PLMA Spring Conference

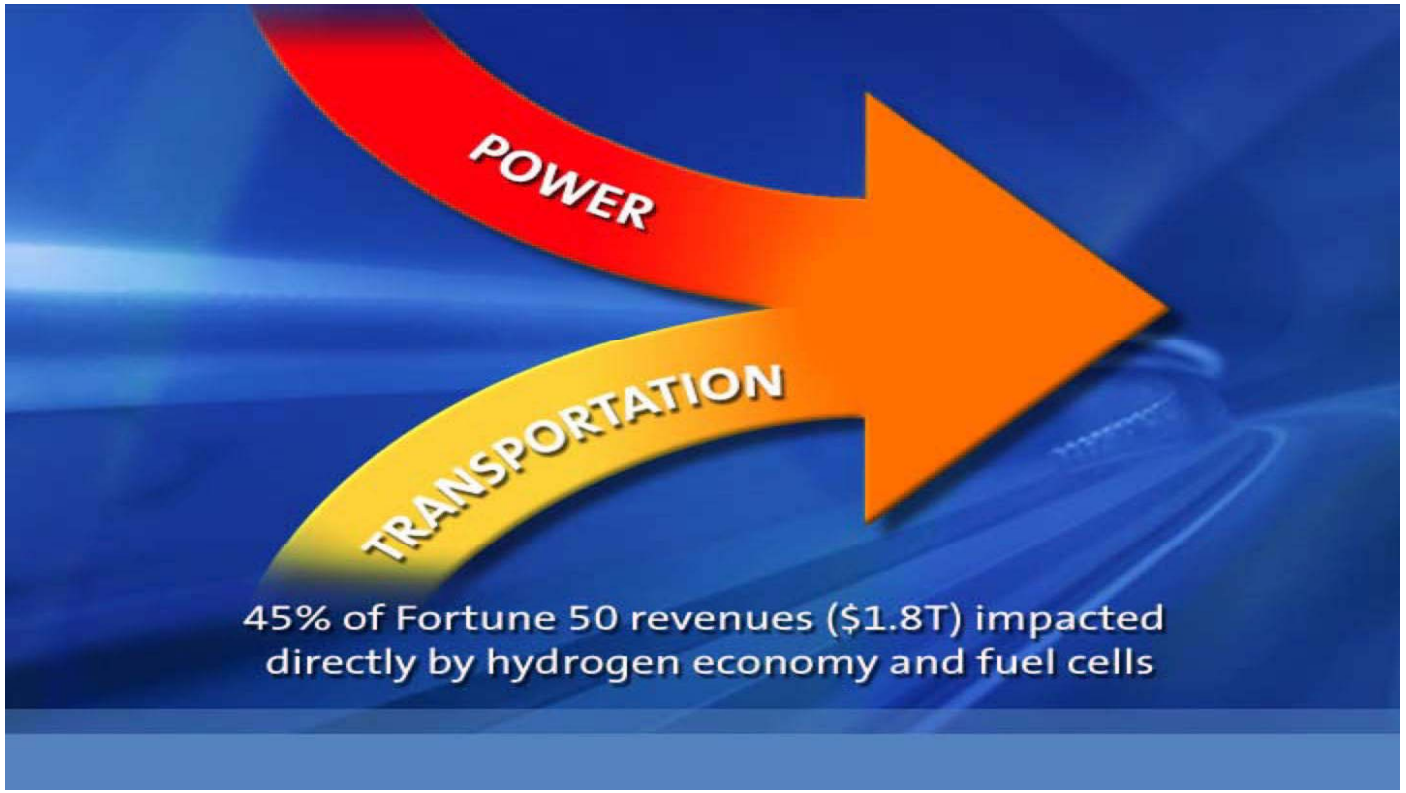
Annapolis
April 29, 2009

Presented by Dick Cromie
Electric Transportation Department
Southern California Edison Company
Rosemead, CA

Electric Transportation at SCE

- Mainstreaming ET into utility operations
- Vehicle Programs Overview
- Energy Storage
- Material Handling & NREVs: Load Management and Demand Response

Convergence: Electricity & Transportation Share Common Goals



❖Electric Transportation Depa

❖EV Technical


HYBRID


Electric Vehicle Technical Center


SPRIN


Garage of the Future

Mainstreaming Electric Transportation at SCE

- Electrification of Transportation (ET) will undergo rapid growth in the next ten years. It may:
  - Substantially increase overall electricity demand
  - Radically alter daily load shapes
  - Decrease societal emissions of CO2, NOx, and PM10 while increasing SCE's emissi profiles
- These impacts create new regulatory/policy and operational challenges for utiliti
- Regulators and industry players must develop a strategy
- SCE will continue to lead in this arena and take actions to mitigate potential threats, capture societal benefits and maximize customer satisfaction.

