Example Summer Daily Load Profile



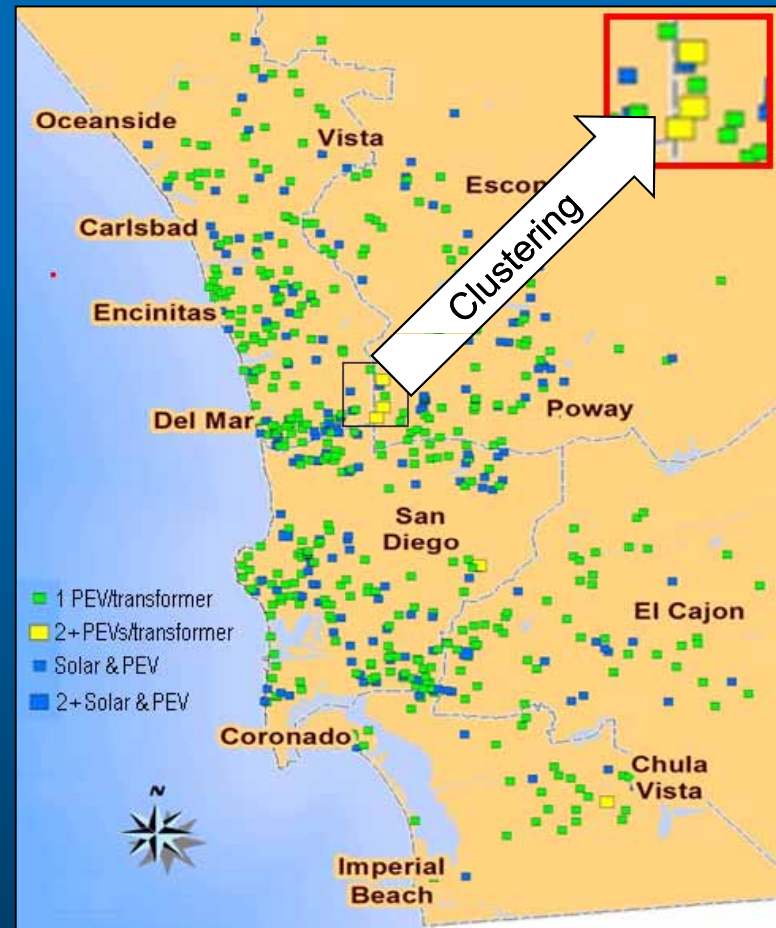
System & PEV charging load profile are for illustrative purposes only, and not intended for forecasting.



Low Rates & Minimizing “on peak” Charging

Through outreach & education, and time-variant rates, SDG&E is helping reduce charging impacts from PEV clustering

- Understanding charging impacts on system
- Reducing fueling cost with off peak rates
- Move charging to the lowest demand time of day



Source: SDG&E Load Research group; actual data gathered from Rate Study participants

EV Project, Nissan & SDG&E

- Largest PEV charging infrastructure in US history
San Diego is one region targeted by Nissan & EV Project
- ARRA / DOE & CEC grants awarded to ECOtality



Single Family & Fleet Chargers

- 1,000 "Free" 240V

Commercial & Public Chargers

- 1,000 240V
- 30 to 60 480V DC Fast Chargers

Nissan LEAF EV - Features

- Five Passenger Hatchback
- About 100 miles/charge
- 100% Electric - Zero Emission Vehicle
- Accepts Level 1, Level 2 and DC Fast Charging
- Lithium Ion Battery (24kWh capacity)
- Displays “distance to empty”
- Has timer to set start & stop times for charging, with an override



Research Advisory Panel

- UC Davis, Tom Turrentine, PHEV Research Center
- EPRI, Bernie Neenan, Electric Transportation Program
- USD-EPIC, Scott Anders (& Nilmini Silva-Send)
- UCSD, Professor Graff Zivin (& Ben Gilbert)
- CEC-PIER, Phil Misemer
- US EPA, Zoltan Jung
- CCSE, Mike Ferry
- SCE, Russ Garwacki
- SMUD, Bill Boyce
- ECOTality, Don Karner
- Coulomb Technologies, Richard Lowenthal
- Boulder Energy Group, Bill Le Blanc
- EEI, Rick Tempchin
- CPUC Staff

What Drives Charging Time Decisions?

