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Battery Charging Systems:

Energy Use, Savings Potential, and Standards Options

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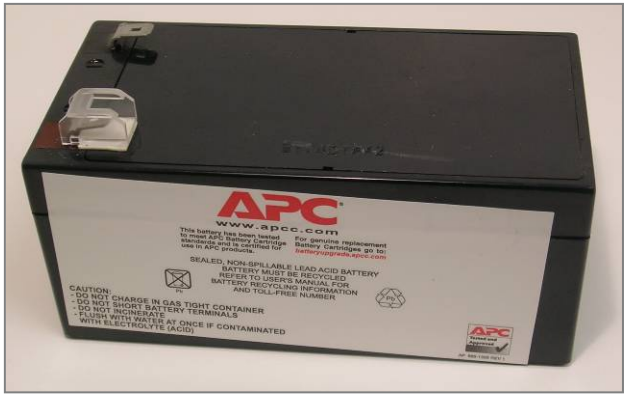


WHAT IS A BATTERY CHARGER SYSTEM?

Battery Charger System (BCS)

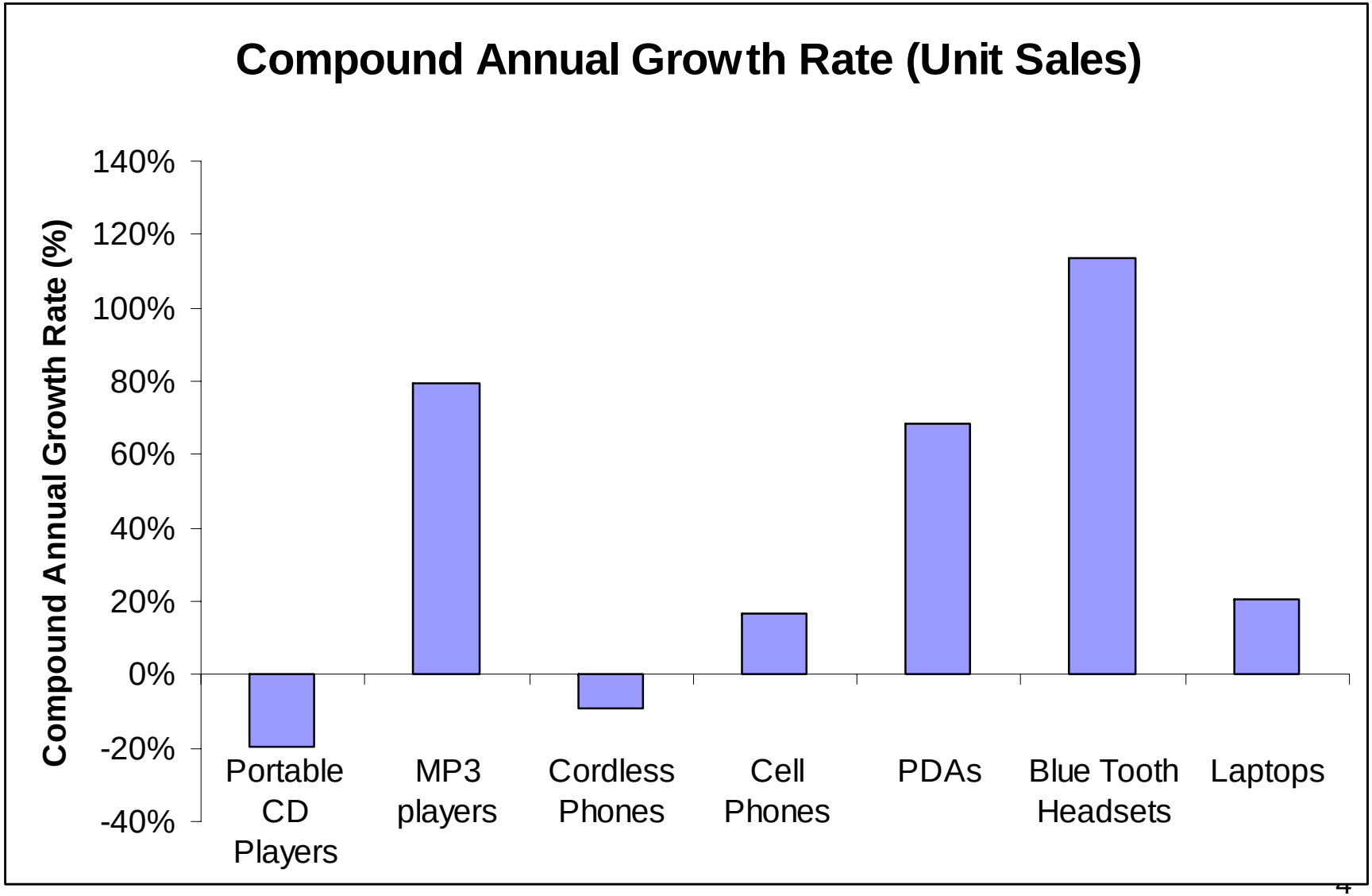
- **Battery chargers coupled with their batteries are together referred to as** *battery charger systems***. This term covers all rechargeable batteries or devices incorporating a rechargeable battery and the chargers used with them.**

This definition aligns with current definition in CA-developed battery charger test procedure