SCE's market assessment goal was to develop a fact-based forecast of technology penetrations, load impacts, & emission reductions, which will determine SCE's potential role and required actions

MARKET ASSESSMENT METHODOLOGY

Technologies Studied

- Battery Electric Vehicles (BEV) and Plug-In Hybrid Electric Vehicles (PHEV)
  - 9 classes from light cars to buses
- Port Electrification
  - Hoteled ships (AMP) & rubber tire gantries
- Rail
  - Passenger Light, Commuter, and High-Speed Rail
  - Freight and High-Speed Freight Rail
- Forklifts
  - Classes 1, 2, & 3
- Trucks
  - Anti-idling auxiliary power units
  - Truck refrigeration units

Approach & Metrics

- Forecast SCE Service Territory penetratio figures by:
  - Year: 2010, 2015, & 2020
  - Cases: Low, Medium, & High
- Assess load impacts with and without utilit involvement
- Quantify potential emissions reductions

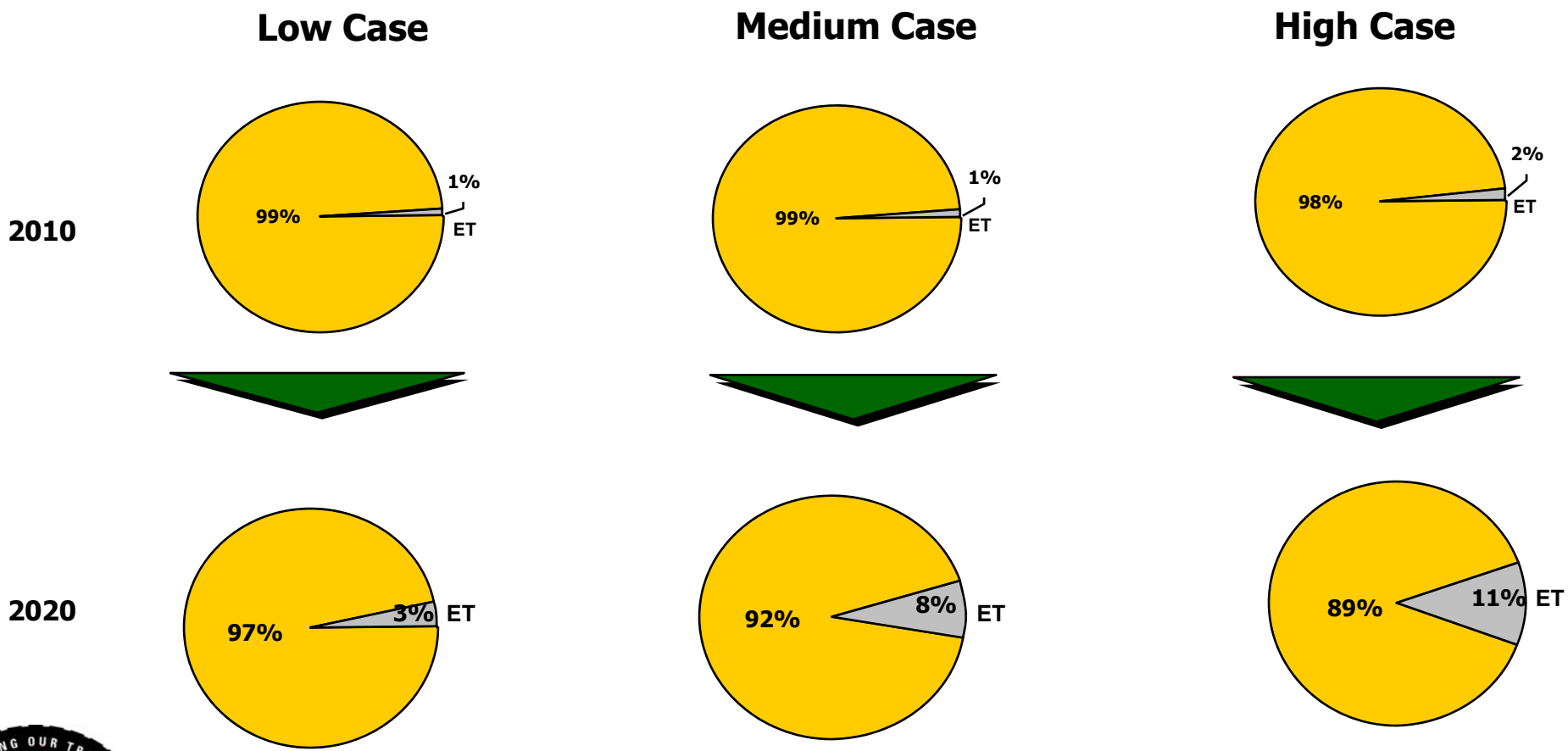
SUMMARY OF LOAD IMPACTS

- ET energy usage may reach as high as 11% of SCE's total load by 2020
