# 2011 APPLIANCE EFFICIENCY RULEMAKING

## Proposed Efficiency Standards for Battery Chargers and Lighting Controls

CALIFORNIA ENERGY COMMISSION

# DRAFT STAFF REPORT

## Staff Analysis of Battery Charger Standards

PHASE 2

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# PREFACE

On February 5, 2007, the California Energy Commission approved an Order Instituting Rulemaking to amend the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 through Section 1608[1]). Subsequently, in its April 2, 2008, Scoping Order,[2] the Energy Commission's Efficiency Committee initiated Phase I of the 2008 Appliance Efficiency Regulations Rulemaking, and further divided Phase I into separate parts.

In Part B of Phase I, the Commission adopted test procedures for small and large battery charger systems. The scoping order noted that in the next phase of the Appliance Efficiency Rulemaking the Efficiency Committee expected to consider power usage regulations and requirements for battery chargers, as well as further amendments to the Appliance Efficiency Regulations, as appropriate.

In August 2010, the Efficiency Committee approved initiation of a Phase II rulemaking under the 2008 Scoping Order. Phase II is a continuation of the previous Phase I rulemaking with the goal to adopt battery charger regulations that would rely upon the test procedure adopted in Phase I. Investor Owned Utilities (IOUs) have prepared a Codes and Standards Enhancement (CASE) report as a basis for considering efficiency regulations for these battery charger systems. The CASE report provides the analysis and recommendations which form the underlying basis for the battery charger regulations proposed in this staff report. The Energy Commission held a staff workshop on October 11, 2010, and provided a comment period to give stakeholders an opportunity to respond to the substance of the CASE report.

The proposal contained in the staff report is based on consideration of the CASE report data, stakeholder comments, and on the preliminary data provided in the U.S. Department of Energy's (DOE) Technical Support Document (TSD) for a federal battery charger systems regulation. [3] This staff report includes efficiency regulations for charge, maintenance, and no battery modes, and for power factor for battery charger systems. The proposed scope of the battery charger regulations includes both consumer products and non-consumer equipment. The proposed battery charger standards will impact only battery charger circuitry. The proposed regulations will not necessitate that manufacturers alter battery chemistry or product design.

In addition to battery charger regulations, the proposed scope of the Phase II rulemaking also includes lighting controls. Lighting controls have been regulated under the Energy Commission's building codes, found in Title 24 of the California Code of Regulations, for many years. The proposal in Phase II is to move these regulations from an installation-based

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[1] All references to title are to the California Code of Regulations and references to section numbers are to Title 20 of those regulations, unless otherwise noted.

[2] http://www.energy.ca.gov/appliances/2008rulemaking/notices/2008-04-02_COMMITTEE_SCOPING_ORDER.PDF

[3] http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/bceps_preanalysis_tsd.pdf

regulation in Title 24 to a sales-based regulation in the Appliance Efficiency Regulations in Title 20. The proposed lighting control regulations are design-based, as the energy savings cannot be measured within the device itself. This is because the savings actually occur in lighting products external to the controls. The energy savings analysis in this report will not show any saving for lighting controls.

# ABSTRACT

This staff report contains proposed standards under the Appliance Efficiency Regulations (California Code of Regulations, Title 20, Sections 1601 through 1608). These regulations are being considered as part of the 2008 Appliance Efficiency Rulemaking, Phase II (Docket # 09-AAER-02).

This report presents Energy Commission staff analysis of the cost effectiveness and technical feasibility of the proposed battery charger regulations, including statewide energy use and savings, and battery safety and related environmental issues. The staff report also summarizes state energy efficiency policy, proposed energy use measurement, federal battery charger proceedings and test methods, and responses to summarized stakeholder comments in Appendix C.

The proposed battery charger standards will result in significant energy and cost savings to the people of California. Battery chargers currently use an estimated 8,000 GWh/year of electricity. However, the actual useful amount of energy delivered to batteries is only 2,900 GWh/year. This difference of 5,100 GWh per year represents a significant potential for energy savings. The proposed standards would save 2,038 GWh a year in energy that is currently wasted as excess heat after the batteries are fully charged. In addition, based on an analysis of available data, Energy Commission staff concludes that the proposed battery charger regulations are both cost effective and technically feasible.

The methodology used to develop these estimates is detailed in Appendix B. The input data, assumptions, formulas and calculations used to develop the energy savings and cost effectiveness of the proposed standards are included to ensure transparency.

This report also includes language to move lighting control regulations from Title 24 to Title 20. Currently, lighting controls have been regulated under the Energy Commission's building codes, found in Title 24. Many lighting control products sold in the market do not meet the energy savings criteria set forth in Title 24. Title 20 requires that all regulated products sold in California must be certified to the Energy Commission. The proposed regulations would move self-contained lighting controls into Title 20 and leave lighting control systems comprised of multiple products in Title 24.

**Keywords:** Appliance Efficiency Regulations, appliance regulations, batteries, battery chargers, external power supplies, energy efficiency, lighting controls

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# Legislative Criteria

Section 25402, subdivision (c), of the Public Resources Code authorizes the Energy Commission to adopt regulations for minimum levels of operating efficiency of appliances whose use, as determined by the Commission, requires a significant amount of energy on a statewide basis. New and revised regulations must be feasible and attainable and must not result in any added total costs to the consumer over the designed life of the appliances concerned. The added total cost is derived by comparing the cost and performance of a typical model that the consumer would purchase with the proposed standard in effect to the cost and performance of a typical model that the consumer would purchase without the proposed standard in effect.

# Background

## Battery Chargers are a Growing Plug Load

The first consumer grade nickel-metal hydride (NiMH) rechargeable battery for smaller applications appeared on the U.S. market in 1989. Lithium ion batteries, which introduced a new level of energy density, became widely available in 1991. Recent developments in lithium ion technology have expanded the rechargeable market into portable electronics as they allow for more flexible and compact designs. The introduction of these battery technologies made consumer-grade rechargeable products both economical and practical.

Since the early 1990s, the number of products sold with rechargeable batteries have grown significantly. Portable devices have grown in number and popularity in the last 20 years. Accordingly, the electricity consumed in charging their batteries has grown and there has been a significant increase in plug load electric consumption.