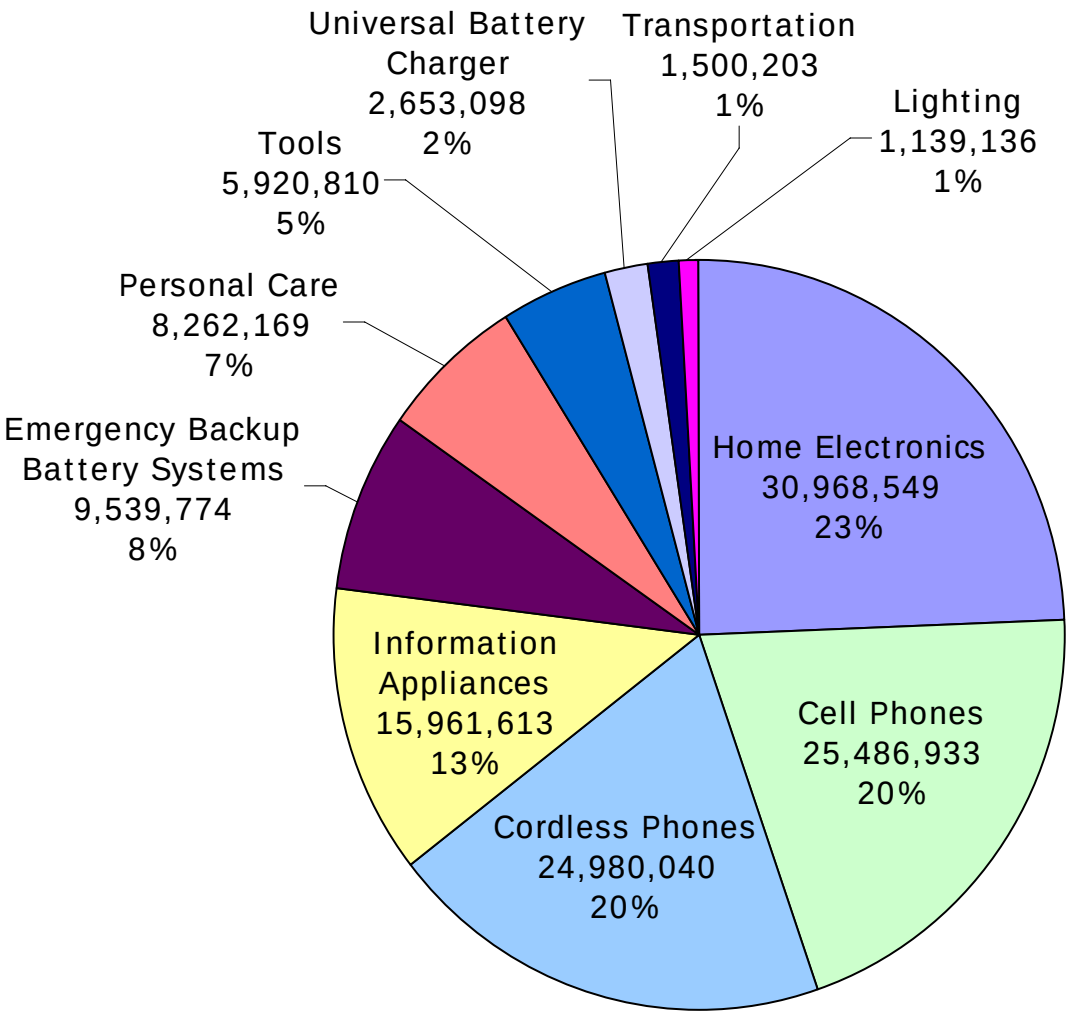
BATTERY CHARGER PRODUCT CATEGORIES

(1) Home Electronics •Audio •Toys •Video •Two-Way Radios	**(2) Cell Phones** •Cell Phones •Cell Phone Accessories	**(3) Cordless Phones**	**(4) Information Appliances** •Laptop •Other Data Devices •Business Equipment	**(5) Emergency Backup Battery Systems** •Lighting •Power •Security
(6) Personal Care •Oral Care •Hair Trimmers •Shavers	**(7) Tools** •Electric Housewares •Outdoor Appliances •Power Tools	**(8) Universal Battery Chargers** •Marine •RV/Auto/ General Use •AA/AAA/9V	**(9) Transportation** •Forklift •Personal Electric Vehicle •Golf Carts/Electric Carts •Electric Cars	**(10) Lighting** •Lanterns •Flashlights

