



Battery Charger Systems

Test Procedure, Call for Data, & Proposed Standards

April 8, 2008

Prepared for:
Patrick Eilert
Ed Elliott
Gary Fernstrom



Prepared by:
Paul Bendt, Ph.D, Ecos Consulting TM

ecos



April 8, 2008

Battery Charger Systems

Test Procedure, Call for Data, & Proposed Standards



Pacific Gas and Electric Company

ecos

Making a World of Difference

Agenda

- ▶ **Background and History**
- ▶ **Test Procedure**
- ▶ **Call for Data**
- ▶ **Tentatively Proposed Standards**



**Pacific Gas and
Electric Company***

ecos

Making a World of Difference

Background and History



*Pacific Gas and
Electric Company*[®]

ecos

Making a World of Difference

What is a Battery Charger System?

Battery Charger System (BCS)

- ▶ Battery chargers coupled with their batteries are together referred to as ***battery charger systems***. This term covers all rechargeable batteries or devices incorporating a rechargeable battery and the chargers used with them.



Pacific Gas and
Electric Company*

ecos

Making a World of Difference

Battery Charger Product Categories

<p>(1) Home Electronics</p> <ul style="list-style-type: none"> ▶ Audio ▶ Toys ▶ Video ▶ Two-Way Radios 	<p>(2) Cell Phones</p> <ul style="list-style-type: none"> ▶ Cell Phones ▶ Cell Phone Accessories 	<p>(3) Cordless Phones</p>	<p>(4) Information Appliances</p> <ul style="list-style-type: none"> ▶ Laptop ▶ Other Data Devices ▶ Business Equipment 	<p>(5) Emergency Backup Battery Systems</p> <ul style="list-style-type: none"> ▶ Lighting ▶ Power ▶ Security
<p>(6) Personal Care</p> <ul style="list-style-type: none"> ▶ Oral Care ▶ Hair Trimmers ▶ Shavers 	<p>(7) Tools</p> <ul style="list-style-type: none"> ▶ Electric House wares ▶ Outdoor Appliances ▶ Power Tools 	<p>(8) Universal Battery Chargers</p> <ul style="list-style-type: none"> ▶ Marine ▶ RV/General Use ▶ AA/AAA/9V 	<p>(9) Transportation</p> <ul style="list-style-type: none"> ▶ Forklift ▶ Personal Electric Vehicle ▶ Golf Carts/Electric Carts ▶ Electric Cars 	<p>(10) Lighting</p> <ul style="list-style-type: none"> ▶ Lanterns ▶ Flashlights