- By 2020, Plug-in Electric Vehicles (PEVs) will account for a majority of ET energy usage
- PEV charging without utility involvement may shift SCE's peak hour to 19:00 and increase peak load by several thousand megawatts
- Assuming perfect load management, SCE could shift charging to off-peak hours, essentially flattening load across the day
- Perfect load management could increase SCE's load factor by as much as 5%

Note: Conclusions are based on an analysis of SCE service territory. Results appear to be scalable to all of California.

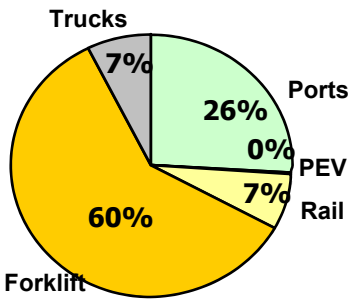
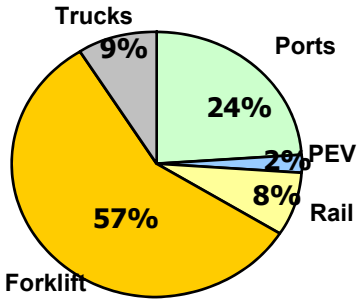
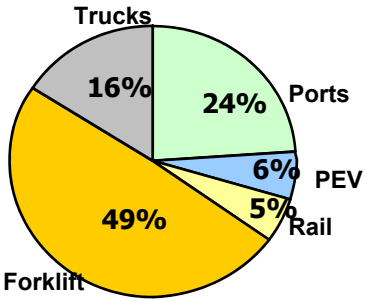
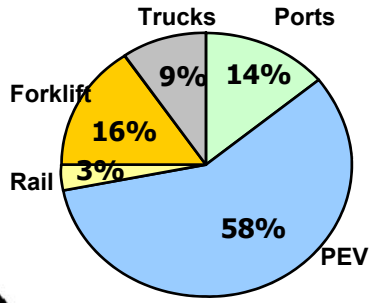
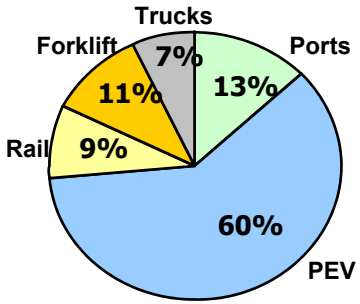
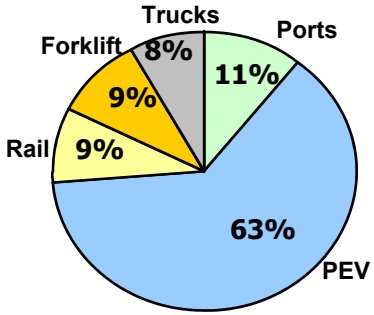
While the energy impacts of Electric Transportation in 2010 are negligible, by 2 it may account for up to 11% of SCE's total load served.

ANNUAL ET ENERGY AS A PERCENT OF SCE'S TOTAL LOAD



Initial ET energy consumption stems from forklifts and ports in 2010, transitioning to much higher impacts from PEVs in 2020.