SALES TRENDS OF FASTEST GROWING/DECLINING PRODUCT CATEGORIES



CA STOCK ESTIMATES



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

PRIOR HISTORY
TEST PROCEDURE DEVELOPMENT

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

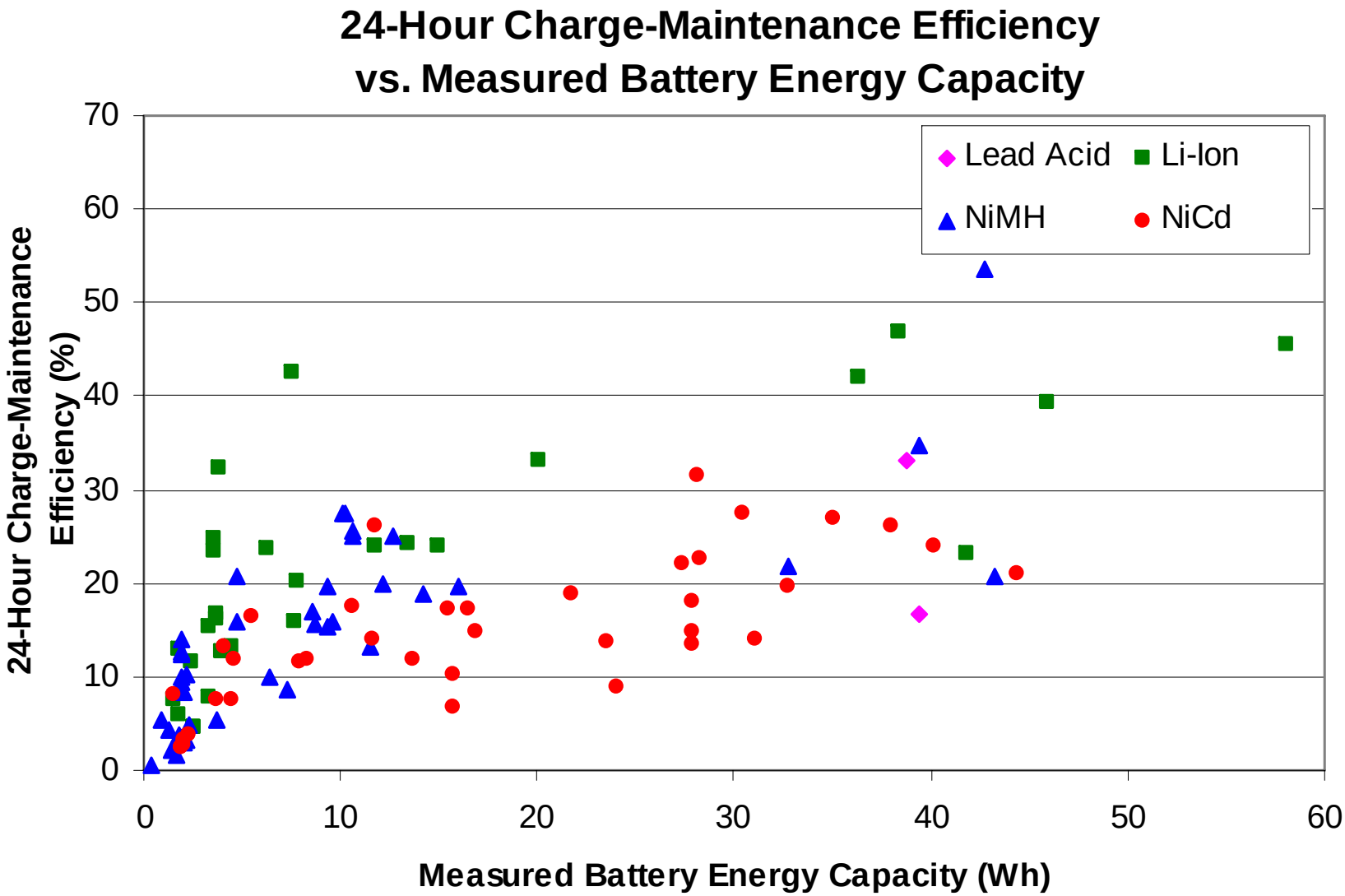
Finalized as of September 2007

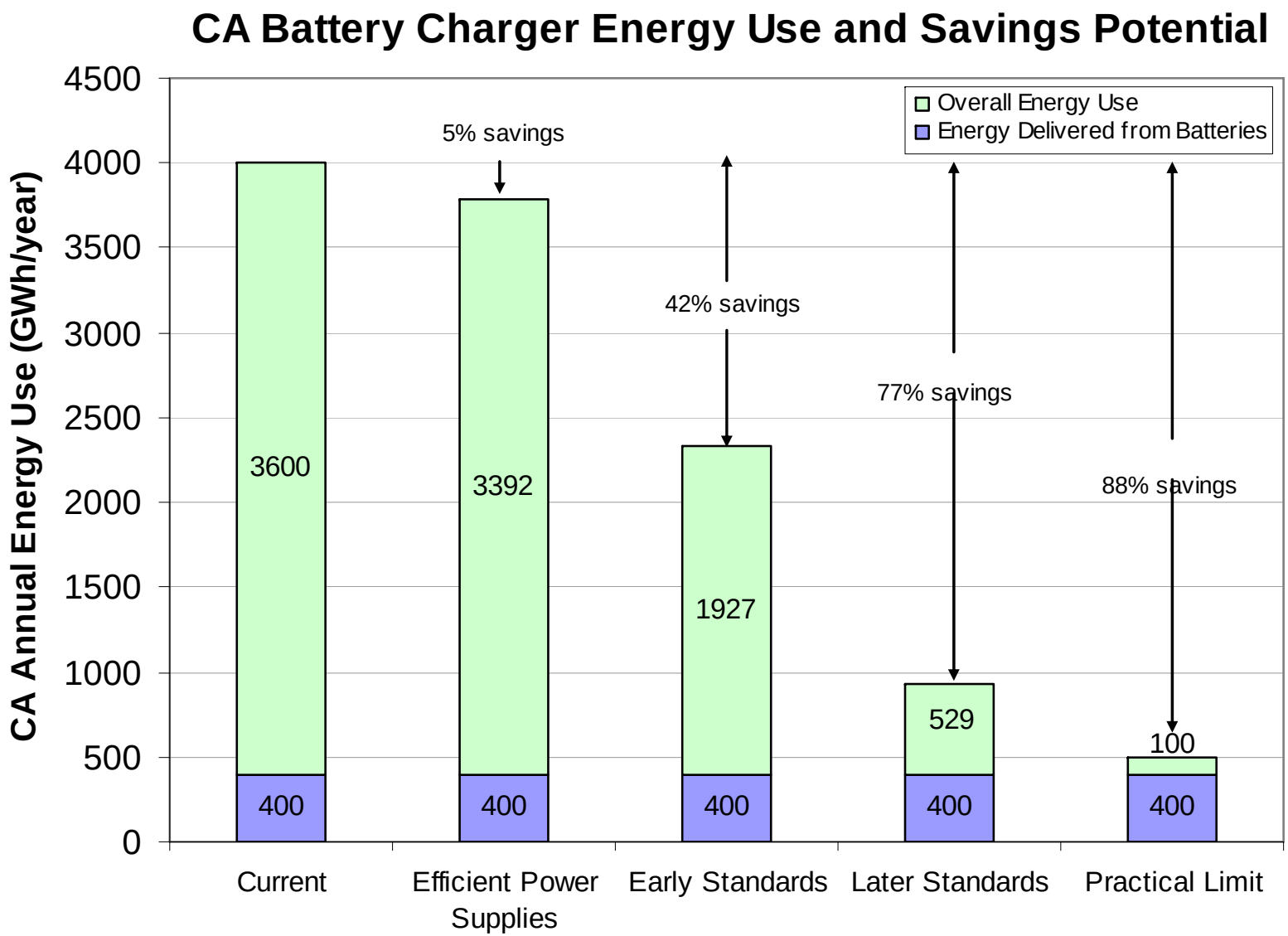
Available at www.EfficientProducts.org/bchargers/ along with comment and response document for final revisions