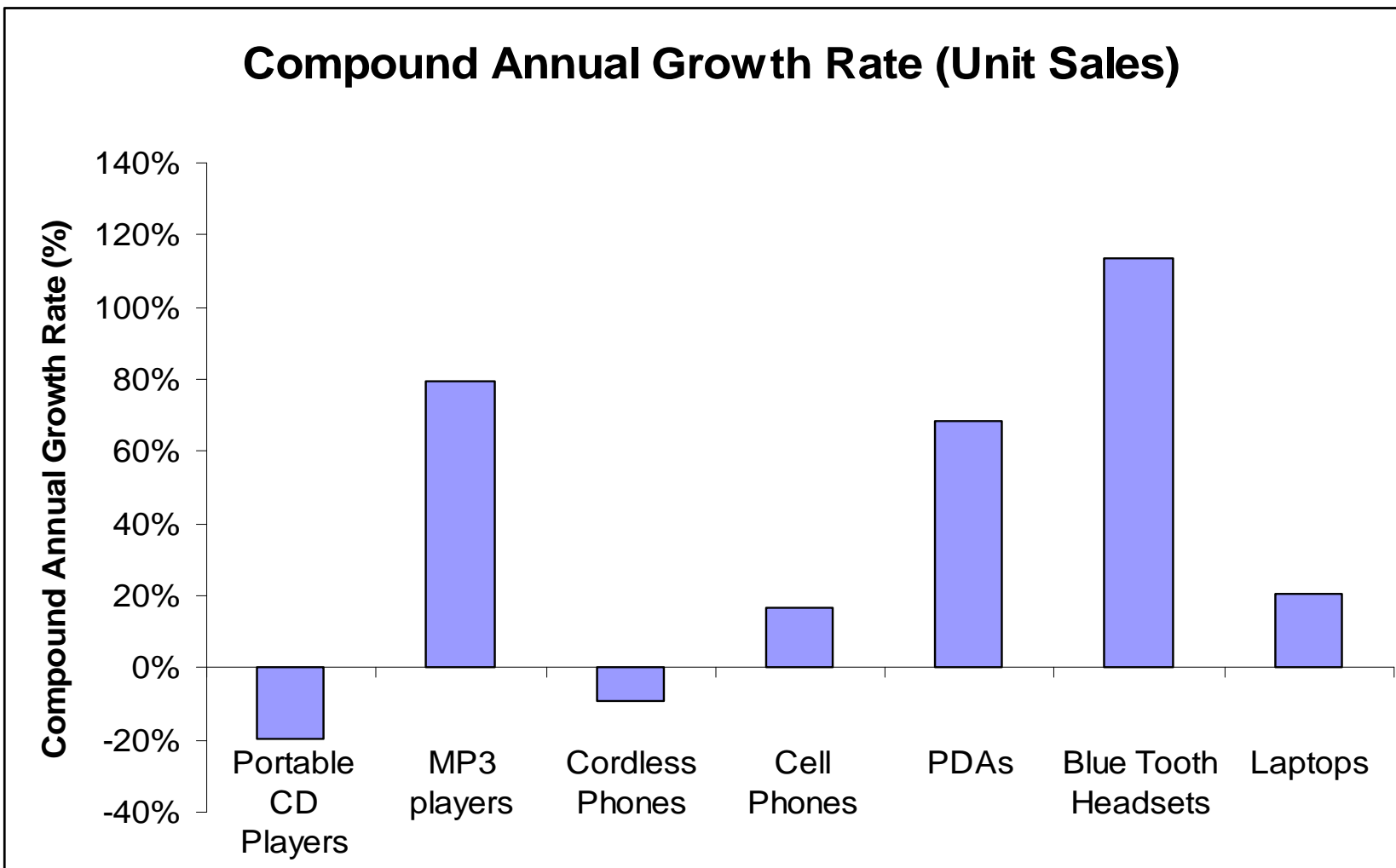


Pacific Gas and Electric Company*

ecos

Making a World of Difference

Sales Trends of Fastest Growing/Declining Product Categories

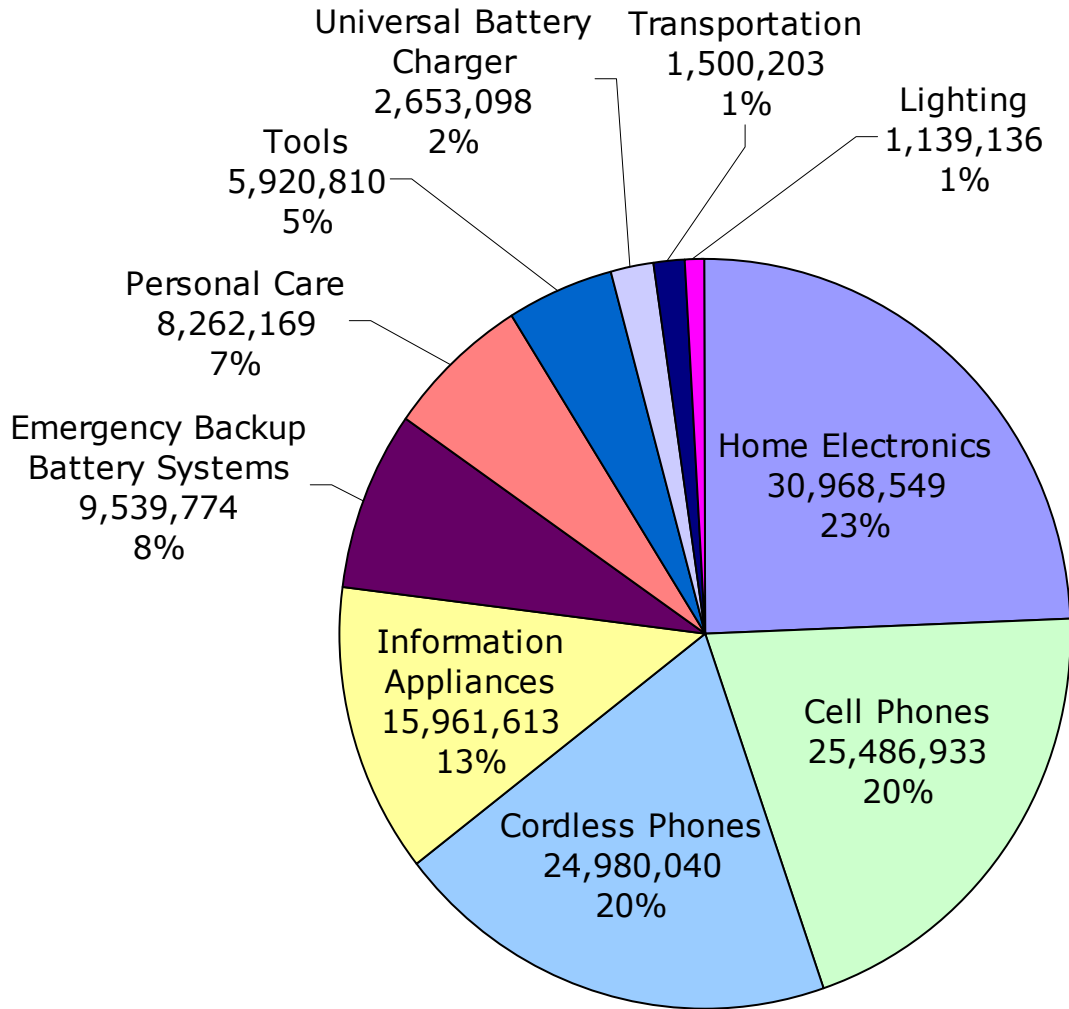


Pacific Gas and Electric Company®

ecos

Making a World of Difference

CA Stock Estimates



- Over 126 million products in California
- Over 9 products per California household

Prior History

Test Procedure Development

EFFICIENTPRODUCTS.ORG

RESEARCHING & REPORTING on the ENERGY EFFICIENCY of CONSUMER PRODUCTS

Home
Survey of Plug Loads
Products
Battery Chargers
Computers
Monitors
Set Top Boxes
Televisions
About

Welcome to EfficientProducts.org

EfficientProducts.org is your source for the latest facts, figures, and research on the energy efficiency of consumer products.

Battery Charger Systems
In just the last two decades, product convenience has improved by leaps and bounds with the growth of an entirely new family of products that incorporate batteries instead of relying always on the wall plug to supply electricity...

Computers
The personal computer may be one of the most revolutionary and wildly successful consumer products of all time. In the 1990s, the number of U.S. households owning computers jumped from 14.8 million in 1990 to 60 million in 2001 as consumers embraced digital photography...

Monitors

What's new?
NEW! Final California Battery Chargers Systems Test Procedure
NEW! NRDC Study of Set-Top Box Efficiency

What is efficiency?
Efficiency is a measure of return on investment. Every process – whether lighting a light bulb or running a car – requires some amount of energy "investment" to perform, but only a fraction of that energy actually goes on to do useful work like illuminating your room or moving passengers down a highway. The useful work performed divided by the original total energy investment (usually expressed as a percent) is the energy efficiency.

Procedure in development for four years, representing input from dozens of stakeholders, including EPA ENERGY STAR and DOE

Updated Version 1.1 as of March 5, 2008 covers batteries that do not have a rated charge capacity

Available at www.EfficientProducts.org/bchargers/ along with comment and response document for final revisions



Pacific Gas and Electric Company*

Making a World of Difference

Extensive Data Gathering and Prior Research

- ▶ Ecos and EPRI tested and measured over 60 products from the different product categories using the recently approved BCS test procedure
- ▶ Total dataset, including legacy research from Ecos, EPRI, and Cadmus Group includes over 250 battery charger measurements
- ▶ Dataset includes 24-hour Charge-Maintenance-Discharge Efficiency, Maintenance Mode Power, and No Battery Mode Power

