

# **Battery Charger Technical Context**

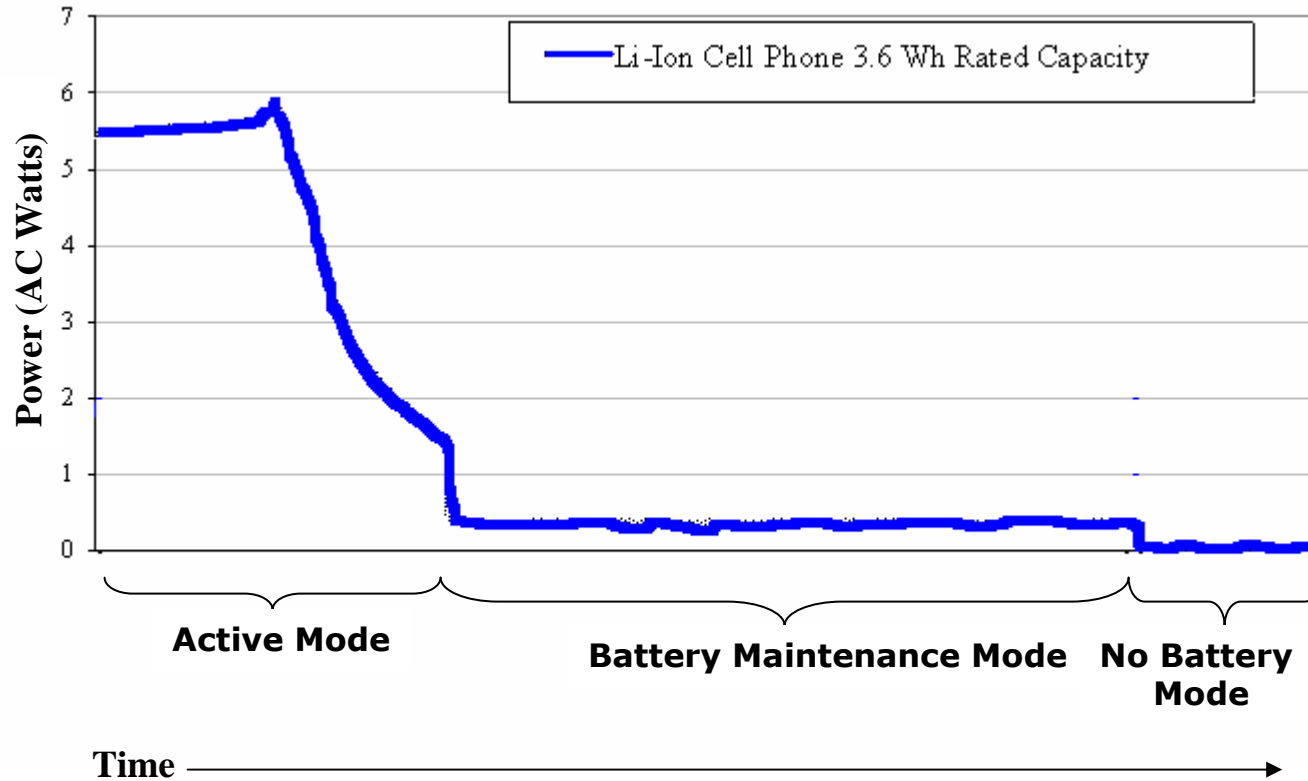
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May 30, 2007