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

SNAPSHOT OF CURRENT DATASET





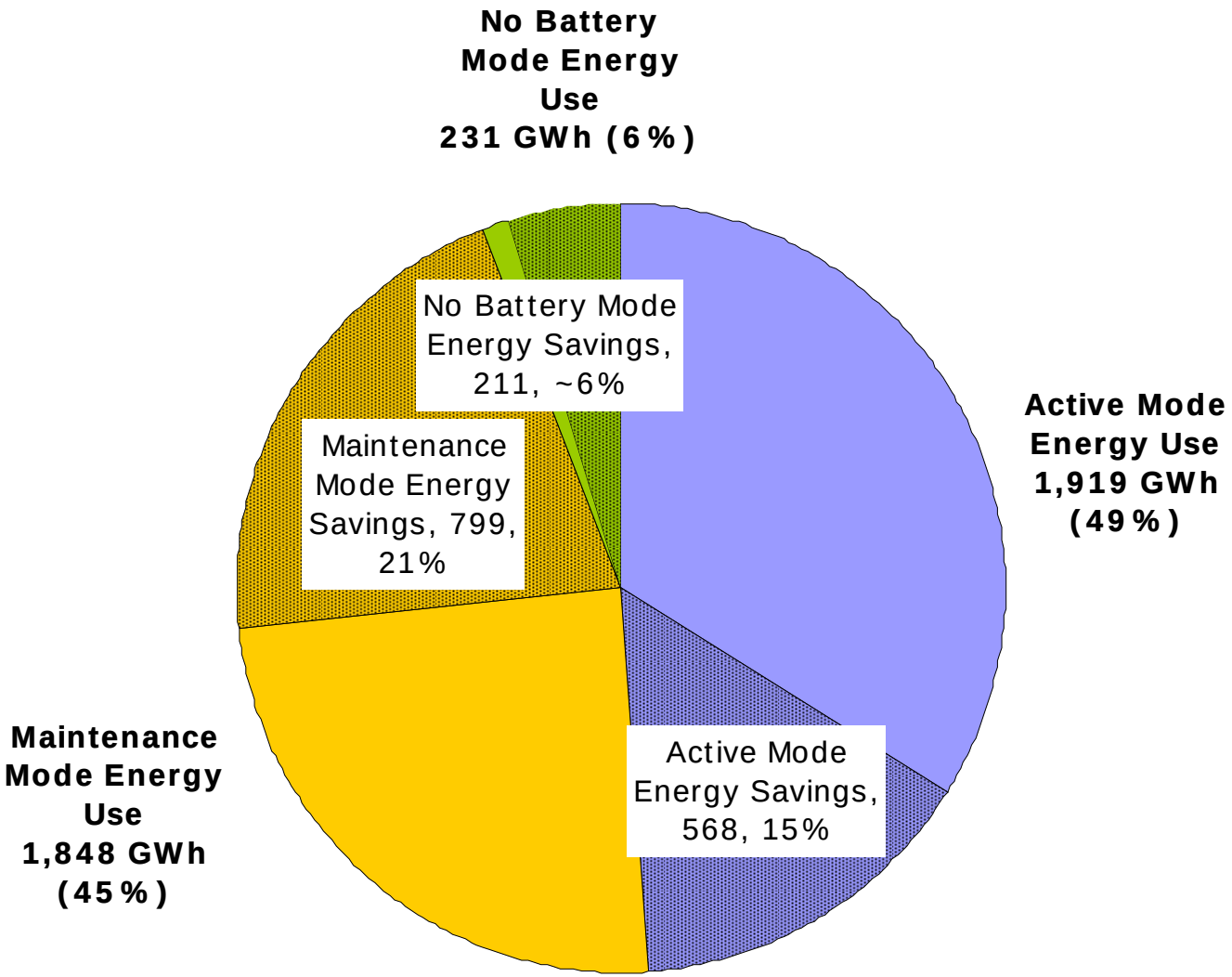
- Potential to reduce BCS energy use by over 40% (1.7 TWh/year) even with early, less stringent standards

LARGEST ENERGY CONSUMING BCS CATEGORIES (GWh per year)

Cordless Phones	**526**
Universal Battery Chargers, Marine Residential Chargers	**245**
Information Technology, Commercial Laptops	**237**
Emergency Backup Battery Systems, Lighting	**113**
Cell Phones	**78**

- Large battery chargers (electric vehicles, forklifts, and golf carts) likely constitute 30% to 40% of total BCS energy use, but further measurements are underway to firm up estimates

CA Battery Charger Annual Energy Use and Savings by Mode



EFFICIENT DESIGN STRATEGIES

1. Don’t charge batteries or overcharge batteries which are already charged
2. Reduce standby power when not actively charging the battery
3. Ensure an efficient power conversion process which eliminates excessive heat loss, etc.
   - Part of this includes the efficiency of the power supply