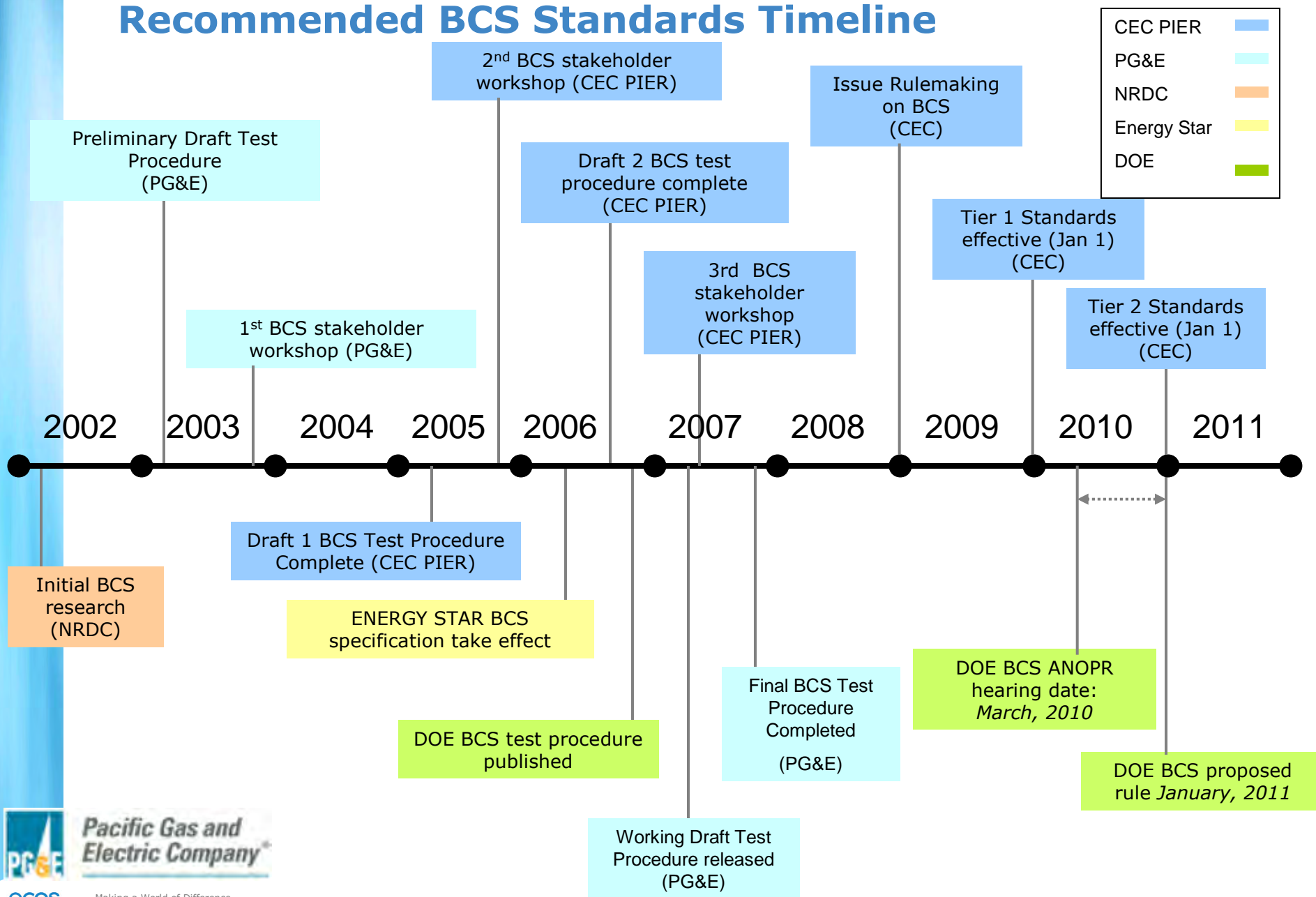


Pacific Gas and
Electric Company®

ecos

Making a World of Difference

Recommended BCS Standards Timeline



Test Procedure



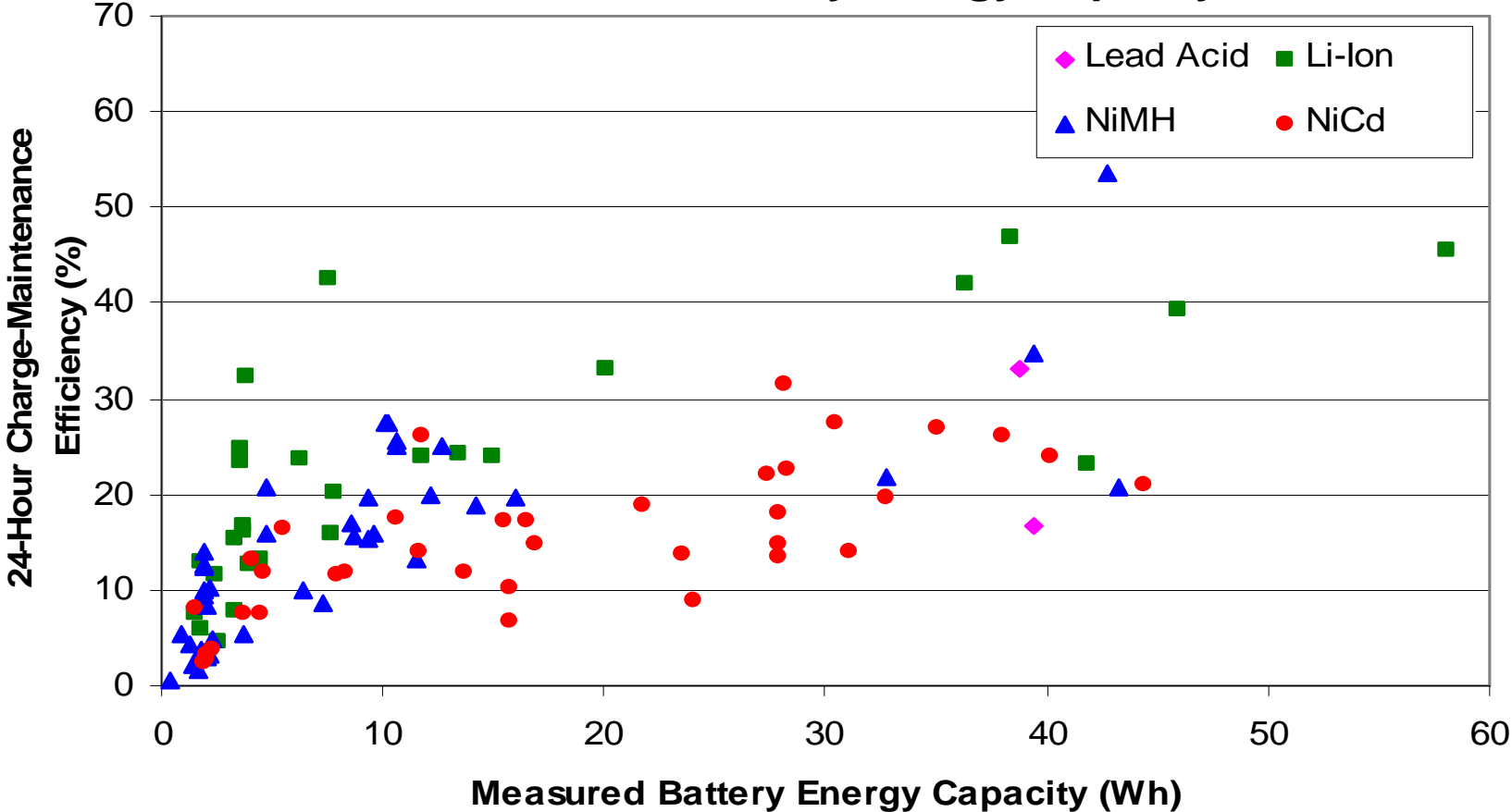
**Pacific Gas and
Electric Company**

ecos

Making a World of Difference

Snapshot of Current Dataset

24-Hour Charge-Maintenance Efficiency vs. Measured Battery Energy Capacity



Pacific Gas and Electric Company

ecos

Making a World of Difference

Updates to Test Procedure

- ▶ **Batteries without a rated charge capacity**
 - About 30% of products tested
 - Determine an appropriate discharge current
- ▶ **Three-phase and over 2kW**
 - Determine if scope can be extended
 - Requesting data and comments
 - Significant savings potential in this category also