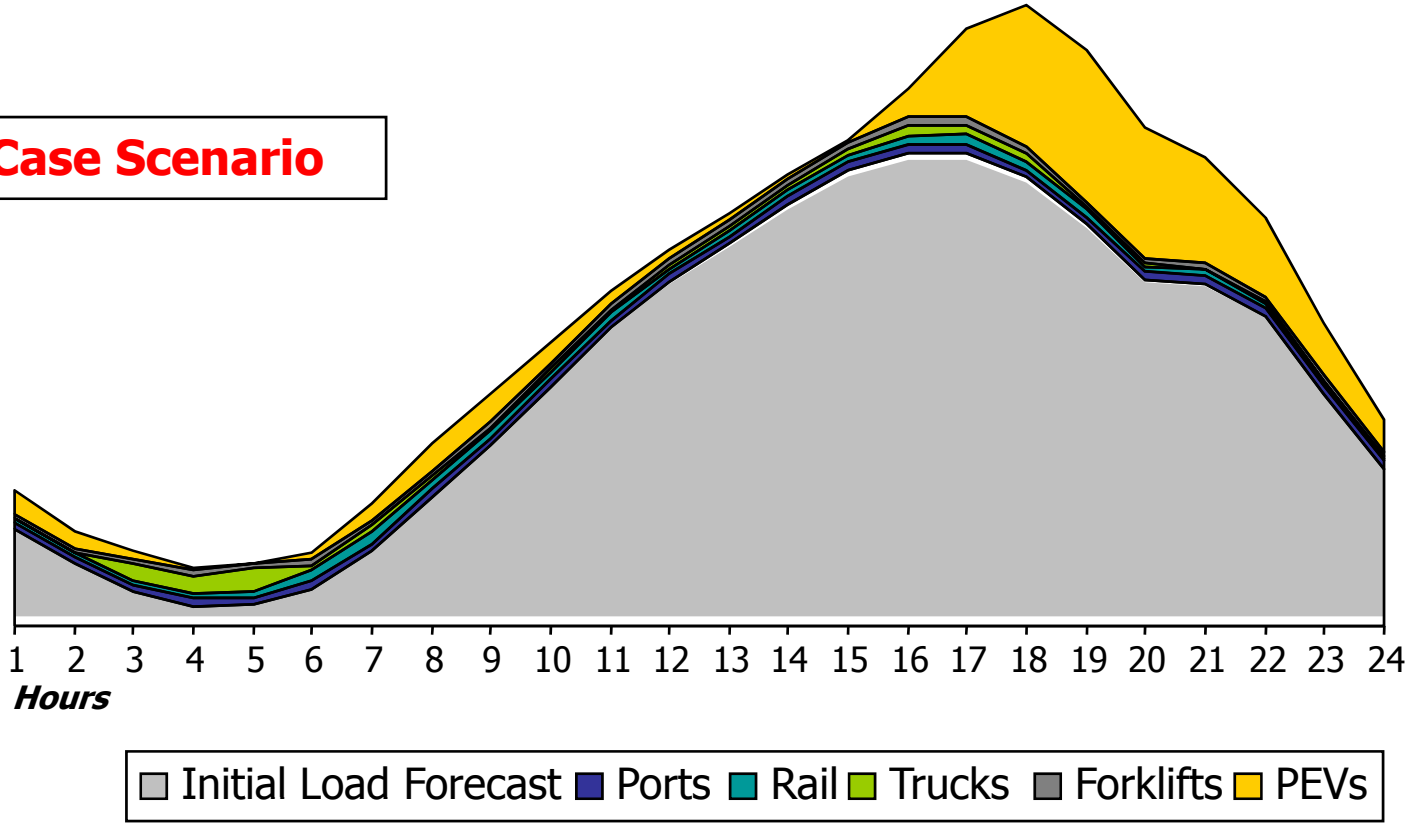
SCE's ANNUAL ET ENERGY CONSUMPTION BY TECHNOLOGY

	Low Case	Medium Case	High Case
2010			
2020			

In summer months, PEV charging shifts SCE's peak hour to 19:00 while increasing its load significantly