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

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		

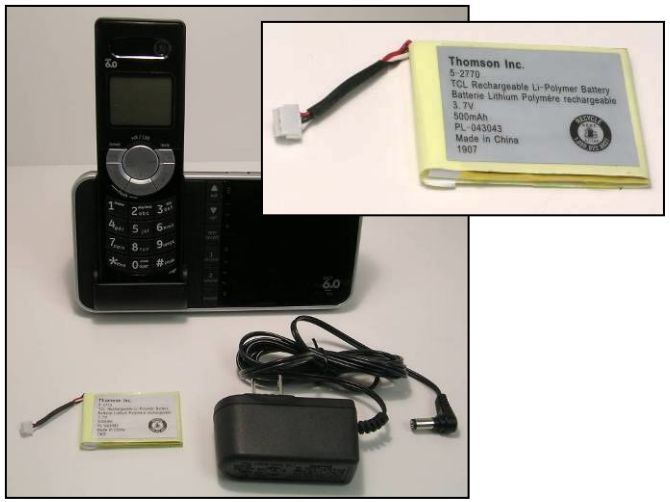
ECONOMIC ANALYSIS

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	

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	

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	

STANDARDS CONCEPTS

- **Three components: Active, Maintenance and No Battery**
- **Active mode considers battery energy:**

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

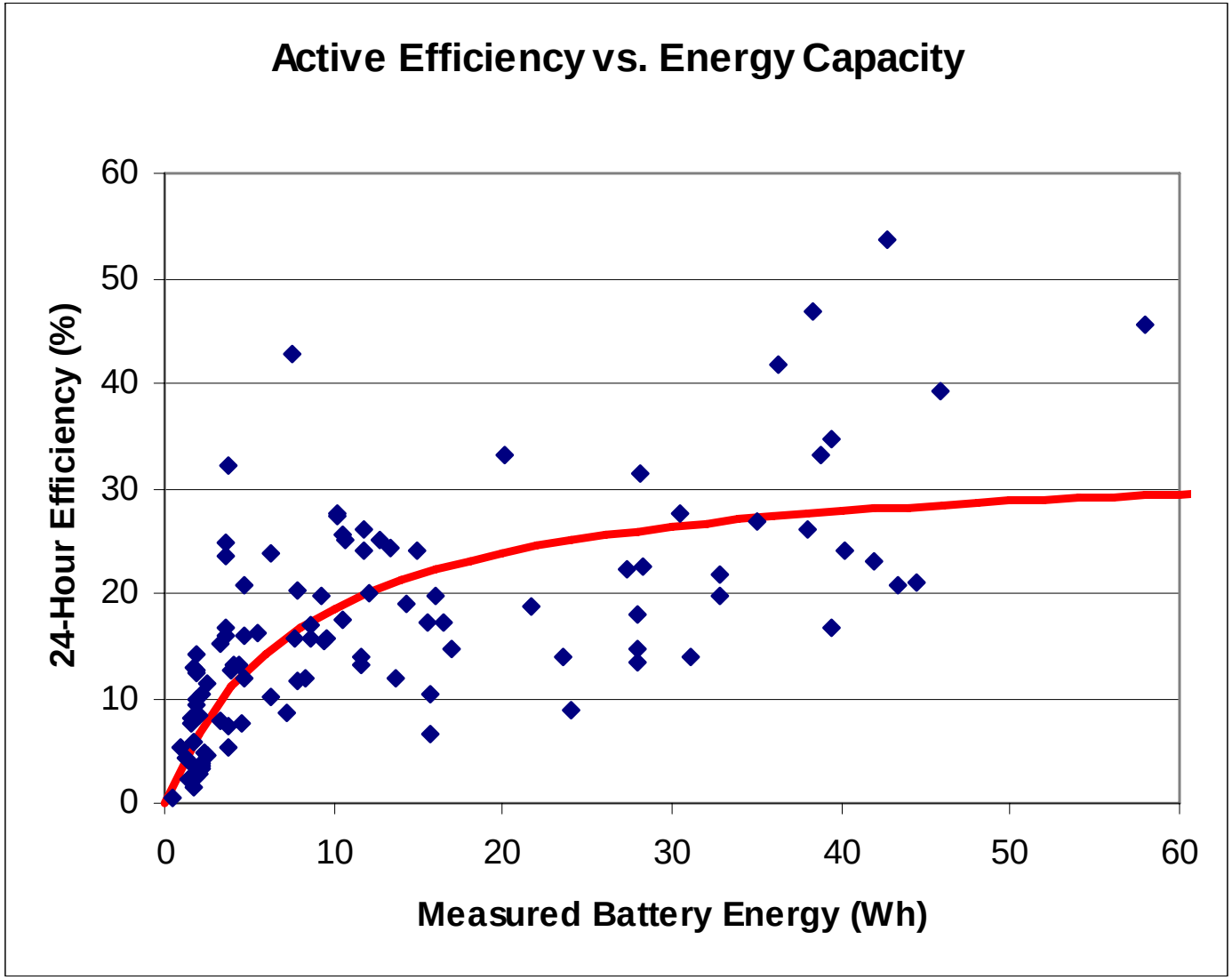
- **Can also be considered as an energy budget:**