Examples of the many common products that operate on rechargeable batteries and use battery chargers include:

- Personal care products;
- Mobile phones and cordless phones;
- Power tools;
- Consumer electronics such as iPods, laptop computers, audio recorders, and cameras; and
- Non-commercial off-road vehicles and forklifts.

Today, approximately 170 million products with rechargeable batteries that require battery charger systems. While battery chargers in California consume approximately 8 billion kilo Watt-hour (kWh) a year, only 2.9 billion kWh of that energy is actually delivered to the batteries. The potential for energy savings is in reducing the 5.1 billion kWh of annual loss while maintaining battery charger performance desired by consumers and industry. A substantial portion of these savings these savings are achievable through improved battery charger design and could reduce this loss of electricity by more than half.[4]

In 2006, Ecos Consulting (Ecos), RLW Analytics, and Lawrence Berkeley National Laboratory conducted a study with funding from the Energy Commission's Public Interest Energy Research (PIER) Program regarding plug load device use. The plug load is the energy consumed by an electrical or electronic device that is plugged into an electrical socket. The purpose of this research was to understand how and when consumers are operating the growing number of electric devices in their homes and to identify where potential energy savings opportunities exist. The research team surveyed 300 California families and metered plug loads in a subsample of 50 homes. The researchers obtained weeklong power and usage pattern measurements for nearly 700 devices in the subsample.[5]

The Codes and Standards Enhancement (CASE) Initiative identifies battery chargers as one of several important plug loads contributing to energy consumption in California residences. The study results identify significant opportunities for cost-effective savings by reducing standby losses.

## Product Description

Battery chargers are differentiated throughout this report into two categories—large and small—based on the overall power and energy of the system. Large battery chargers are defined as those which draw peak power of 2 kW or more. The test procedures are fully described later in the report. In U.S. Department of Energy's (DOE) proposed test procedure, golf cart chargers, which potentially draw as much as 2kW are tested using the small battery charger procedure to align with the proposed federal test procedure, and are included in the small battery chargers category in this report.

Consumer battery charger and non-consumer battery charger are terms used to differentiate products which are being considered for federal regulation (consumer) versus the all-inclusive scope of this staff report (both consumer and non-consumer). A consumer product is defined in federal law[6] as a product which, to any significant extent, is distributed in commerce for personal use or consumption by individuals. A non-consumer battery charger covers products outside the scope of that definition and covers chargers used primarily in commercial settings.

To capture the range of affected devices that are sold in California the existing regulations include the following definition for a "Battery Charger System."[7]

> "Battery charger system" means a battery charger coupled with its batteries, or battery chargers coupled with their batteries, which together are referred to as *battery charger systems*. This term covers all rechargeable batteries or devices incorporating a rechargeable

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[4]http://www.efficientproducts.org/reports/bchargers/1270_BatteryChargerTechincalPrimer_FINAL_29Sep2006.pdf
[5]http://www.efficientproducts.org/product.php?productID=11
[6]42 United States Code section 6291, subd. (1).
[7]Title 20 Part 2 Article 4 section 1602(w)

battery and the chargers used with them. Battery charger systems include, but are not limited to:

- electronic devices with batteries that are normally charged from AC line voltage or DC input voltage through an internal or external power supply and a dedicated battery charger;
- the battery and battery charger components of devices that are designed to run on battery power during part or all of their operations;
- dedicated battery systems primarily designed for electrical or emergency backup; and
- universal devices whose primary function is to charge batteries, along with the batteries they are designed to charge. These units include chargers for power tool batteries and chargers for automotive, rechargeable AA, AAA, C, D, or 9 V batteries, as well as chargers for batteries used in larger industrial motive equipment.

The charging circuitry of battery charger systems may or may not be located within the housing of the end-use device itself. In many cases, the battery may be charged with a dedicated external charger and power supply combination that is separate from the device that runs on power from the battery.

The proposed regulations cover both internal and external power supply-driven products that have rechargeable batteries, including consumer, non-consumer, and industrial battery chargers. Battery chargers generally fall into four types of form factors:

- Power supply and charge control circuitry, each in separate housings;
- Power supply and charge control circuitry in one housing, battery in separate housing;
- Charge control circuitry and battery in one housing, power supply in separate housing; and
- Power supply, charge control circuitry, and battery all in the same housing

At present, the Energy Commission and DOE regulate external power supplies (EPS). The EPS regulations exclude battery charger power supplies (BCPS) based on statement from several many manufacturers during the EPS rulemaking process to the effect that BCPS are not EPS and should be exempted from the EPS standards. To cover these products as appropriate, the proposed battery chargers regulations include BCPS.

# Efficiency Policy

The State of California has set clear policy goals regarding reduction of electricity demand through energy efficiency. In September of 2000, the California Legislature enacted AB 970 in response to the ongoing electricity crisis. Among other things, AB 970 stated that within 120 days of the effective date of the law, the Energy Commission should adopt and implement updated and cost-effective regulations pursuant to Section 25402 of the Public Resources Code to ensure the maximum feasible reductions in wasteful, uneconomic, inefficient, or unnecessary consumption of electricity.

California's existing efficiency regulations have historically made a significant difference in California's energy consumption. Appliance energy efficiency is identified as a key component to achieving the greenhouse gas (GHG) emission goals of Assembly Bill 32 (Núñez, Chapter 488 Status of 2006)[8] (AB 32) and those contained in the California Air Resources Board's *Climate Change Scoping Plan.*[9] Appliance efficiency regulations are also identified as key components in reducing electrical energy consumption in the Energy Commission's *Integrated Energy Policy Report* (IEPR) and the California Public Utilities Commission's (CPUC) *Long Term Energy Efficiency Strategic Plan*.

The CASE report identifies battery chargers as a category of products with significant potential for GHG reductions and energy savings. The CASE report estimates that the proposed regulations would reduce 1.8 million metric tons (MMT) of $CO_2$ emissions, the equivalent of removing 138,000 cars from the road annually. These greenhouse gas reductions through energy efficiency are key strategy for attaining the goals of AB 32. [10]

Regarding research and development, the Energy Commission is committed to working with manufacturers to encourage and accelerate the development of energy efficient battery chargers technologies through PIER funded research and development. In addition, the Commission's staff is working to increase compliance with existing efficiency regulations through certification, enforcement, and outreach through its appliance program.