2020 SUMMER LOAD IMPACT – WITHOUT LOAD MANAGEMENT

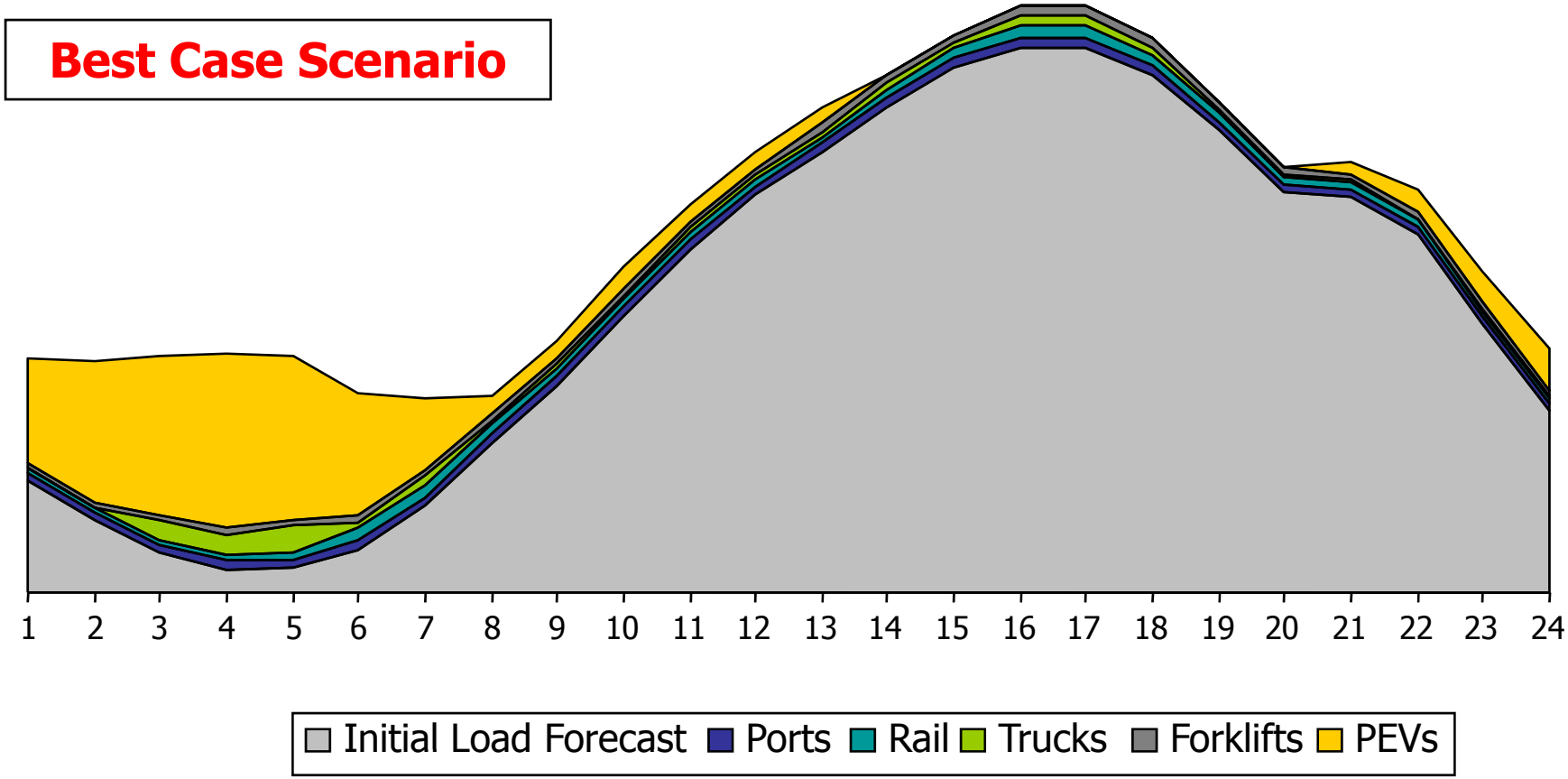
Worst Case Scenario



Assuming perfect load management, SCE could shift charging to off-peak hours, improving SCE's load factor by up to 5%.

2020 SUMMER LOAD IMPACT – WITH LOAD MANAGEMENT

Best Case Scenario



Today's EVs are Working Hard

- **SCE Fleet Statistics**
  - 267 active EVs – some with over 100,000 miles
  - 18 million miles driven since 1989
- **Maintenance Benefits**
  - 3500 oil changes & 1800 smog checks avoided, with savings of over $450,000
- **Energy & Environmental**
  - 2M gallons of gas saved vs. 20 M kWh used
  - Net savings to SCE = $4M
  - 20,000 tons of tailpipe pollutants eliminated

20 Years of SCE Plug-In Leadership

E operates the nation's largest fleet of
ery EVs (Toyota RAV4s) having traveled
Over 14m EV miles- 13m since 1998!

SCE and Chevron celebrate grand opening
Of SCE's Hydrogen Energy Station. By year end
SCE will operate up to 10 FCEVs

UC Irvine and Toyota announced a collaborat
including SCE to evaluate the technology
and system impacts of PHEVs

SCE is evaluating the nation's first PHEV fleet vans
from DaimlerChrysler and has begun work on a PHEV
medium duty utility bucket truck w/ Ford, EPRI and Eaton

SCE and Ford announced the first OEM led effort to evaluate the
complete energy system impacts of fully certified PHEVs on the utility

Auto Industry Interest in PHEVs (and PEVs) Announced Programs by Most Major OEMs

	PHEV or EREV	EV
duction	 **Saturn VUE** 2-Mode Blended	 **Chevrolet Volt** Extended Range EV 40-mile EV range 16kWh Li-Ion
	 **Nissan**	 **Daimler Smart ForTwo**
	 **Mitsubishi iMIEV** 100 mile range, PG&E, SCE demo	
	 **Ford Escape PHEV** 20 car fleet with SCE/EPRI/Utilities	 **Ford/Eaton Trouble Truck** 10 truck fleet w/ utilities
	 **Dodge ZEO** 150-200 mile range	 **Subaru R1e** 50 Mile AER 10-car fleet
emo	**Toyota Prius PHEV** 500-car fleet	 **VW Golf TwinDrive** 30 mile EV range