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

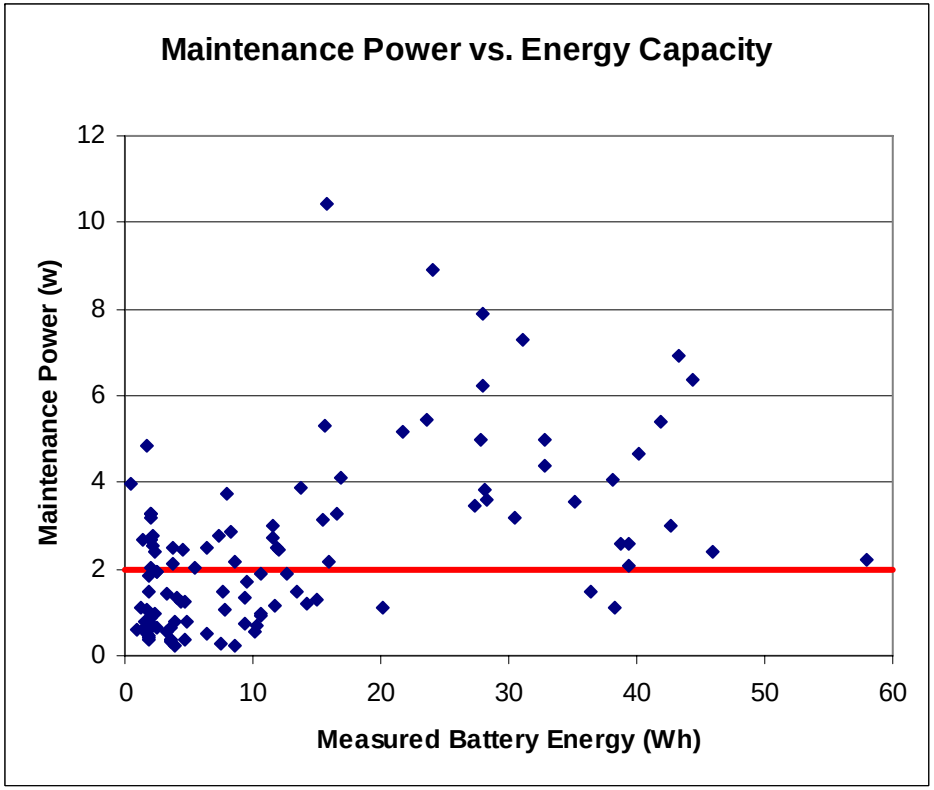
- **May consider infrequently used products with more emphasis on maintenance mode and less on active mode**
- **Staged Standards**

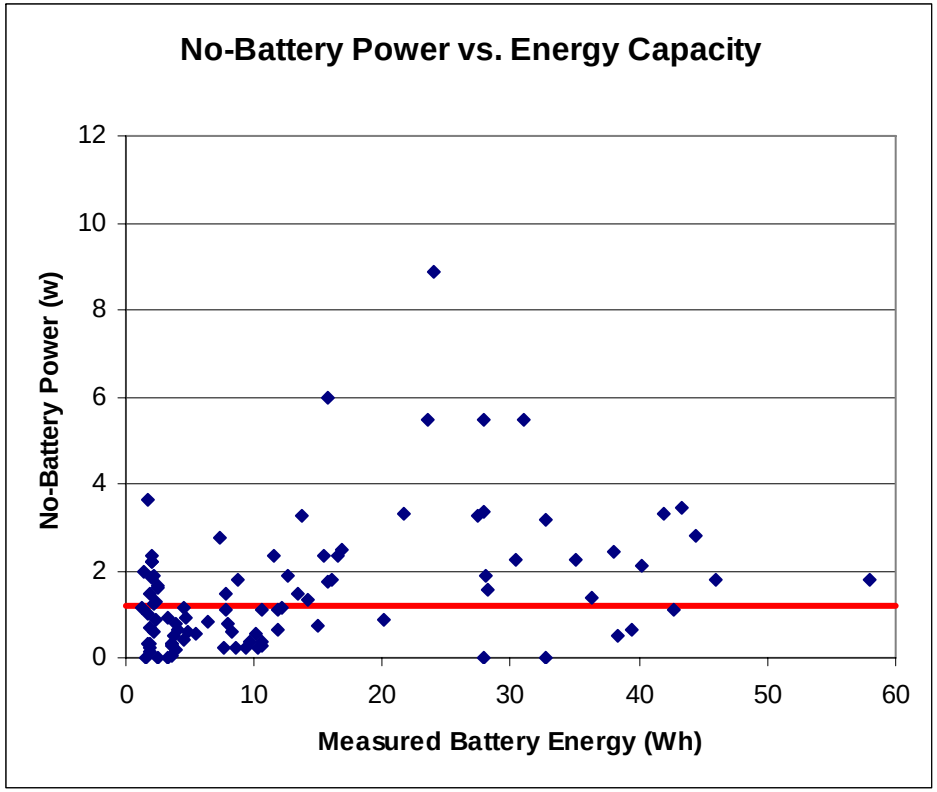
1. **Near Term, removes least efficient chargers**
2. **Eventual standard for improved efficiency**
3. **Voluntary level representing best current practice**