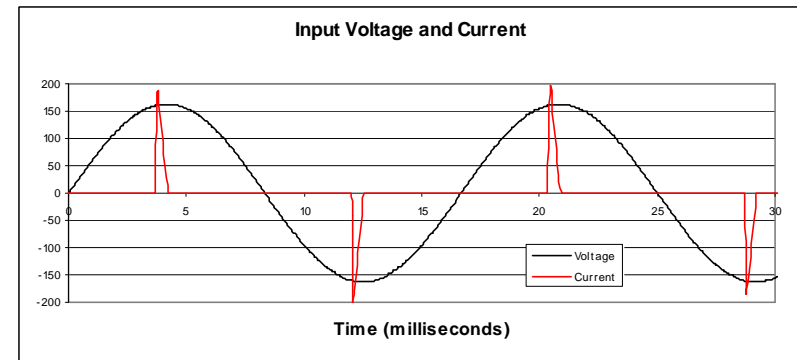
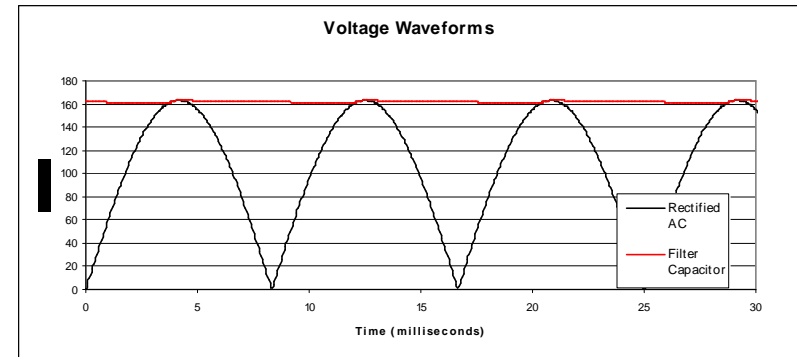
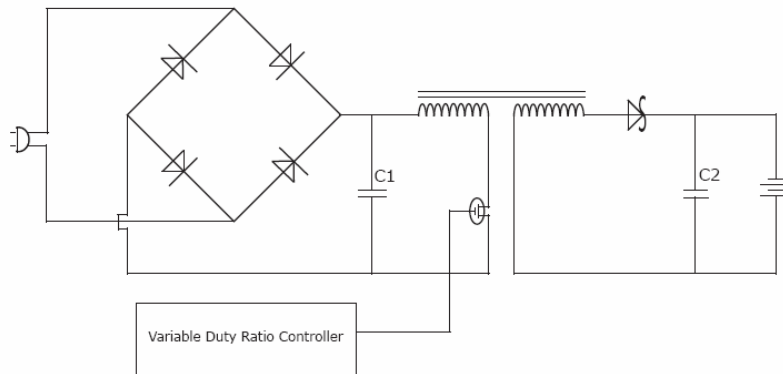


Pacific Gas and
Electric Company®

ecos

Making a World of Difference

Power Factor for Battery Chargers

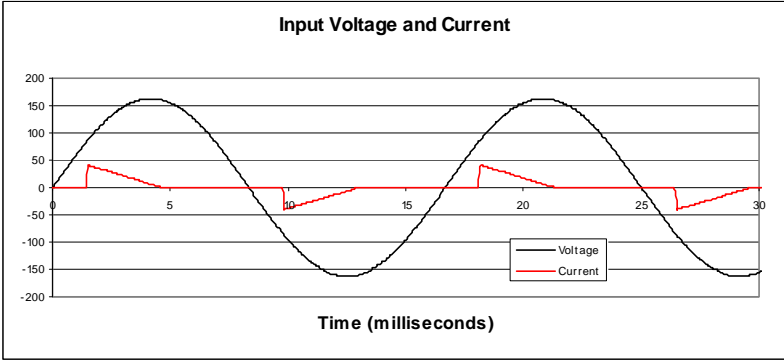
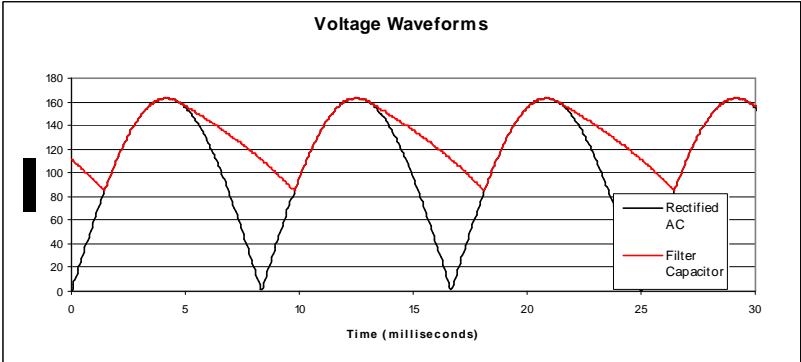
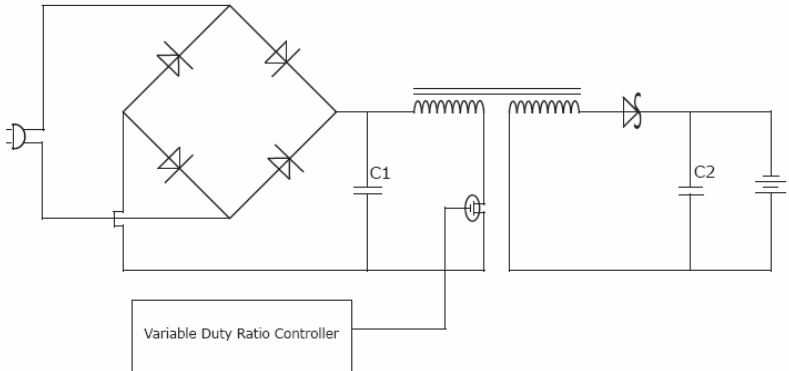


Pacific Gas and Electric Company®

ecos

Making a World of Difference

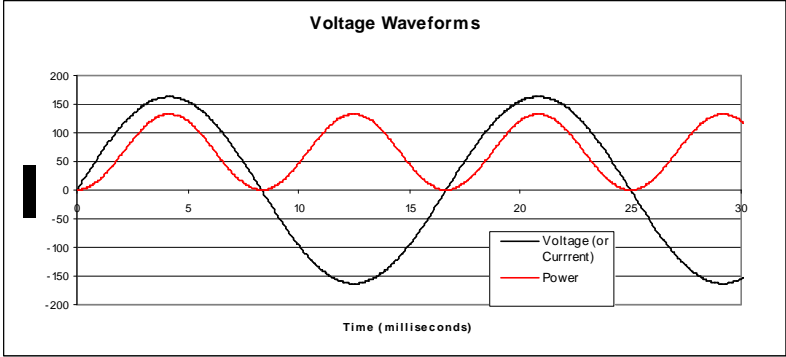
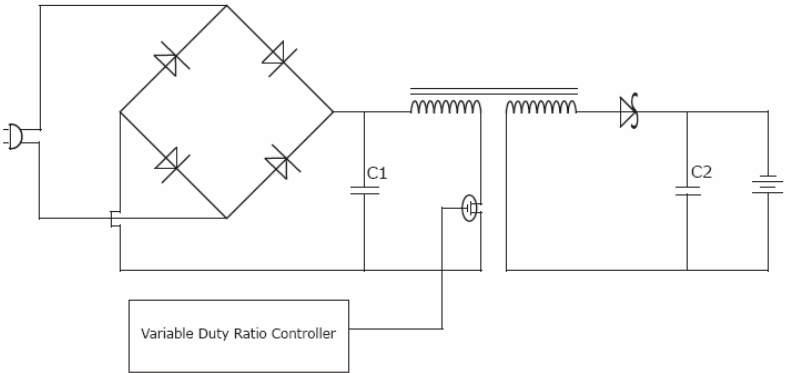
Power Factor for Battery Chargers