## Test Procedure Covers All Three Modes Involved in Battery Charging

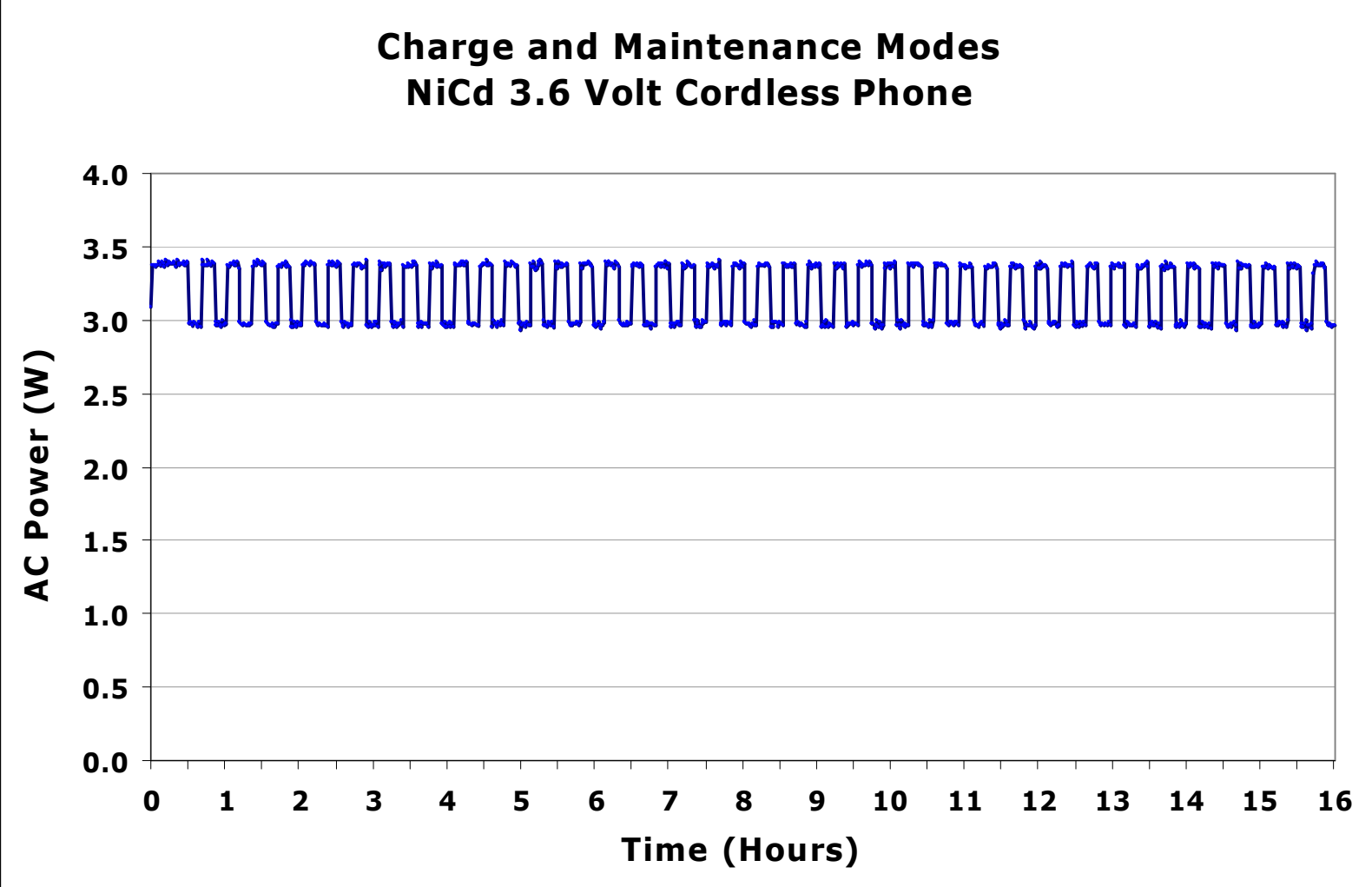


**Active or Charge Mode** - battery charger is delivering current in order to bring the battery from a state of discharge to a state at or near 100% capacity