These energy efficiency efforts are also important for reducing demand. Under the Energy Commission's loading order, energy efficiency is the highest priority. Meeting efficiency goals is important because California's demand for electricity continues to grow, with statewide electricity consumption forecast to increase an average of 1.25 percent per year over the next decade. In addition, the State faces rapidly escalating fuel prices. [11]

The combination of these pressures poses significant economic and social risk to California. Energy efficiency measures are uniquely poised to play a central role in reconciling the current energy and climate change challenges. This fact is acknowledged in virtually every discussion of GHG abatement opportunities, including McKinsey & Company's comprehensive 2007 review. [12]

California's appliance regulations adopted between 1975 through 2005 are forecasted to have saved 18,761 GWh in 2010.[13] This represents 6.7 percent of California's electric load in 2010. This is approximately the amount of energy produced by California's two largest power plants. At the current electric power average rate of 14¢ per kilowatt-hour, California's consumers saved about $2.68 billion in 2010.

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[8] http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf

[9] http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

[10] CASE Initiative Analysis of Standards Options for Battery Charger Systems, page 39 and 40

[11] http://www.californiaenergyefficiency.com/docs/EEStrategicPlan.pdf

[12] http://www.californiaenergyefficiency.com/docs/EEStrategicPlan.pdf

[13] http://www.energy.ca.gov/2009_energypolicy/index.html Program forecasted for 2020 will grow to 27,116 GWh a year. This would represent 8.6 percent of projected load in 2020. At the current rate of 14¢ per kWh, this would save the state approximately $3.8 billion for 2020.

In the Executive Summary of the 2009 IEPR,[14] it is noted that California's building and appliance regulations provide a significant share of energy savings from reduced energy demand. The 2008 Building Efficiency Regulations took effect on January 1, 2010, and require, on average, a 15 percent increase in energy efficiency savings compared with the 2005 Building Efficiency Regulations. The 2009 Appliance Efficiency Regulations became effective on August 9, 2009, and, as required by AB 1109, set new efficiency regulations for general-purpose lighting of a phased 50 percent increase in efficiency for residential general service lighting by 2018. The first phase became effective on January 1, 2010. The Energy Commission adopted television regulations in 2009, which became effective January 1, 2011.

The Energy Commission will adopt and implement building and appliance regulations that put California on the path to zero net energy residential buildings by 2020 and zero net energy commercial buildings by 2030. The IEPR further recommends that the Energy Commission, in cooperation with the CPUC, the investor-owned and publicly owned utilities will devote sufficient resources to develop the capability to differentiate these future energy efficiency savings from energy efficiency savings that are already accounted for in the demand forecast.[15]

The CPUC states in its *Energy Efficiency Strategic Plan* the following specific goals:

- All new residential construction in California will be zero net energy by 2020
- All new commercial construction in California will be zero net energy by 2030; and
- Heating, Ventilation and Air Conditioning (HVAC) will be transformed to ensure that its energy performance is optimal for California’s climate. [16]

The above measures were selected for their potential impact on the energy efficiency and their ability to stimulate the construction and bring energy efficient technologies and products in to the market.[17]

## Zero Net Energy plan

In order to achieve the goal of zero net energy, it is critical to reduce the wasteful power consumption resulting from plug loads. Plug loads are beginning to equal loads such as heating, cooling, and lighting. Therefore, the CPUC’s *Energy Efficiency Strategic Plan* includes development and adoption of broader appliance efficiency codes and regulations for plug loads such as copy machine, printers, battery chargers, televisions, and other devices.

The Energy Commission and CPUC, along with non-governmental organizations, are working on the development of milestones and pathways to achieve zero net energy goals. One of the

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[14] http://www.energy.ca.gov/2009_energypolicy/index.html Program forecasted for 2020 will grow to 27,116 GWh a year. This would represent 8.6 percent of projected load in 2020. At the current rate of 14¢ per kWh, this would save the state approximately $3.8 billion for 2020.
[15] http://www.energy.ca.gov/2009_energypolicy/index.html
[16] http://docs.cpuc.ca.gov/efile/RULINGS/85174.pdf Page 60
[17] http://docs.cpuc.ca.gov/efile/RULINGS/85174.pdf

most important efforts identified is to reduce power consumption from plug loads in all residential and commercial buildings. Battery chargers are specifically identified as critical component of plug load power reduction to help meet that goal.

## Battery Charger Test Procedure

A meaningful and repeatable method of measuring battery charger efficiency is a critical component to gathering information and setting regulations. Recognizing this, the Energy Commission adopted the "Energy Efficiency Battery Charger Test Procedure" Version 2.2, developed by Ecos and EPRI and vetted through the rulemaking process. The Commission adopted test procedure Version 2.2, dated November 12, 2008, and this test procedure is available on Ecos' website at

http://efficientproducts.org/product.php?productID=4 [18]

The test method consists of two parts: Part 1 is for battery chargers with input power of 2 kW or less, and Part 2 is for those with input power of 2 kW and above. The test method requires that test be conducted for 24-hours for testing power use in charging mode, maintenance mode, and no battery mode. The test method also considers the various design schemes of batteries and includes strategies for testing each type. The three types of general battery charger categories are:

- The charger, battery, and product are all contained within a single housing;
- The charger is external to the product, and batteries are moved from the product to the charger to recharge; and
- The battery is not removed from the product, but the product must be connected to a charger or an external power supply in order to recharge.

Another important consideration when testing battery chargers is the selection of batteries for the test. The test provides a decision path for finding the correct battery or series of batteries to use to test battery charger. For example, if the charger is always sold with a particular battery, it should be tested with that battery. For a few cases, such as multi-chemistry chargers, either the manufacturers can provide batteries with the battery charger to the test lab or test labs themselves can select suitable battery packs.