Pacific Gas and Electric Company

Making a World of Difference

Power Factor for Battery Chargers



Recommended Action

- ▶ **Adopt the Battery Charger Test Procedure**
 - Provides proven and reliable techniques for measuring energy consumption in all operating modes
- ▶ **Call for data from all interested parties, to be submitted by May 16, 2008**
 - Seeking data on all categories of products to ensure a representative sample
 - Particularly interested in test data on large chargers, including 3-phase and over 2 kW
 - Also interested in test data on any products with special requirements
 - Proposed language for data request is included in proposal submitted to CEC by PG&E, Energy Solutions and Ecos.

Break



**Pacific Gas and
Electric Company**

ecos

Making a World of Difference

Tentatively Proposed Standards



**Pacific Gas and
Electric Company**

ecos

Making a World of Difference

Standards Concepts

- ▶ **Three components: Active, Maintenance and No Battery**

- ▶ **Active mode considers battery energy:**

$$Eff = \frac{E_{batt}}{E_{24}} \geq \frac{E_{batt}}{a + b * E_{batt}}$$

- ▶ **Can also be considered as an energy budget:**

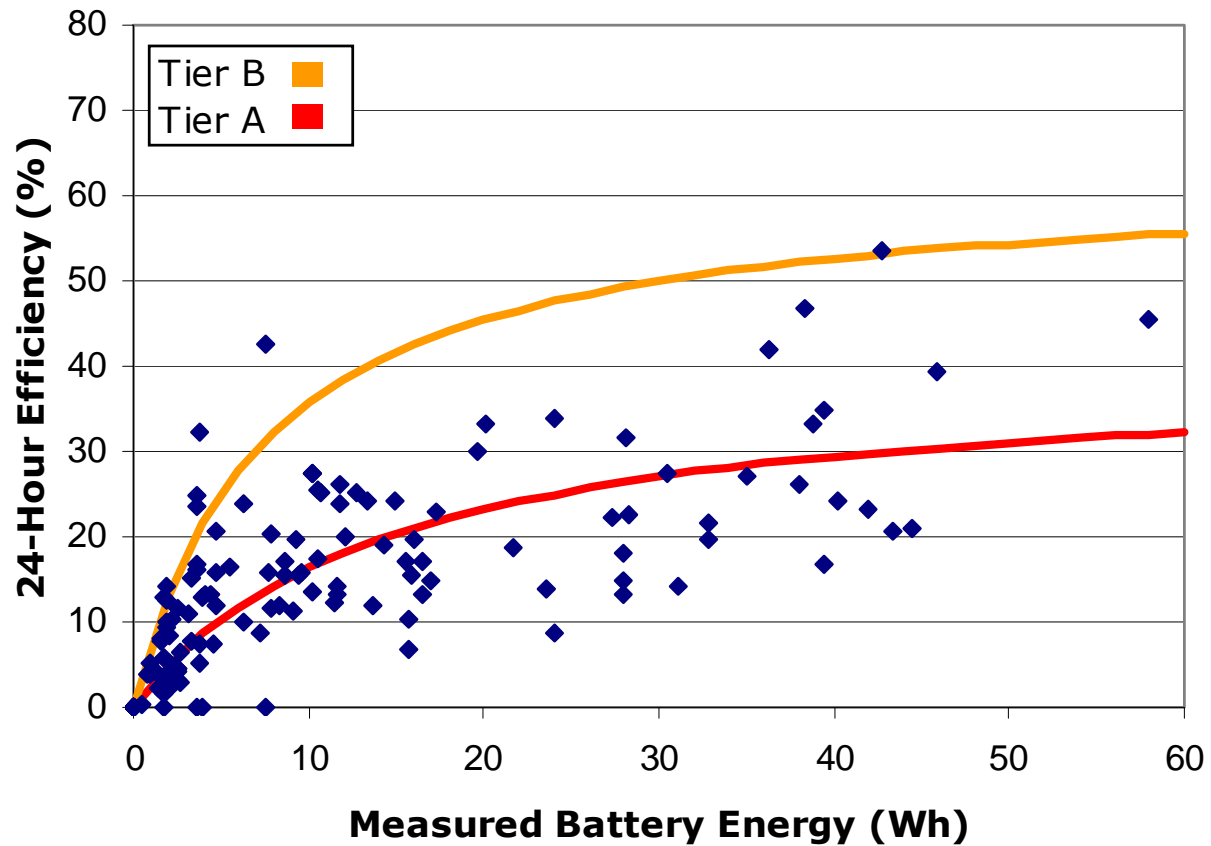
$$E_{24} \leq a + b * E_{batt}$$

- ▶ **Staged Standards**

- Near Term, removes least efficient chargers
- Later standard for improved efficiency