SCE Leadership- Ford/SCE Partnership

SCE and Ford announced the first OEM led effort to evaluate the complete energy system impacts of fully certified PHEVs on the utility grid

SCE – EPRI - Ford PHEV Program

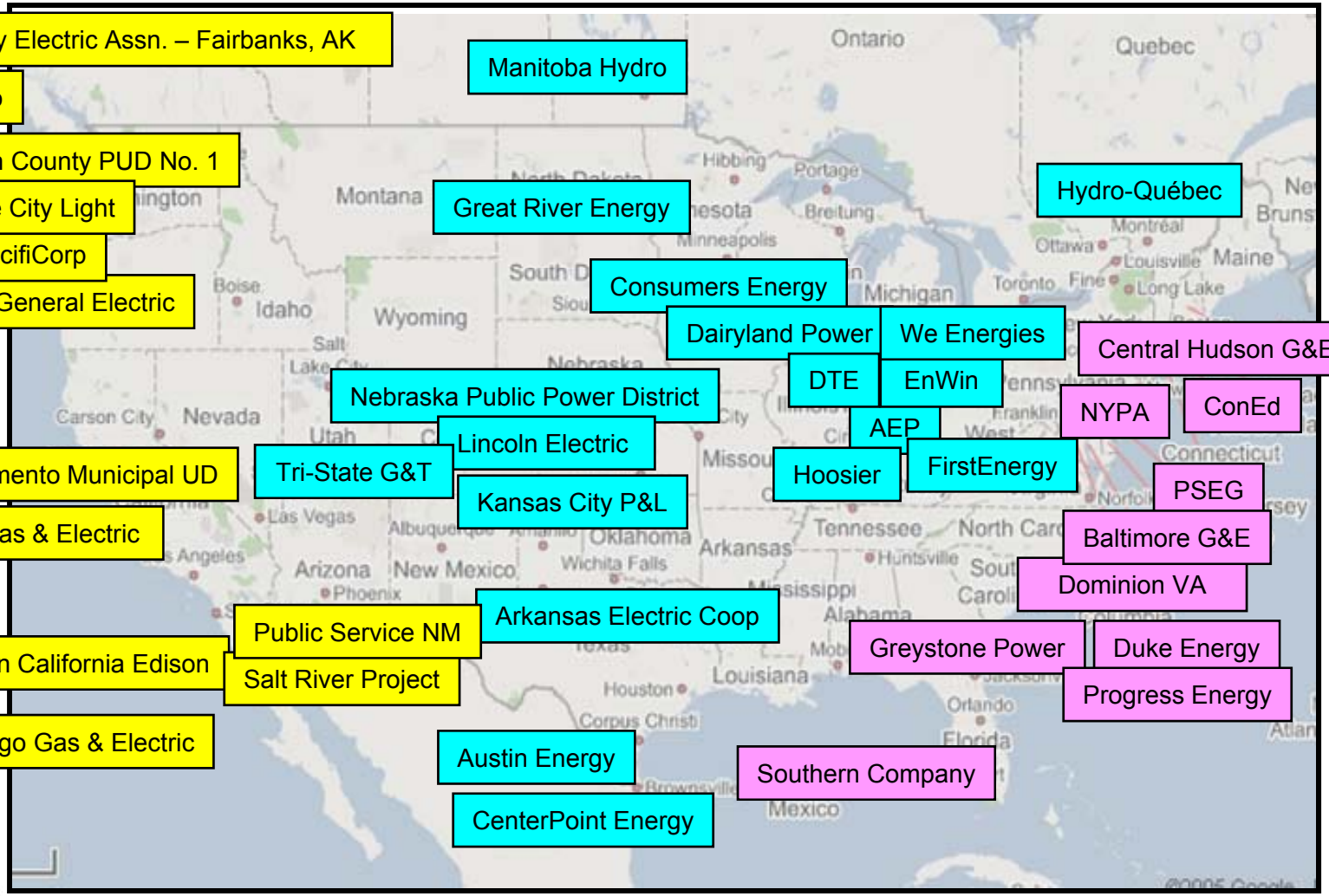
1st OEM—Utility Demo of PHEV Passenger Vehicles

- **Fleet demonstration of 20 PHEV Escape prototypes**
  - SCE, EPRI & 7 Utility partners
- **Analytical effort – development of sustainable business case for PHEVs:**
  - Utility value proposition
  - OEM value proposition
  - Battery value proposition
- **$30M total program**
  - $10M DOE Award, $7M Utility funding
- **First vehicles delivered**
  - 10 in 2008 and 10 in 2009
- **<u>First & only</u> nationwide opportunity to test OEM-built and certified vehicles**