The small battery charger test procedure yields four primary results: 24-hour energy consumption, maintenance mode power, power factor, and no battery mode power. The 24-hour test connects the charger with a properly discharged battery and measures the following 24-hours of power. The maintenance mode power measures the power drawn by the battery charger when connected to a full battery. The no battery mode power measures the power drawn with no battery attached at all. The testing requires, as much as possible, that non-charger functions to be turned off in order to ensure that the test procedure is measuring the efficiency of a product's battery charger and not its other functions,

[18] http://www.efficientproducts.org/reports/bchargers/BatteryChargerSystemTestProcedure_V2_2.pdf

The large battery charger test procedure also measures no battery and maintenance power. Instead of measuring the 24-hour energy efficiency the test procedure for large chargers measures charge return factor. The test procedure measures the amount of energy delivered to a battery and compares it to the amount of energy the battery has to deliver to the end use product.

Staff is proposing some non-substantive changes to the test method. These changes are to correct grammatical and spelling errors; the corrected language appears at the end of the staff report.

In order to develop battery charger regulations, the Efficiency Committee issued a request to battery charger manufacturers in November of 2008 to submit test data for their battery charger systems using the California test procedure.[19] Ecos Consulting tested many battery chargers and collected test data to develop the proposed battery charger regulations. The resulting analysis is present in the CASE report.

## Lighting Control Test

The Energy Commission is not proposing any test methods for lighting controls. The proposed regulations for lighting controls are prescriptive and therefore can be evaluated without specific test methods.

## Estimated Energy Consumption for Battery Chargers in California

Battery charger systems consume a significant amount of statewide peak energy. Today, battery charger systems consume 7,128 GWh[20] per year in California. This and represents significant energy consumption across the industrial, commercial, and residential sectors. In addition, the energy drawn by battery chargers is growing significantly. The stock and sales section of Appendix B shows high annual growth rates for battery charger stock. According to the CASE report, California's battery charger compound annual growth rate (CAGR) is estimated to be 10 percent in 2010.[21] Energy Commission staff estimated per capita battery charger energy use, without any efficiency improvements, using the CASE report's 2010 CAGR for battery charger stock from 2009 through 2012 and using the CASE report's 2013 CAGR for the years 2013 through 2015. The results showed that 2015-charger ownership per capita would be 136 percent of 2009 levels.

The scope of the proposed battery charger regulations encompasses many products and their associated loads. The CASE report categorizes these products into 16 groups, which encompass the majority of battery charger products. The report estimates that the combined sale of battery

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19 http://www.efficientproducts.org/reports/bchargers/1413_Battery%20Charger%20System%20Test%20Procedure_V2_2_2_FINAL.pdf

20 Appendix B, baseline energy use

21 CASE Initiative Analysis of Standards Options for Battery Charger Systems, page 32

chargers is 57 million units in 2009. The total stock of battery chargers of all categories in California is estimated to be 170 million. Appendix B summarizes stock and sales estimates and provides per-unit electric consumption of battery chargers in California. These figures were used in the staff analysis of savings and consumption.

# Regulatory Approaches

## ENERGY STAR®

The U.S. Environmental Protection Agency's (EPA) voluntary ENERGY STAR® program was the first government program to specify efficiency levels for battery chargers. However, the ENERGY STAR′ version 1.0 specifications and test procedure address only a narrow range of small battery charger products in low power modes. The scope of the ENERGY STAR specification includes:

- battery chargers packaged with portable, rechargeable products whose principal output is mechanical motion, light, the movement of air, or the production of heat, for example small home appliances, personal care products, power tools, flashlights, and floor care products);
- stand alone battery chargers sold with products that use a detachable battery, for example, some digital camera and camcorder designs); and
- universal battery chargers intended to charge standard sized batteries including AAA, AA, C, D, 9-volt.

The ENERGY STAR specifications for battery chargers are under revision but no final specifications have yet been released. New ENERGY STAR specifications will help incentivize manufacturers to improve their products and lead to innovation of most efficient side of the battery charger spectrum.

While ENERGY STAR is an important voluntary program, its limited scope and exclusion of an active mode charge standard yields less energy savings than what is possible through the Energy Commission's proposed regulations. The ENERGY STAR has announced its intent to incorporate charge mode into a future battery chargers specification and is interested in reviewing the test procedure that has been adopted by the Commission.

Energy Commission staff considered the ENERGY STAR specification as a potential model for California standards but concluded that it does not take advantage of a large portion of the potential energy savings due to its limited scope in both covered products and in covered modes of operation.

## Federal Regulations and Test Method

Currently there are no federal energy efficiency standards for battery chargers. A provision requiring DOE to develop battery charger regulations was included in the Energy Independence and Security Act of 2007 (EISA). The battery charger provisions in EISA are as follows:

> "Battery chargers.—No later than July 1, 2011, the Secretary shall issue a final rule that prescribes energy conservation regulations for battery chargers or classes of battery chargers or determine that no energy conservation standard is technically feasible and economically justified."

The scope of the battery chargers standards contemplated by DOE in its current rulemaking proceeding is limited to consumer battery chargers. The energy commission's scope includes both consumer and non-consumer battery chargers.

In 2006, DOE adopted a test procedure for battery chargers. This procedure tests battery chargers for consumer products only in standby mode, and not in active or maintenance mode. This test method preempts the Energy Commission's procedure to test the consumer products in multiple modes. However, in April of 2010, DOE issued a Notice of Proposed Rulemaking to adopt a battery charger test method for consumer products that relies heavily on Part I of the Energy Commission-adopted test method—including active and multiple output modes. DOE has not yet issued a final rule regarding a revised test procedure.

DOE released its framework document in June 2009 and a preliminary analysis Technical Support Document (TSD) in September of 2010, laying out its approach for a federal energy conservation standard for consumer battery chargers. Large battery chargers and non-consumer chargers are not in the scope of the federal proceeding. The TSD outlines an approach that differs in many ways from the CASE report. There are two critical divergences in the approaches: regulated metrics and product categories. The TSD proposes to regulate battery chargers based on an annual energy use calculation as opposed to the four metrics in the CASE report of 24 hour, maintenance, power factor, and no battery mode. Using the annual energy use method would require an additional set of assumptions about product duty cycle. Energy Commission staff have concluded that the proposed regulations cover a broad array of products with different duty cycles and that the DOE approach is unable to address this issue. In addition staff have concluded that the duty cycles, closely tied to consumer behavior, are likely to evolve with time and that standards based on specific duty cycles are not appropriate.