Standards Concepts

Efficiency vs. Energy Capacity



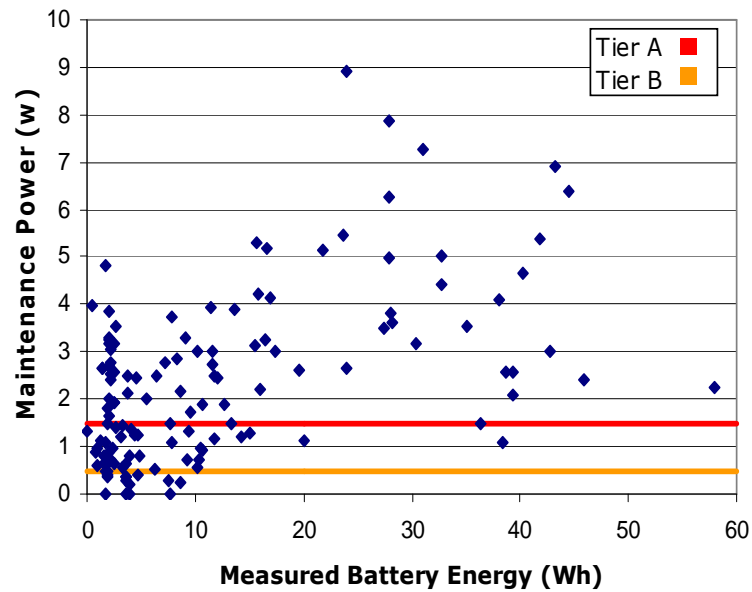
Pacific Gas and Electric Company

ecos

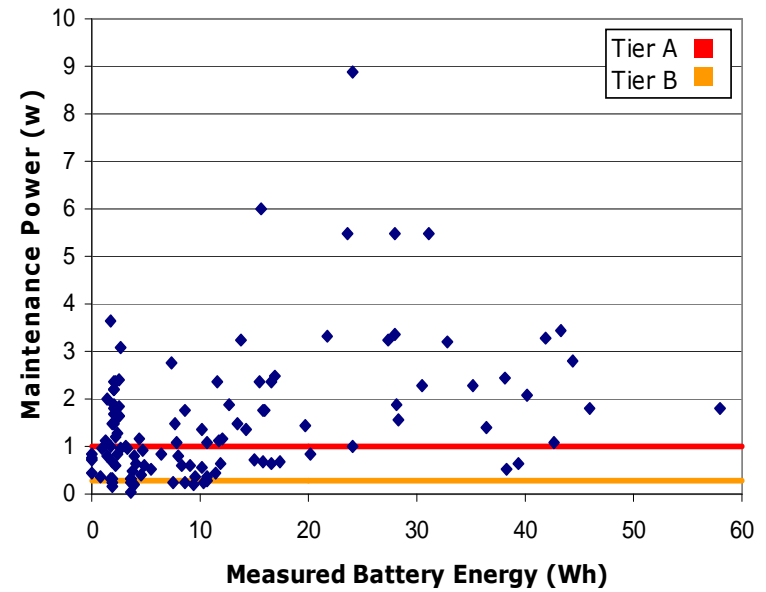
Making a World of Difference

Standards Concepts

Maintenance Power vs. Energy Capacity



No Battery Power vs. Energy Capacity

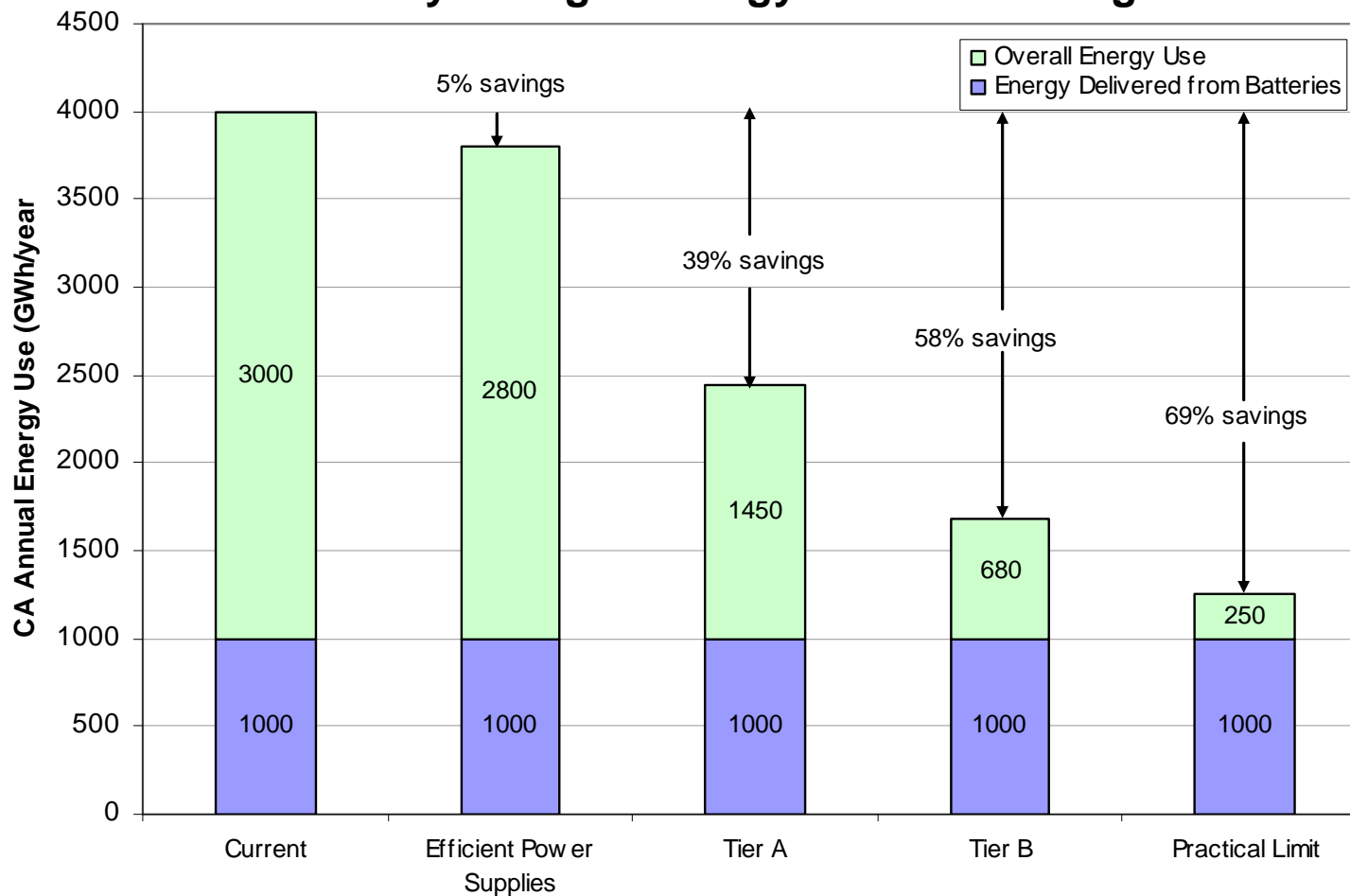


Pacific Gas and Electric Company®

ecos

Making a World of Difference

CA Battery Charger Energy Use and Savings Potential



► Potential to reduce BCS energy use by 39% (1.55 TWh/year) even with early, less stringent standards