STANDARDS CONCEPTS

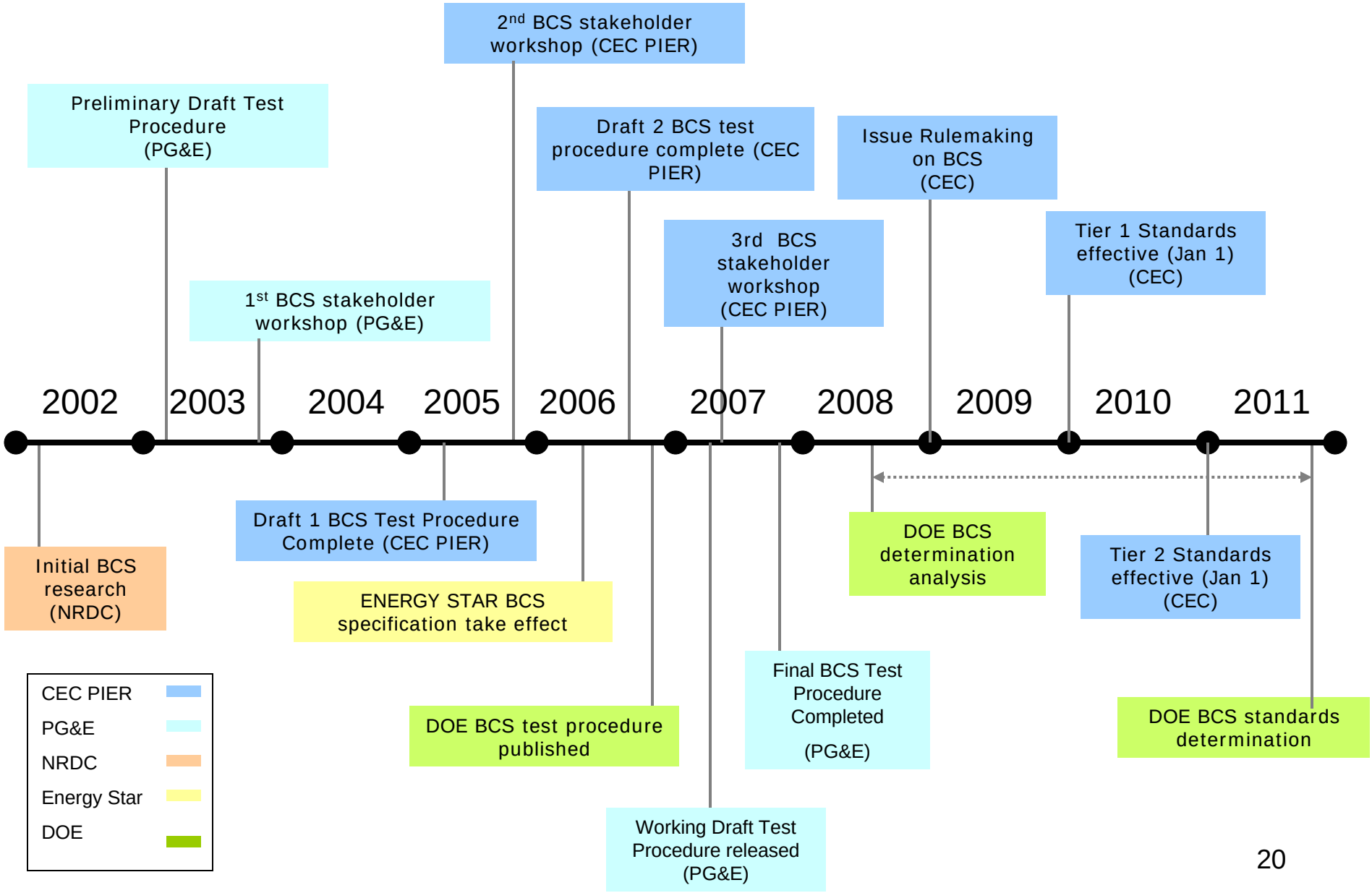


STANDARDS CONCEPTS





Recommended BCS Standards Timeline



REGULATORY CONSIDERATIONS

- Ten states have current or pending legislation on external power supplies

The federal energy bill which passed in December 2007 defines Class A external power supplies which do not include EPSs associated with battery charger systems

  - Therefore, federal standards do not preempt CA standards on EPSs associated with battery charger systems

  The federal energy bill states that a determination date and standard for battery chargers are both due no later than July 1, 2011. Eventual standards would take effect three years later in 2014.

- Coordinate with Canadians, Europeans and other jurisdictions for consistent international test method

BACKUP SLIDES

HOW DOES EPS COMPLIANCE WITH CEC STANDARDS AFFECT BASE CASE SCENARIO?

1. Full Compliance (CA Tier 2) Scenario
   - Assumes all EPSs will be compliant under the CA Tier 2 standard. Assumes the product is the same, but is shipped with a compliant EPS.
2. Current EPS Market Scenario
   - Assumes the current market, where all EPSs do not comply with the CA Tier 2 EPS standard.

PROPOSED STANDARDS

- Infrequently Used Products
  - Product categories would be defined by the standard
  - Not typically used daily, therefore they spend more time in maintenance mode relative to frequently used products
  - Examples: homeowner power tools, camcorders, universal battery chargers
- Frequently Used Products
  - Product categories would be defined by the standard
  - Typically used daily, therefore they spend a larger portion of time in active mode relative to infrequently used products
  - Examples: contractor tools, cellular phones, laptops

NON-ENERGY BENEFITS

- Reduced CO2 Emissions
  - Power plants not needed
  - Cars off road
  - Lessened emissions
- Solid Waste
  - Possibly a longer, more useful life for batteries if they are not constantly being overcharged, therefore less overall waste

HIGH EFFICIENCY HAS BEEN ACHIEVED

Power Tool

42.6% Efficiency (24-hr)