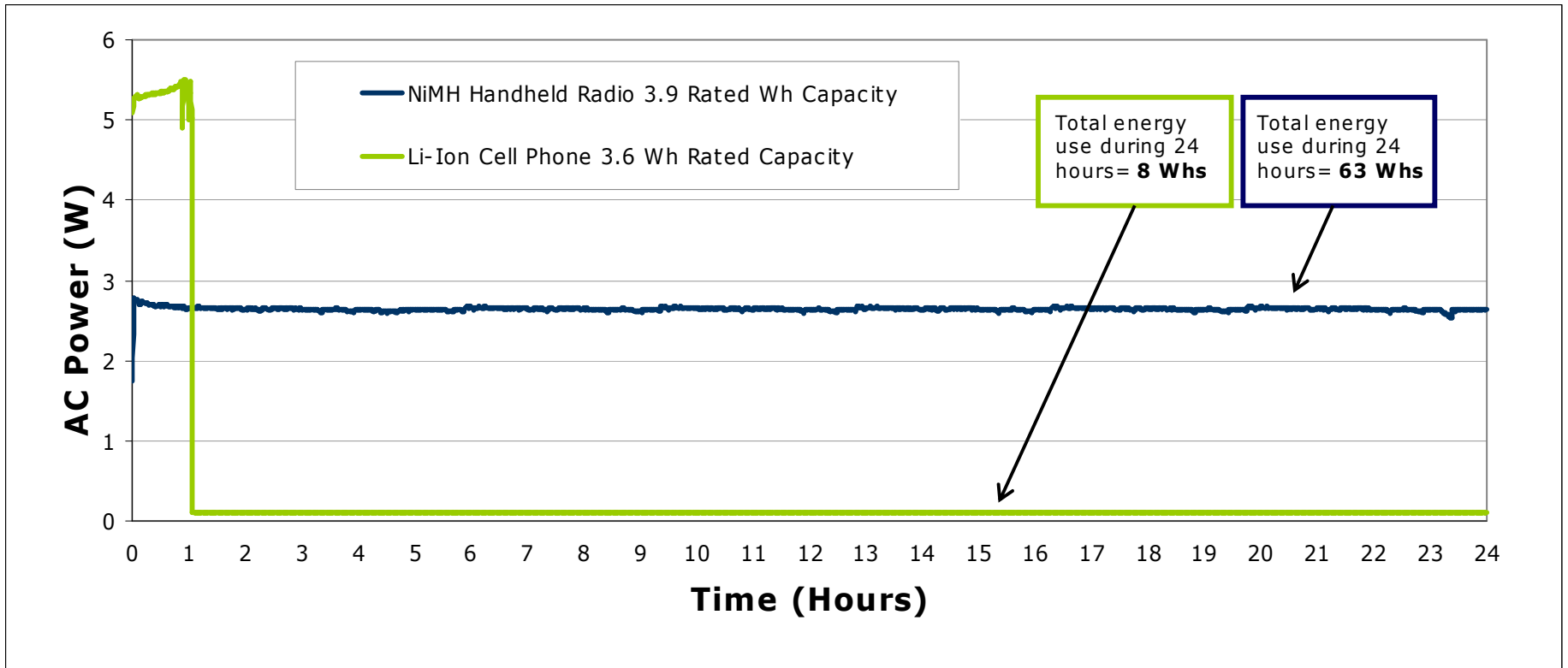
**Battery Maintenance** - battery charger may be delivering current to the battery in order to counteract self-discharge of the battery which is at or near 100% capacity