General Motors Collaboration

- GM has a strong commitment to mass production
- Broad EPRI/utility collaboration 37+ partners
- Identify utility preparation requirements for PHEV rollout
- Conduct public outreach and education. Shape public policy
- Address technical aspects of connecting PHEVs to grid, AMI integration, standards etc

GM – Utility Collaboration



SCE's Unique EV Technical Center

- ❑ 20 Years Of Leadership
- ❑ ISO certified
- ❑ 4 years of PHEV battery testing

  (3700 cycles for Li-ion)
- ❑ PHEV light and medium duty vehicle evaluation programs
- ❑ DOE, OEM, battery manufacturer collaboration programs

SCE's "Future Garage" Systems Study

Lithium Ion Evaluation and Demonstration Programs

itsubishi Heavy Industries
1.5-3 kW residential/
small commercial PSU

AES 1 MW substation energy storage system

$3M Residential Stationary Battery Pilot Program

Test and evaluate lithium-ion batteries (PHEV type/size) in residential energy storage applications and in conjunction with on-site renewables

OBJECTIVES:

1. **Assess current technology (battery/controls) availability**
2. **Validate concept at SCE's EV Technical Center**
3. **Evaluate customer response to dynamic pricing signals using home PSU**
4. **Partner w/ battery and controls manufacturers**
5. **Partner w/ wind and solar manufacturers**
6. **Assess volume potential and pricing impacts for advanced batteries**

Why Are We Interested in Battery Charging?

- Industrial Battery Charging for Non-Road Electric Vehicles (NREVs) is a significant load on our electric system – up to 100 MW on-peak. Impact of logistics!
- Understand the system impact of commonly used non-linear loads (chargers)
- A commitment to our customers in helping them save money and operate more profitably
- Lots of potential for NREV energy efficiency improvements (new AC golf carts improved 40%)

Road Map for Success

Peak Load Reduction Program for Non-Road EVs
2001-2002

- **43 customers - 74 sites**
  - 22 Refrigerated Warehouses: 4000 kW
  - 39 Golf courses: 3100 kW
  - 13 Commercial-Industrial: 2000 kW
- **9.1 MW shifted to off-peak hours**
- **5357 electric vehicle chargers**
  - 3577 Golf Carts
  - 1780 Forklifts
- **8 installing contractors, 9 months to full commissioning**

Demand Response Success

Trojan Battery – Santa Fe Springs

- Largest employer in Santa Fe Springs, CA
  - Urgent customer retention issues
  - Makes 1.8 M golf cart batteries/yr; 4 MW customer
  - **3.2 MW DR auto-dispatch within 15 minutes**
- SCE-ET provided profile analysis & simulation studies
- Trojan computerized their battery formation rectifiers 100%
- Saved 15% battery formation kWhs and 17% plant-wide (12 MkWhs annual)
- Formation time savings enabled reduction from 2 shifts to 1
- Battery quality and consistency improved
- **DR equipment incentive alone = $576,000, plus EE incentives**