To address the differences in duty cycles, battery capacities, and technologies the TSD suggests 10 product categories for consumer products as opposed to the Energy Commission's three. This means that the TSD proposes ten separate standards are appropriate to cover consumer battery chargers. Because the Energy Commission's proposed standards do not require duty cycle assumptions to calculate standards, unlike the TSD approach, the need to subdivide the standards is negated. The proposed standards ensure efficiency in all modes of battery charger operation, regardless of duty cycle. The TSD approach only ensures efficiency for products when consumers use them according to imprecise duty cycle estimates. Staff have therefore proposed to take the regulatory approach outlined in the CASE report rather than the approach outlined in the DOE TSD.

Staff estimate that by July of 2011, the battery charger regulatory proposals from DOE and California will be available. There is potential that these standards will vary in stringency, causing manufacturers of consumer products to meet different standards within a relatively short timeframe. However, these differences do not necessarily require manufacturers to go through two different redesign and production change processes. Because both standards will be available, the manufacturers can simply design their products to meet the more stringent standards. However, since DOE has not yet issued a Notice of Proposed Rulemaking (NOPR) defining its proposed regulations, the Energy Commission will re-evaluate the impacts to manufacturing redesign from federal versus Californian standards once the NOPR is released.

### The CASE report

The California IOUs submitted a CASE report to the Energy Commission for consideration in standards development. Staff have analyzed the proposal in the CASE report to determine whether it meets the legislative criteria for Commission prescription of appliance efficiency standards. Staff have proposed a slightly modified regulation from the proposal contained in CASE report, in part based on with stakeholder comments received during and after the staff workshop held on October 11, 2010, on this CASE report. The sections below describe the staff analysis and modified proposal.

### Stakeholder's Input

Staff have analyzed stakeholders' comments on the CASE report and provided responses to those comments in Appendix C, Response to Stakeholder Comments, of this report. Staff have issued a request to all stakeholders to provide information and data. Staff will analyze the data submitted and, if appropriate, make changes to the proposed regulations.

## Savings and Cost Analysis

The proposed battery charger regulations represent a significant energy savings opportunity. Table 1 summarizes the short- longer-term energy and peak reduction potential for battery chargers regulations. According to the CASE report, battery charger regulations have the potential to reduce peak demand by 361 MW. The model developed by staff and outlined in Appendix B estimates savings of 2,038 GWh of energy per year with existing stock that is fully compliant with the proposed regulations. The existing stock number is based on the estimated number of all categories and types of battery chargers that are currently in use in California. The existing stock replacement number refers to design life for each category type.[22] This is calculated by summing the stock savings for each product type. These savings amount to $300 million a year in reduced utility costs at the rate of $0.14 per kWh. The savings do not include assumptions based on savings once a federal standard preempts the state standards as the federal standards are currently unknown.

Staff have calculated the peak energy savings/hours in a year are 2100GWh/8760 hours = .24 GW which is the same as 240 MW. This calculation is based on the assumption that battery charger's load profile is completely flat and energy would be evenly generated over the entire year to provide electricity for battery chargers. Staff recognizes that this is a conservative estimate of peak load inputs.

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[22] http://www.energy.ca.gov/appliances/battery_chargers/documents/2010-10-11_workshop/2010-10-11_Battery_Charger_Title_20_CASE_Report_v2-2-2.pdf Table 17, page 43

**Table 1: Statewide Annual Energy Savings***

| Category | First year peak reduction (MW)* | First year energy reduction (GWh) | Stock peak reduction (MW)* | Stock energy reduction (GWh) | Stock Energy Savings ($)** |
|---|---|---|---|---|---|
| **Small Chargers** | 64.8 | 335 | 322 | 1805 | 253 M |
| **Large Chargers** | 3.5 | 25 | 39 | 343 | 48 M |
| **Total** | 68.3 | 360 | 361 | 2038 | 301 M |

*Savings are based on the Tier 2 level of large chargers and are based on 2013 stock and sales projections. The first year and stock savings are totals of product categories in appendix B.
**Stock Energy Savings assumes a cost of $0.14 per kWh
*** Peak reductions are taken from the CASE report.

The CASE report also shows that the proposed regulations are highly cost effective with payback generally occurring in the first year. Table 2 summarizes the unit cost effectiveness of the proposed regulations based upon an aggregated version of Table 18 in the CASE report.

**Table 2: Unit Energy Savings and Cost Effectiveness**

| Category | Design Life (Years) | Annual Unit Energy Savings (kWh/year) | Incremental Cost of Improvement Per Unit ($) | Average Annual Present Value Savings ($)** | Simple Payback Period (Years) | Life Cycle Benefit ($) |
|---|---|---|---|---|---|---|
| **Small Chargers** | 3.3 | 11.5 | $0.30 | $0.78 | 0.4 | 2.27 |
| **Large Chargers** | 15 | 2,509 | $342.86 | 327.30 | 1.05 | 4566.64 |

*Unit analysis done for proposed small chargers and Tier 2 large chargers regulations.
**Present value calculated using 3% discount rate and $0.14 per kWh

The values shown in Table 2 are averages for the small and large charger categories. The design life, incremental cost, and savings derived for the most common products in each category were aggregated into this table by averaging sales weight. The cost-effectiveness for each product category is analyzed in appendix B table B-6. The average annual present value savings is calculated by totaling avoided expenses of $0.14 per kWh, discounted at 3%[23] for future savings, and dividing by the design life. The simple payback is the incremental cost divided by the average annual present value savings. This payback estimate is conservative because the first year savings will be greater than the discounted average savings. The life cycle benefit is the difference between the average annual present value savings multiplied by the design life and the incremental cost of improvement per unit.

The savings estimates compare baseline product category energy consumption with the energy consumption under the proposed regulations including current compliance rate estimates. For statewide estimates, these savings are multiplied by sales for first year figures and by California stock for stock figures. The details of these calculations are available in appendix B.