**No Battery Mode** - no batteries installed in the appliance

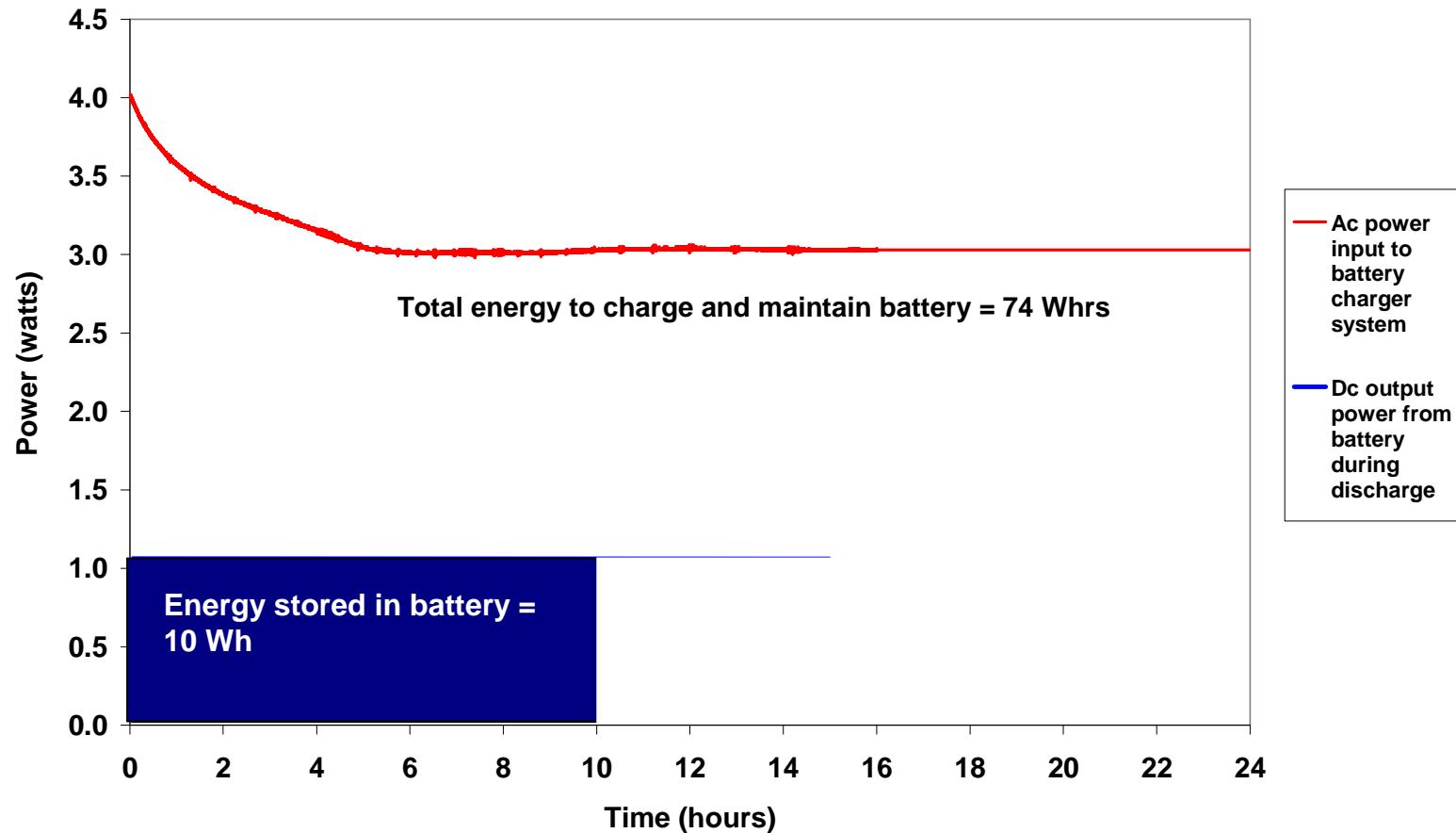
# Some BCSs Draw the Same Amount of Power in Charge and Maintenance Modes



# Continuous Chargers Use More Energy than "Smart" Battery Charging Systems, Even Within BCSs with Similar Battery Capacities