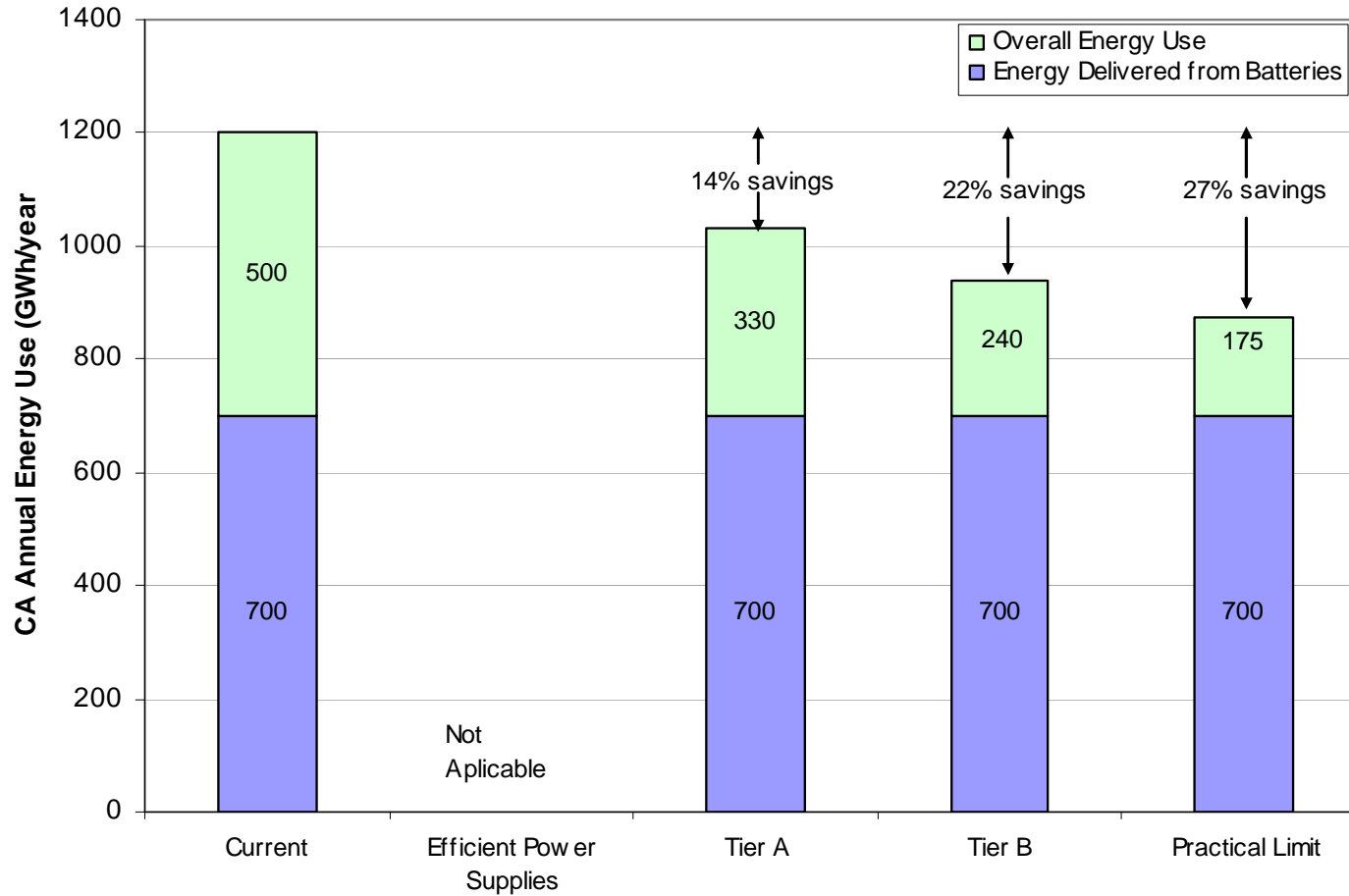


Pacific Gas and Electric Company

ecos

Making a World of Difference

Large 1-Phase Battery Chargers



► Large chargers (golf carts, forklifts, and electric vehicles) have significant potential for savings.



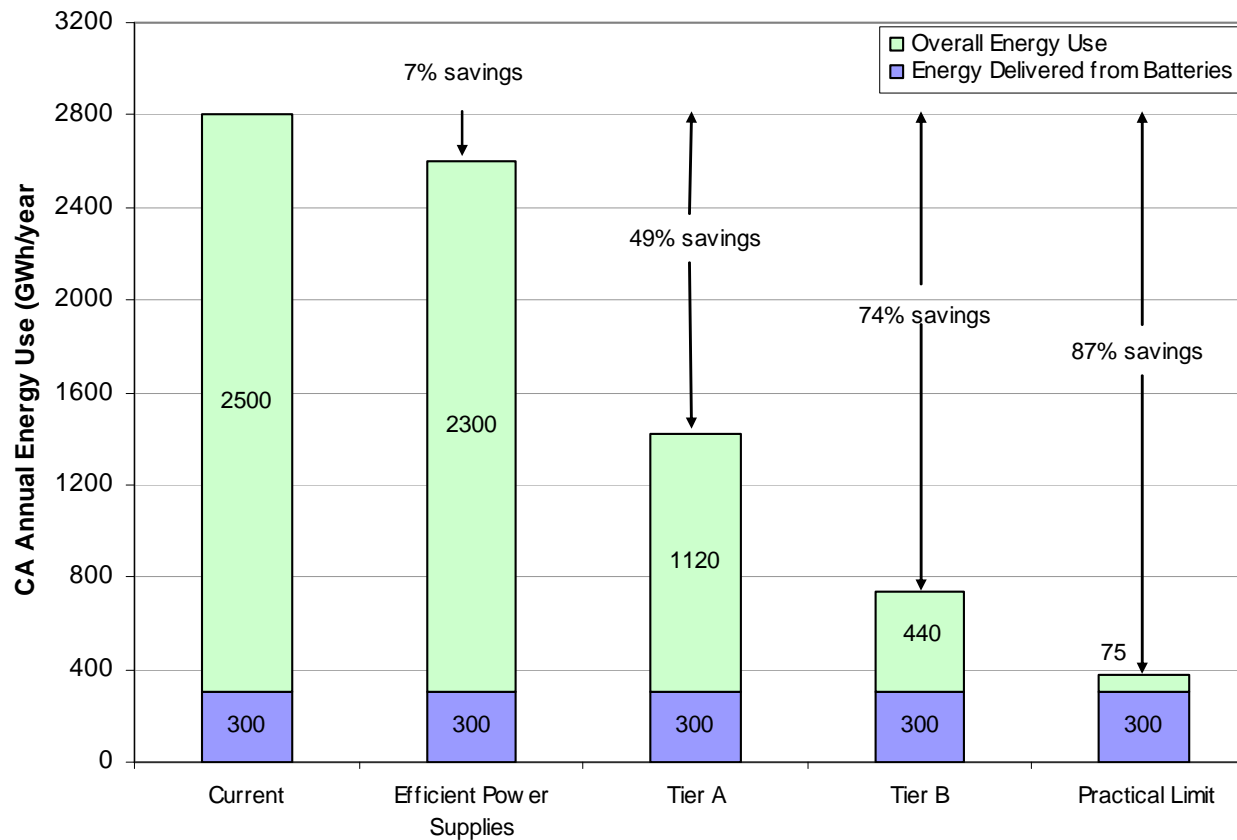
Pacific Gas and Electric Company*

ecos

Making a World of Difference

CA Energy Use and Savings Potential

Consumer and Auto/Marine Battery Chargers



► Small chargers for consumer products have low efficiencies and present an opportunity for large energy savings.