Range of Comparable Power Tool 24-hr Efficiencies: 11%-24%

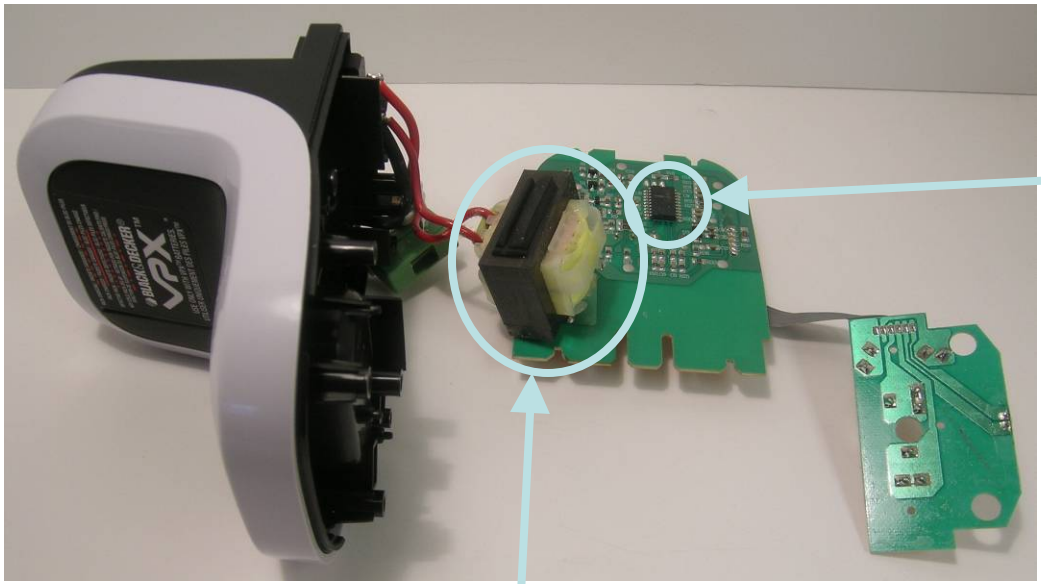
Cell Phone

32.2% Efficiency (24-hr)

Range of Other Cell Phone 24-hr Efficiencies: 7%-25%

Manufacturers can meet high efficiency standards, as the best in practice are doing it already

IMPROVED EFFICIENCY DOES NOT ALWAYS MEAN HIGHER COSTS



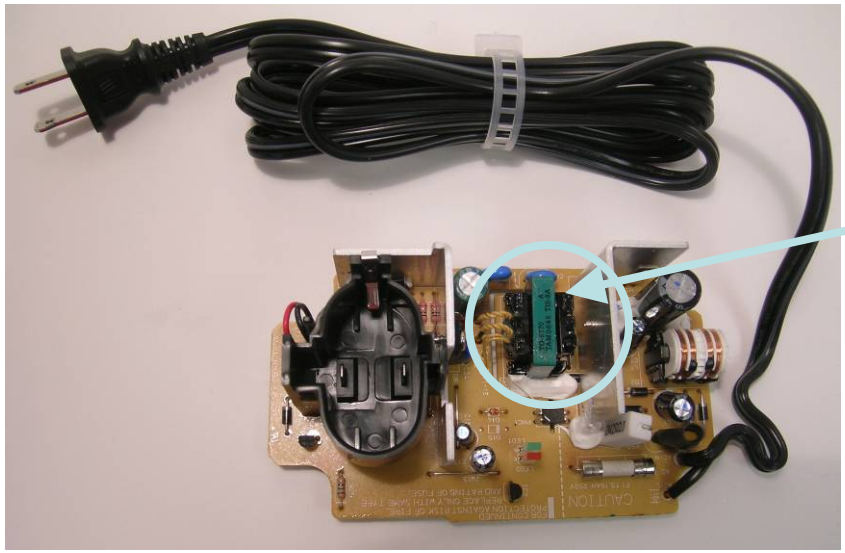
Incorporates integrated circuitry for charge control

Product B: 23.7% 24-hr efficiency

Maintenance Mode Power: .5W

Contains a large 60 Hz transformer to step down voltage rather than a smaller high frequency transformer

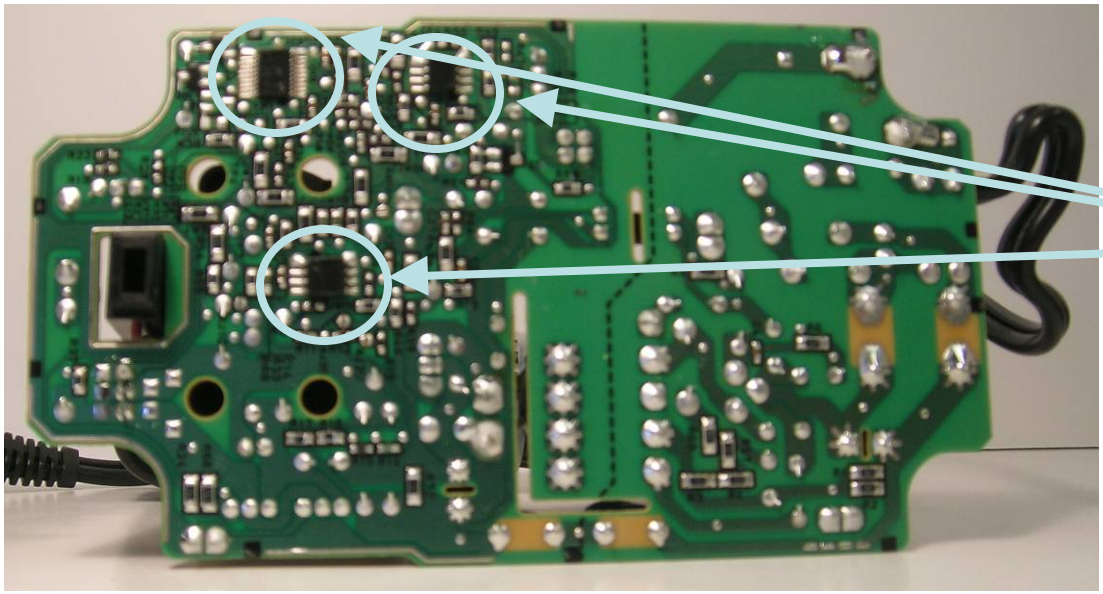
IMPROVED EFFICIENCY DOES NOT ALWAYS MEAN HIGHER COSTS



incorporates small transformer which operates at high frequency

Product C: 42.6% 24-hour efficiency

Maintenance Mode Power: 0.28 W



incorporates integrated circuitry for charge control and the switching power supply

IMPROVED EFFICIENCY DOES NOT HAVE TO MEAN HIGHER COSTS

Incorporates a single diode in order to convert AC to DC

The charge control is simply the resistance of the transformer windings

Product A: 11.8% 24-hr efficiency

Maintenance Mode Power: 2.8W