PEV Rates & Technology Study – CPUC approved experimental PEV rates for EV Project & Nissan deployment

- **Price – Large \$ Savings?**
Low super off-peak rates
- **Technology & Information – “Set & Forget”?**
On-board Leaf technology
- **Convenience & Lifestyle – Do Travel Needs Rule?**
Schedule & green values



Study Objective

Objective

To examine PEV consumer charging preferences, use of technology, and other relevant factors by incorporating a controlled study of CPUC-approved time-differentiated rates into EV Project & Nissan Leaf launch in San Diego.

Working Hypotheses

Time variant pricing and technology use will influence consumer charging behavior.

Greater price variations will drive more charging activity to off-peak periods. Enabling technology will facilitate charging behavior that is convenient and economic to the consumer.

Study Design

Dependent Variable

Time-of-use Charging

Ratio of on-peak charging kWh to off-peak and super off-peak charging kWh per day



Independent Variable

3 Time Variant Priced Rates

Each differing in super off-peak to on-peak price spread

Conditioning Variables

- Use of Enabling Technology
- Driver Profile
- Use of Charging Facilities

Study Variables

Time-of-Use Charging

- kWh use collected in 15 minute intervals, separately metered
- Aggregated to time-of-use periods

Rates & Pricing Treatment

- Randomly assign participants to one experimental EV rate
- Open Issue – rates associated with public & workplace charging

Use of Enabling Technology with Rate Knowledge

- On-board Leaf programmable timers
- Use of cell phone communication applications
- Understanding of TOU rates and bill impact

Conditioning Variables

Driver Profile

- Vehicle Use – Miles per day, week & driving conditions
- Participants Characteristics – demographics, household & consumption data

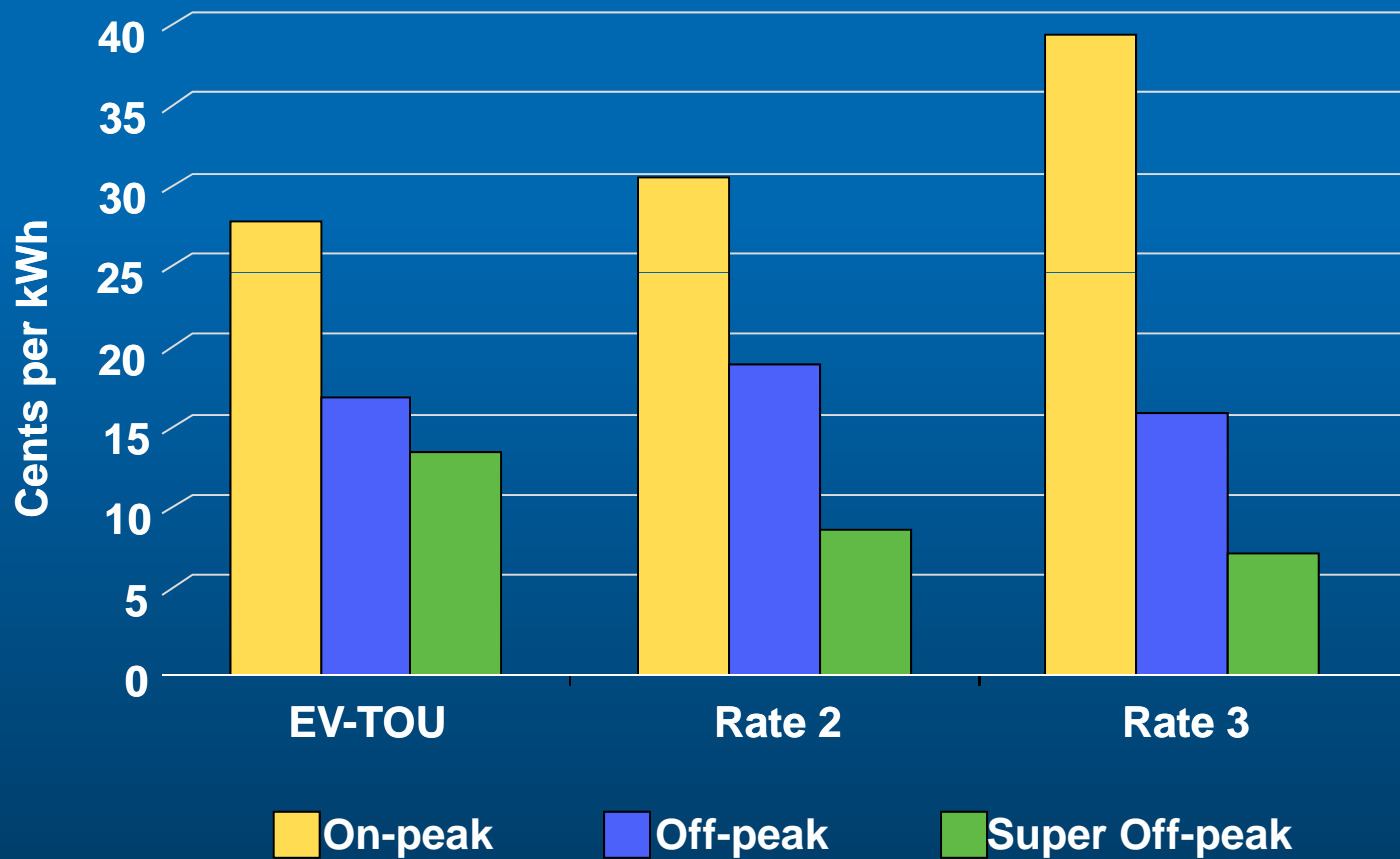
Driver Access to & Use of Charging Facilities