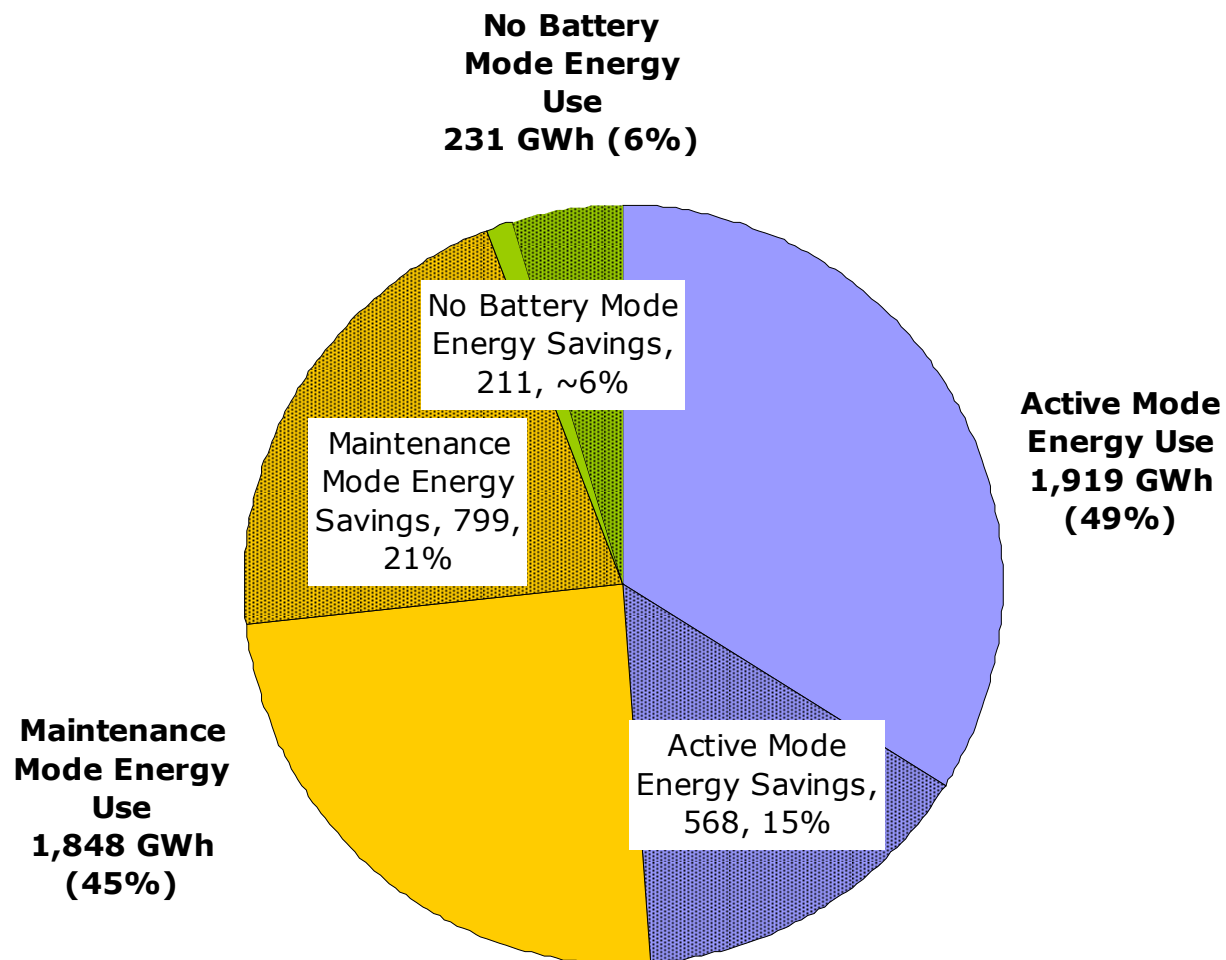


Pacific Gas and Electric Company*

ecos

Making a World of Difference

CA Battery Charger Annual Energy Use and Savings by Mode



Pacific Gas and Electric Company®

ecds

Making a World of Difference

Efficient Design Strategies

- 1. Don't continue to charge batteries are already fully charged**
- 2. Reduce standby power when not actively charging the battery**
- 3. Use an efficient power conversion process, including an efficient power supply**
- 4. Use power factor correction**

▶ **These recommendations can be achieved through multiple design paths**



**Pacific Gas and
Electric Company***

ecos

Making a World of Difference

Economic Analysis

Product Examples – Power Tools



Product A	Product B	Product C
NiCd battery	Li-Ion battery	Li-Ion Battery
11.8% 24-hr Efficiency	23.7% 24-hr Efficiency	42.6% 24-hr Efficiency
Maintenance Mode: 2.8W	Maintenance Mode: 0.5W	Maintenance Mode: 0.28W
No Battery Mode: 0.6W	No Battery Mode: 0.42	No Battery Mode: 0.2W
Purchase Price: \$23.99	Purchase Price: \$34.97	Purchase Price: \$95.99
Difference in Technology: Charging Circuitry Incremental Cost: Minimal		

Economic Analysis

Product Examples – Universal Chargers



Product A	Product B
NiMH batteries	NiMH batteries
13.1% 24-hr Efficiency	27.5% 24-hr Efficiency
Maintenance Mode: 2.74W	Maintenance Mode: 0.7W
No Battery Mode: 2.4W	No Battery Mode: 0.2W
Purchase Price: \$25.00	Purchase Price: \$20.49
Difference in Technology: Charging Technology	
Incremental Cost: Minimal to none	



Pacific Gas and Electric Company®

ecos

Making a World of Difference

Economic Analysis

Product Examples – Cordless Phones



Product A (Base Unit Only)	Product B
NiMH batteries	Li-Poly Battery
3.64% 24-hr Efficiency	5.80% 24-hr Efficiency
Maintenance Mode: 1.82W	Maintenance Mode: 1.07W
No Battery Mode: 1.47W	No Battery Mode: 1.00W
Purchase Price: \$54.99	Purchase Price: \$65.99
Difference in Technology: Battery Chemistry, Charging Circuitry	
Incremental Cost: Minimal	



Pacific Gas and Electric Company®

ecos

Making a World of Difference

Economic Analysis

Product Examples – Two-Way Radios



Product A	Product B
NiMH batteries	Li-Ion Battery
10%-20% 24-hr Efficiency	20%-24% 24-hr Efficiency
Maintenance Mode: 2.43W	Maintenance Mode: 1.3W
No Battery Mode: 1.15W	No Battery Mode: .74W
Purchase Price: \$69.95	Purchase Price: \$79.95
Difference in Technology: Battery Chemistry, Charging Technology	
Incremental Cost: Minimal	



Pacific Gas and Electric Company®

ecos

Making a World of Difference

Products with Unique Requirements



- ▶ **Some types of products may need energy allowances, but should not be excluded from standards.**



**Pacific Gas and
Electric Company***

ecos

Making a World of Difference

Recommended BCS Standards Timeline