ET's Savings Recommendations

-30 examples of 200 total customers influenced

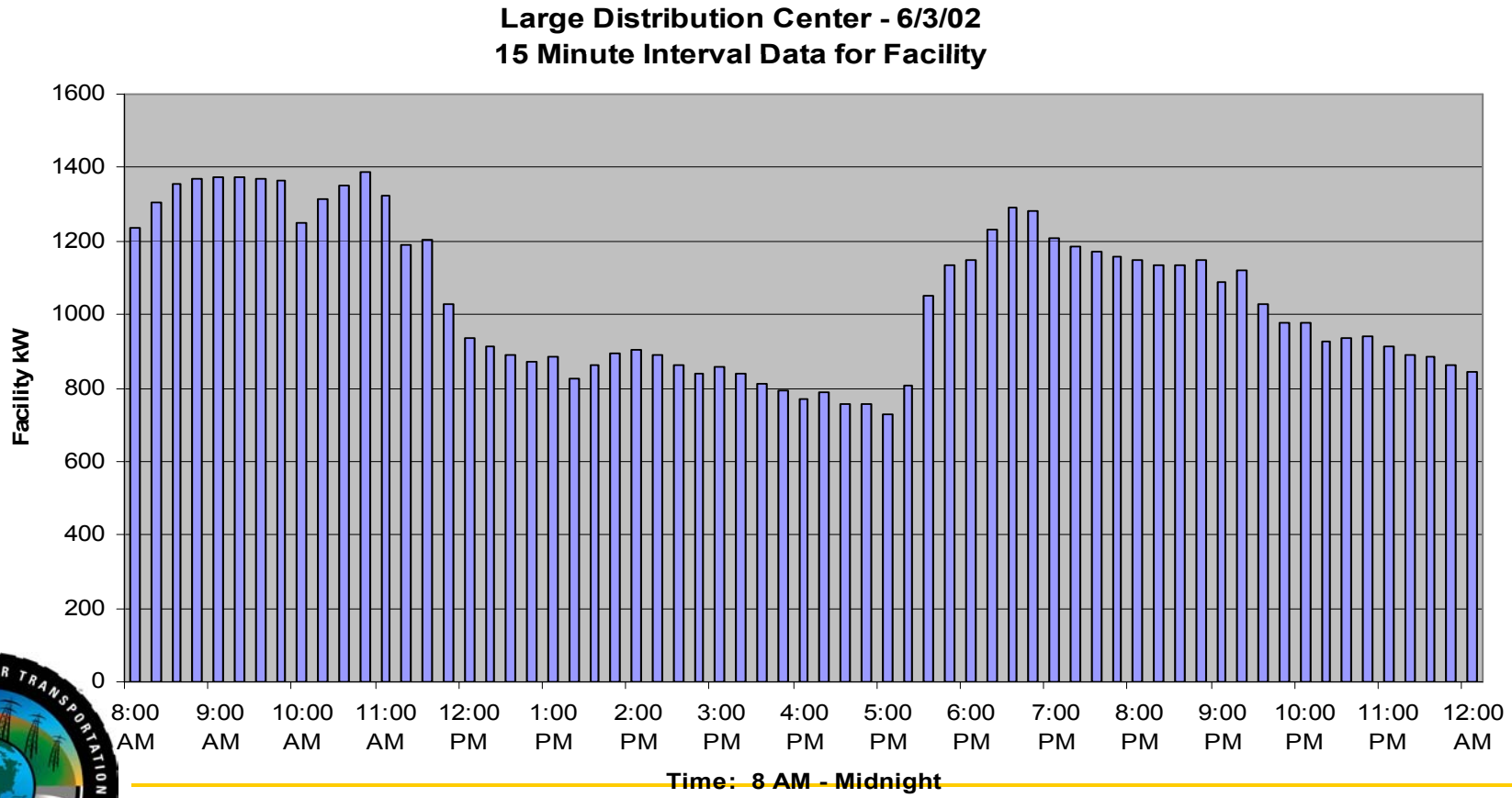
-Total recommended load shift = 21 MW for all 200 customers

-Total estimated 5 year savings = $8.1 M for all 200 customers

- **Stater Brothers**
- **Toyota**
- **Nissan**
- **Kohls**
- **Rite-Aid**
- **Lowes**
- **Ross Stores**
- **New Balance**
- **Leiner Health**
- **Dreyers Ice Cream**
- **Trojan Battery**
- **Payless Shoes**
- **McCabes Foods**
- **Club Corp**
- **Jack-in-the-Box**
- **Sysco Food Services**
- **American Golf Corp.**
- **Cardinal Health**
- **Amerisource Bergen**
- **American Honda**
- **Albertsons**
- **Ingram Micro**
- **Pacific Palms Resort**
- **PETCO**
- **Bentley Carpet**
- **US Navy**
- **Mattel Inc.**
- **Michaels Stores**
- **McMaster - Carr**
- **Specialty Merchandise**

Example: Food Distribution Center

15 min Data with Chargers off (25% kW reduction 1-5PM)



Opportunities

- **An estimated 50 Million kWhs could be saved if customers replaced the industrial chargers with higher efficiency models.**
- **Energy Efficiency Improvements:**
  - **More efficient charge strategy**
  - **Reduce idling (standby) losses**
  - **More on-board intelligence (integration with EMS)**
  - **DOE, EPRI, CEC "Energy Star" initiative uses SCE test procedure**
  - **New AC golf cart 39% more efficient than current models**
- **Demand Response / Load Shifting Opportunities:**
  - **0.8 kW per golf cart charger (diversified)**
  - **2-5 kW per forklift charger (diversified)**
  - **Up to 3500 kW per battery manufacturing plant**

Opportunities

- Use charger microprocessor to program or delay start times
- Install time clocks – sometimes these have utility rebates
- Install Energy Management Systems (EMS) on chargers. May provide load shifting economic benefits or allow participation in DR programs and/or technology incentives
- Consider battery management systems
  - Can pay dividends by reducing number of batteries purchased
  - Guarantees more uniform rotation and longer battery life
  - Emerging availability of DR and load shifting software
  - Ensures fresh batteries always available
  - Next step is battery to charger communication & control

Thank You

Richard.Cromie@sce.com

(626) 302-1616

SOUTHERN CALIFORNIA EDISON®