While the incremental cost of some products may increase depending on what approach manufacturers take to comply, the energy savings over the life of the products will recover more than these costs. Some examples of incremental cost included in CASE report include the following:

- Improving the efficiency of a low power product like a cordless phone or power tool can cost less than $1.00, because changes can be as simple as swapping out linear power supplies with switch mode supplies. For a total incremental cost less than $2.00, switch controlled current regulating components, usually DC-to-DC converters, can be incorporated to significantly reduce maintenance and no-battery losses.
- A battery charger can be totally redesigned and brought to market at an incremental manufacturing cost near zero. By replacing some components with more efficient ones, incremental costs near $0.40 are common.

The estimated costs of compliance for each product category are summarized in Appendix B Table B-6. The CASE report estimates zero incremental consumer cost for products in categories where significant numbers of competing products already on the market meet the standard. As indicated in Table 5, the manufacturer does not totally redesign the products, the cost to comply is more than offset by the energy savings over the life of the product. The annual savings as the result of the regulations that are estimated in Table 4 are $347 million.

# Battery Charger Regulations: Technical Feasibility

The proposed battery chargers regulations are based on the premise that after the battery has been recharged the battery charger should shut off the flow of electricity. Many battery-equipped products have a battery charger that continues to provide charge current to the battery after it is fully charged. The continuous current heats the fully charged battery resulting in wasted energy and potentially damaging the battery itself. There are battery charger systems

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[23] 3% discount rate is based on http://www.energy.ca.gov/appliances/2009_tvregs/documents/comments/TN%2053907%2011-2-09%20Discussion%20of%20Cost%20Effectiveness%20Calculations_1.pdf

currently on the market, across most product categories and price levels, that have already addressed the problem by including relatively inexpensive charge sensors and switches in their product designs. This capability can be implemented with inexpensive off the shelf technology that will not require major redesign of products regulated under the proposed standard. In summary, the proposed regulations will not require new technology development and can use existing switch technology to turn power on/off.

It is also important to point out that many battery chargers on the market today already meet the proposed standards at competitive price points. These products represent best practices for energy efficiency and clearly demonstrate feasibility. In fact, the proposed regulations are based largely upon data from laboratory test results of battery chargers on the market using the Energy Commission's test procedure.

Figure 1 below demonstrates the concept of choosing a standard that contemplates the use of existing efficient technologies in order to phase out the less efficient technologies. The red bars highlight products that meet the regulations and the blue squares outside of the line represent products that do not meet the regulations. The regulations are also technology-neutral in the sense that the levels are sufficiently stringent to improve efficiency but not so stringent as to eliminate an important battery charger type.

## Figure 1

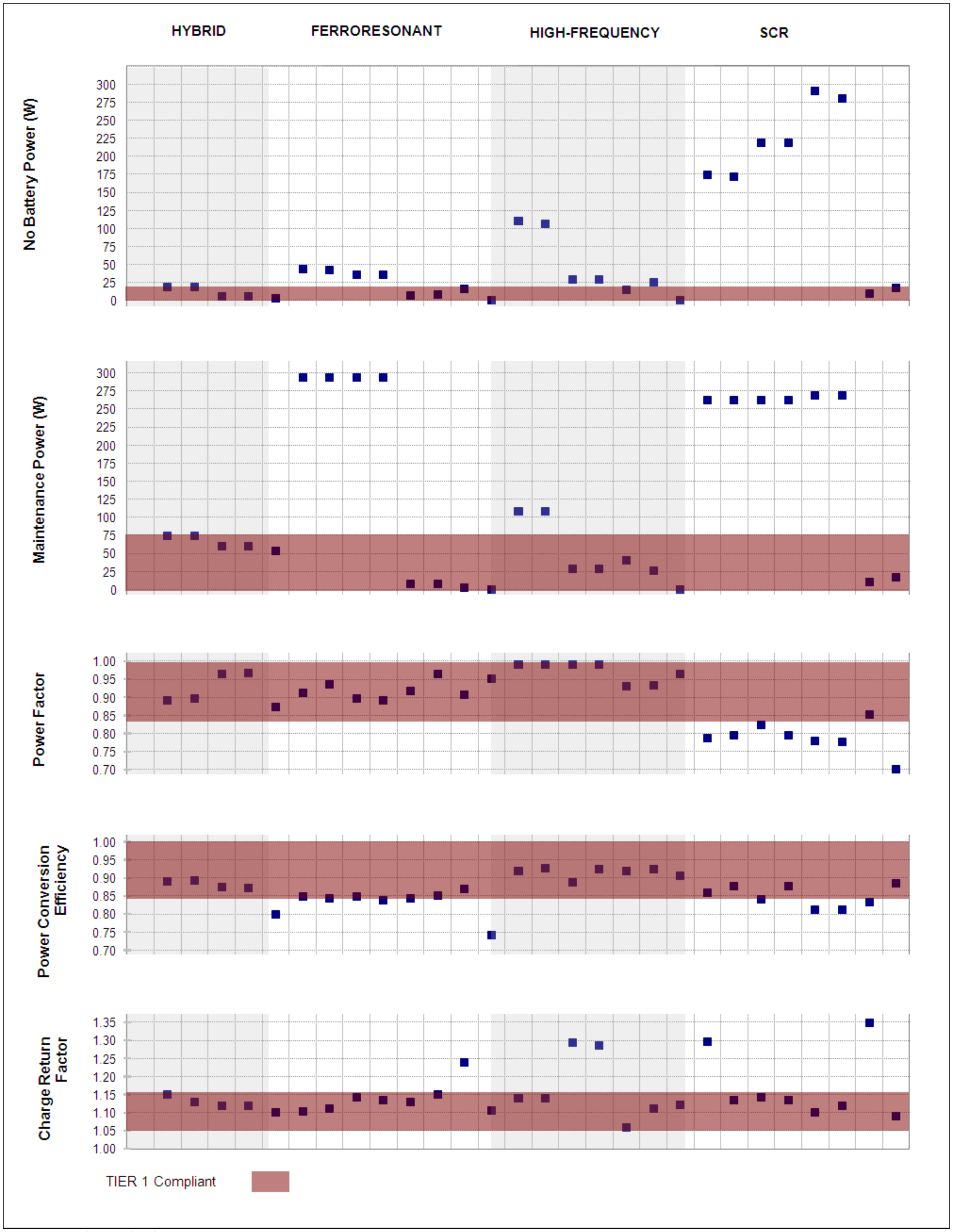


*Figure 8 of the CASE report, page 26

The CASE report discusses the many strategies available to battery chargers manufacturers and designers to significantly improve the efficiency of power conversion and charge control of each type of product. Small battery chargers use linear and switch mode technologies, whereas large battery chargers use switch mode, ferroresonant, and silicon controlled rectifier (SCR) technologies. Designers of rechargeable batteries often do not focus on the amount of energy consumed in the process of converting AC electricity from the utility grid into DC electricity stored in the battery. By implementing simple strategies to improve battery-operating efficiency, designers can meet their product performance requirements and also meet the efficiency standards proposed in the regulations. The following performance factors must be considered to design an efficient charger:

- High power conversion efficiency;
- Low power in maintenance mode;
- Low power in no-battery mode;
- High power factor;
- Narrow range of charge return factor; and
- Charger responding appropriately to partial discharge, interrupted charging

The CASE report used a study conducted by Ecos and the Electric Power Research Institute (EPRI) that found tremendous variation in the efficiency of battery chargers while charging or maintaining charge in connected batteries, and in the amount of power that chargers draw when no batteries are connected.[24]

Based on that study, Ecos developed a technical report for the Energy Commission titled *Research Findings on Standards for Battery Charger Systems and Internal Power Supplies*.[25] This document identifies design choices that impact charger efficiency and notes the following components or methods that can lead to higher efficiency in battery chargers:

- Use of higher-voltage systems;
- Use of efficient, switch-mode power supplies;
- Use of improved semiconductor switches to stop charging when batteries are full;
- Battery chemistries with higher coulombic efficiencies[26] and lower self-discharge rates; and

[24] http://www.esource.com/esource/getpub/public/pdf/cec/CEC-TB-44_BatteryChargers.pdf
[25] http://www.energy.ca.gov/2007publications/CEC-500-2007-091/CEC-500-2007-091.PDF

[26] Coulombic Efficiency is the ratio between the energy removed from a battery during discharge compared with the energy used during charging to restore the original capacity.

- Lower current rate for charge and discharge cycles.

Although all of these approaches can be applied to battery chargers, the best approach will differ depending on the product type and manufacturer's design. Staff acknowledges that each business will need to consider multi-faceted inputs to make this decision. Therefore, staff does not propose to mandate which path is best for businesses. The technology neutral approach of the proposed regulations leaves the path of compliance up to the manufacturer.

Based on an analysis of the CASE report and DOE's TSD data, Energy Commission staff conclude that there are no technical barriers preventing the development of battery chargers with higher energy efficiency. In fact, in the savings and cost analysis portion of this report staff have found that more efficient battery chargers will result in a positive net financial gain to consumers.

Additionally, some stakeholders submitted comments on CASE report alleging deficiencies in the CASE report. Staff have provided responses to those comments in Appendix A, Response to Stakeholder Comments.

The proposed regulations can be met by replacing the charge current controller in the battery chargers circuitry with a comparator[27] and a transistor used as an on/off switch. Component costs are generally below a dollar.[28] Additionally, highly efficient technologies exist that could sharply reduce electric power consumption in battery chargers without negatively affecting the ability to charge batteries quickly and to full capacity. Smart chargers use a microprocessor to monitor temperature, voltage, and state of charge, which allows them to optimize the charging cycle. Numerous improvements in existing battery technologies have made batteries safer to operate, while increasing charge capacity and energy density, and reducing the charging time. New developments and technologies in batteries are leading to an increase in the use of batteries in electrical and electronic devices. An efficient battery charging system is a critical component in the successful operation of battery-operated devices. The proposed battery chargers regulations will help to accelerate this transformation and will help to reduce California's power consumption.

## General Strategies to Improve Efficiency of All Charge Control Technologies

The proposed regulations for most battery chargers can be met by implementing straightforward design changes. These concepts include turning the charger off when the

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Coulombic efficiency actually refers to charge (coulomb) efficiency, not energy efficiency

[27] Comparator is a device that compares two voltages or currents and switches its output to indicate which is larger.

[28] http://www.analog.com/en/amplifiers-and-comparators/current-sense-amplifiers/adm4073/products/product.html (Example: comparator d circuit has more functions than what is needed to control the charge current. Cost per unit is $0.99 ¢ based on an order of 1000 units)

battery is fully charged and implementing hysteresis during charging. Many simple cost effective solutions are available to manufacturers to turn the battery chargers off after the batteries are charged to full capacity.

The least efficient chargers on the market today continue to provide charge to fully charged batteries. This is detrimental both to the battery life, product safety, and to the consumer's electricity bills. Figure 2 below shows the profile of an inefficient battery charger.

**Figure 2**

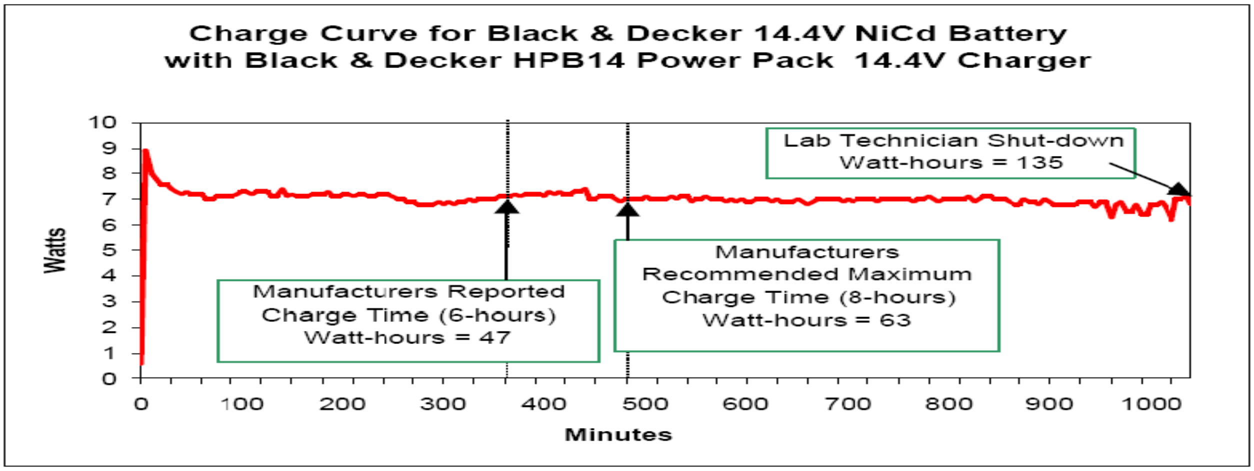


Figure 1 demonstrates the results of a test conducted by Ecos Consulting.