# Basic Technical Approach to Efficiency Metric



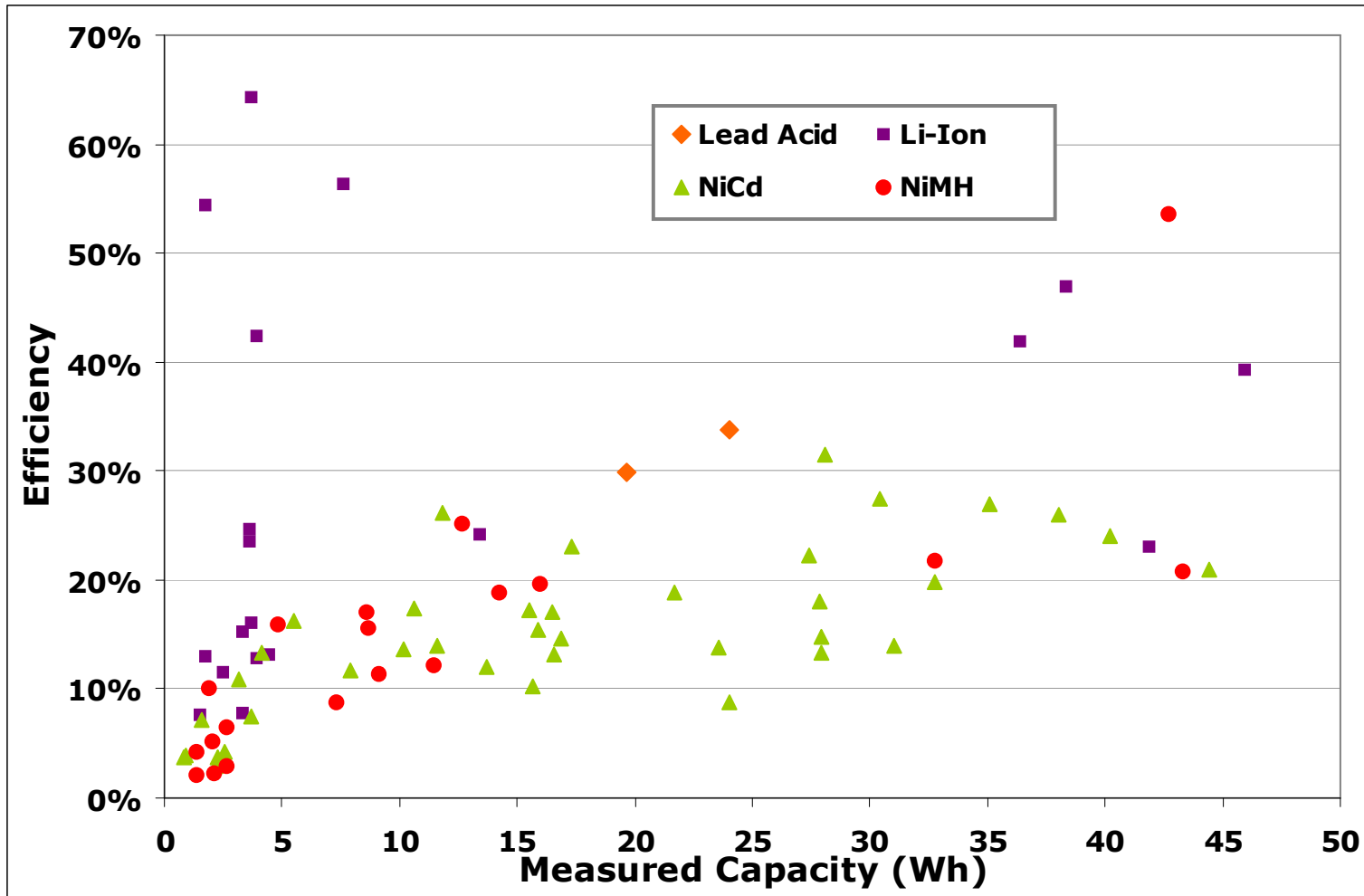
**24-hour charge and maintenance efficiency = 13.5%**

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**Active and maintenance mode** → % Efficiency = 
$$\frac{\text{Battery Energy Output}}{\text{Ac Energy Input (during designated cycle)}}$$