- At home, at work & other non-home charging facilities
- Location, charging times, kWh & rates charged



*Investigating potential data collection & analysis collaborators: SEU, Grid Point, Idaho Nat. Labs, UC Davis & Ohio State

PEV Experimental Rates – Summer



The use of Experimental Rates requires CPUC approval.

Experimental Rate Features

- TOU periods consistent with current Schedule EV-TOU
- TOU periods approximate periods of differing system demand
- 3 TOU periods, 7-days per week, no change seasonally
- Separate SubMetering of PEV Usage
- Temporary experimental rates NOT indicative of future rate proposals (intended only for analysis of price elasticity of demand)
- **Super-Off-Peak (midnight to 5am)** rates should not be less than generation marginal energy costs
- **On-Peak (noon to 8pm)** rates shouldn't greatly exceed customer's rates for Tier 4 usage under applicable residential rate
- No "true-up" of revenue differences at end of experimental period
- No "bill protection"

Pricing Signal – the PEV Customer Bill

July 2011 SDG&E Bill

- TOU Rate EPEV-Z
- 161 kWh used
- 527 miles driven
- 3.3 Miles / kWh
- 90% Super off-peak
- \$13.80 Total EV Bill
- 2.6 cents / mile*

<i>Detail of Current Charges - Continued</i>				
Electricity Delivery (<i>Details below</i>)		161 kWh		
<i>SUMMER USAGE</i>	On-Peak	Off-Peak	Super Off-Peak	
kWh used	3	14	144	
Rate/kWh	\$.23136	\$.09075	\$.02662	
Charge	\$.69	+ \$1.27	+ \$3.83	= 5.79
DWR Bond Charge		161 kWh x \$.00505		.81
Electricity Generation (<i>Details below</i>)		161 kWh		
<i>SUMMER USAGE</i>	On-Peak	Off-Peak	Super Off-Peak	
kWh used	3	14	144	
Rate/kWh	\$.14687	\$.05751	\$.03545	
Charge	\$.44	+ \$.81	+ \$5.10	= 6.35
Total Electric Charges				\$12.95
TAXES & FEES ON ELECTRIC CHARGES				
				Amount (\$)
City of San Diego Franchise Fee Differential		11.78 x 5.78%		.68
Franchise Fees on Electric Energy Supplied by Others		1.17 x 6.88%		.08
State Surcharge Tax		161 kWh x \$.000290		.05
State Regulatory Fee		161 kWh x \$.000240		.04
Total Taxes & Fees on Electric Charges				\$.85
Total Electric Service				\$13.80

* At 25 MPG Gas Car = 15 cents / mile @ \$3.75 /gal.

PEV Metering

House Meter

EV Project participants eligible for separately submetered experimental rate.

Service Order staff determines location of submeter.

Disconnect breaker between submeter & EVSE

Submeter (series) after main panel breaker, load side



SDG&E Connected.....to electric vehicles

www.SDGE.COM/CleanTransportation

GETTING THE WORD OUT ABOUT THE BENEFITS OF EV RATES

- **Push to the SDG&E Clean Transportation Web resources**
- **Working with dealerships**
- **Participation/coordination community PEV events**
- **Targeted communications & workshops**
- **Contractor & Inspector Training/Forums**
- **Web resources – e.g., GoElectricDrive.com**
- **Study data collection ends Q2 2013**