**Standby mode** → Single standby power draw limit (watts)

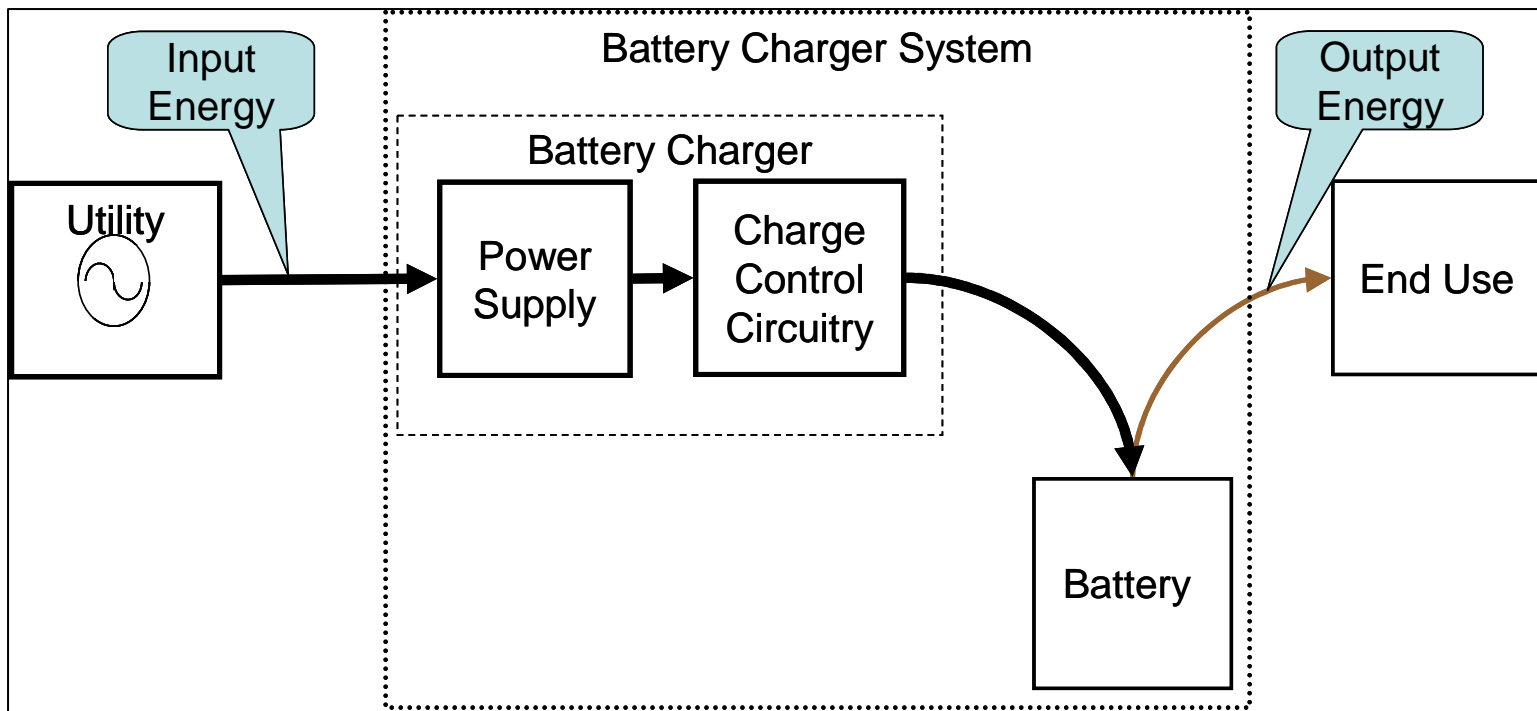
# 24-hour Efficiency Varies Across All Battery Chemistries and Capacities



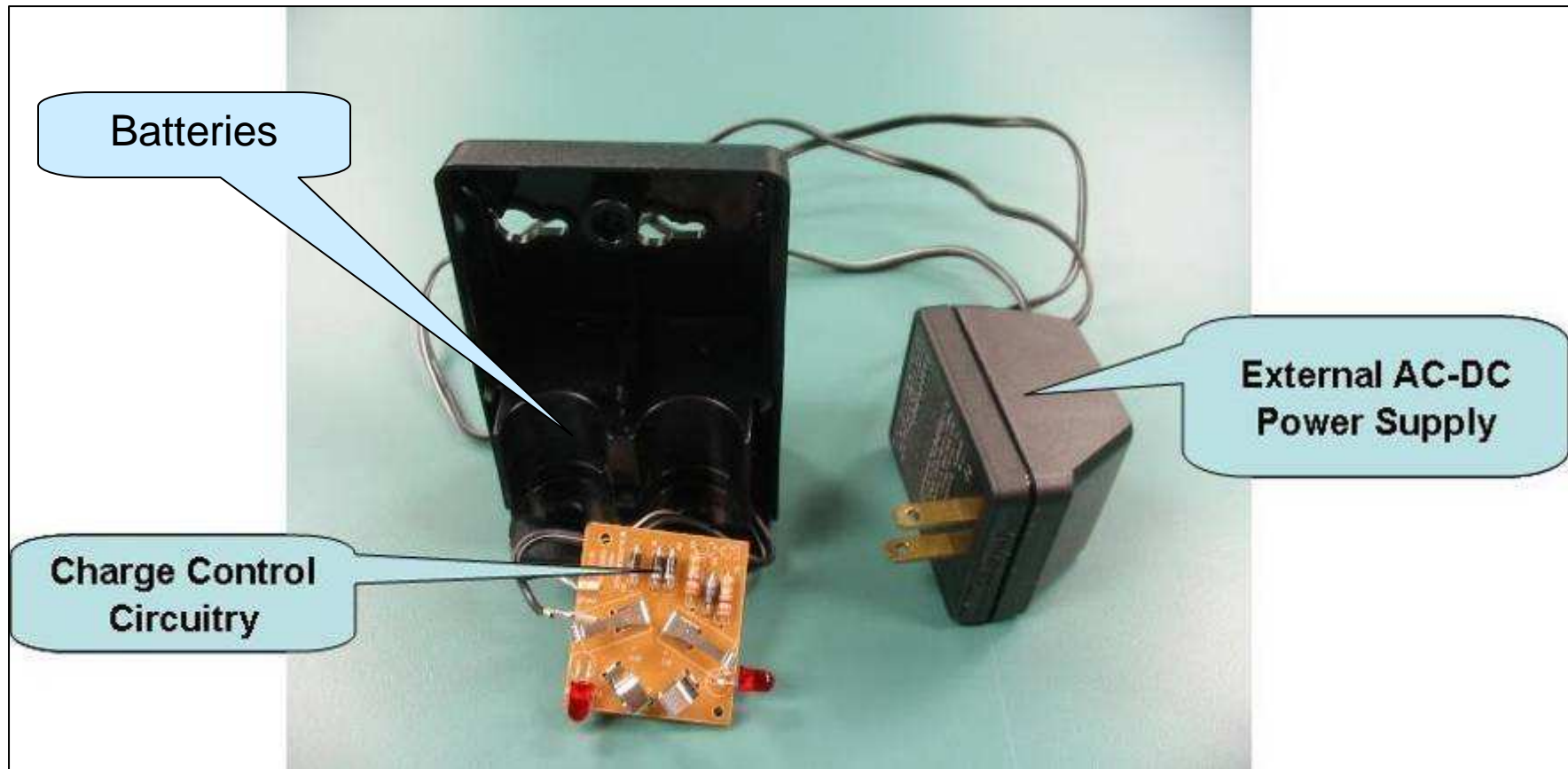
$$\% \text{ Efficiency} = \frac{\text{Energy from battery discharged at } 0.2 \text{ C}}{\text{Energy to charge \& maintain battery over 24 hours}}$$

## Energy Loss Can Occur in All Three Elements of a Battery Charger:

- 1) The **power supply** converts ac power to dc power
- 2) **Charge control circuitry** charges the battery
- 3) The **battery** stores dc energy for later use

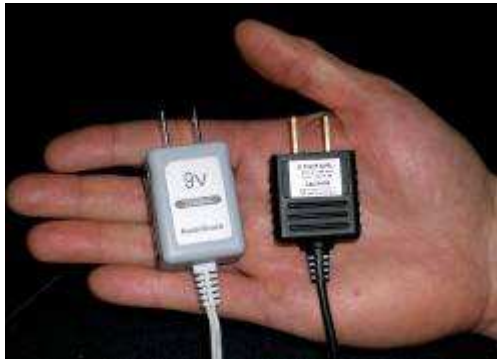


## Examples of the Three Elements Inside a Power Tool Battery Charger System



# Summary of possible technical approaches to improve efficiency

- 1) Increase efficiency of the ac-dc power conversion circuitry
- 2) Increase charge mode efficiency through better battery charging circuitry and more efficient chemistries
- 3) Reduce battery maintenance energy through smarter charging circuits
- 4) Disconnect mains power when no battery is present
- 5) Improve efficiency of dc load to allow use of smaller battery for similar run-time



## Efficiency has other market advantages:

- *Smaller size for portable applications*
- *Reduced cost for shipping and packaging products*
- *Reducing cost of copper for linear power supplies*

# Designing Battery Charger Systems for Improved Energy Efficiency

A Technical Primer



More technical details on battery chargers can be found in the technical primer available at [www.efficientproducts.org](http://www.efficientproducts.org).

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Prepared for the California Energy Commission  
Contract # 500-04-030, Brad Meister, Contract Manager  
September 28, 2006