In the graph above, the battery charger consumes approximately 0.5 watts in no-battery mode and an average of seven watts in charge mode. During a 24-hour test, this charger would yield 168 watt-hours of energy. The battery capacity is 36 watt-hours yielding a result of 21% in 24-hour efficiency test and would not meet the proposed efficiency standard in the regulations. If the charger were to turn off after the maximum charge time, the test would yield 64 watt-hours and a 56.25% 24-hour efficiency and which would meet the proposed standards.

This transition from a high power charge mode to a low power mode can be implemented using a comparator and transistor as an on/off switch. This switch can also be automated using a timer, a temperature sensor, a voltage sensor, or any number of other open or closed control systems.

Maintenance mode is necessary due to an electrochemical process called self-discharge. This internal process causes the battery to lose charge over time. This self-discharge rate varies by state of charge, chemistry, temperature, and battery design. To keep batteries charged a charger might incorporate a maintenance mode that re-energizes the batteries to replace the self-discharge losses. The self-discharge is particularly acute at the maximum capacity of the battery and follows an exponential charge decay curve.

Self-discharge rate is typically small over the first 24-hour period. A 0.5 maintenance mode is feasible for products designed to charge high capacity batteries. The extreme case is a charger designed to charge batteries with a capacity of 1000 watt-hours, the maximum capacity within the scope of the proposed small charger regulations. If one assumes a charge efficiency of 70%, a battery capacity of 1,000 Wh, and a self-discharge rate of 0.56% per day (extrapolated from a monthly self-discharge rate[29]) a reasonable power allowance for maintenance mode can be calculated as $1000 \times \frac{0.0056}{0.7 \times 24}$ yielding 0.33 watts. Paired with a power supply that consumes 0.17 watts in no battery mode this extreme case can meet the proposed standards.

Some chargers are designed to counteract self-discharge by constantly charging the battery to maintain energy storage. These chargers are called "trickle chargers" and are the type of chargers that will draw more power in maintenance mode than in no-battery mode. The proposed regulations for maintenance mode are based upon some basic assumptions. First the larger the battery's capacity the greater the power necessary to maintain that battery. A 3 percent daily discharge rate, 70 percent charge efficiency, and the no battery mode power of charger were used to derive the standard formula. The maintenance mode test measures the average power over the last 4 hours of the test and the result is applied to a fully charged battery.

- Lowering charge current reduces charge mode and maintenance-mode power levels and heating losses.
- Battery sensing circuitry reduces the no-battery mode power, reduces unnecessary overcharge energy usage, improves charge return factor, reduces heat in the battery and can lengthen battery life.
- Higher internal system voltage reduce resistive and conversion losses and may reduce system current. (Geist, Kameth, et al., 2006)
- Reduced fixed energy consumption reduces no-battery mode power and energy usage overall.

In conclusion, the proposed regulations can be met without limiting the overall technical approach to battery charging. The following details some of the technology solutions that will help improve efficiency of large and small batteries chargers.

- Linear Design
  - Using full wave rectifiers instead of half wave rectifiers can drastically improve efficiency. Full wave rectifiers deliver twice the output power therefore full wave rectifiers are more efficient than half wave rectifiers.
  - Replacing linear power supplies with switch mode power supplies can easily and cost-effectively improve the 24-hour efficiency of small chargers by nearly 15 percent

[29] Isidor Buchman, Batteries in a Portable World, 2nd Edition, Cadex Electronics, 292 pp, 2001: NiCd loses 40% in 3 months, NiMH loses 10% in 1 month, Li-Ion loses less than half that of NiCd and NiMH, so say ~0.15% loss/day, sealed lead acid loses 40% in 12 months; all daily self-discharge values are calculated assuming simple exponential decay.

(Geist, Kameth, et al., 2006) Any efficiency improvement in power conversion will cascade energy savings in all three modes of battery charger operation: charge, maintenance, and no battery.

- o Substituting the entire linear battery charger with a switch-mode design, including the power supply and the charge regulating elements or some form of charger termination, can improve 24-hour efficiency by around 40 percent, while simultaneously reducing battery maintenance and no battery mode power. (Geist, Kameth et al. 2006)

- Switch Mode:

  Switch mode chargers can be made more efficient through sophisticated design methods, including:

  - o Hysteresis charging

    Hysteresis is a property of physical and chemical systems that do not instantly follow the forces applied to them, but react slowly, or do not return completely to their original state. Example: In the case of magnetic systems, when an external magnetic field is applied to a magnetic material, the material becomes magnetized, absorbing some of the external field. When the external field is removed, the material remains magnetized to some extent, retaining some magnetic field.

    Hysteresis can reduce energy usage in maintenance mode by using short pulses of high current to maintain the battery's voltage.

  - o Resonant switching configuration: in charge mode, this configuration can reduce switching losses in larger battery chargers with switch-mode power supplies. In this circuit design, power transistors switch on and off at the precise time that the voltage or current passes through zero, reducing heating loss in the transistors. (Geist, Kameth, et al., 2006).

  - o Synchronous rectification: Synchronous rectification can reduce voltage drop and thus power losses in the power supply by using a transistor to conduct during certain cycles of operation as opposed to a diode.

  - o Charge control: Battery charge control can use current and voltage regulating circuits.

  - o Periodic maintenance: With a combination of battery voltage sensing circuitry and the switching controlled energy delivery, switch mode systems can provide periodic maintenance to batteries, as opposed to constant unchecked battery maintenance.

- Ferroresonant

  - o Ferroresonant chargers operate by way of a special component called a ferroresonant transformer. The ferroresonant transformer reduces the voltage from the wall outlet to a lower regulated voltage level while simultaneously controlling the charge current. A rectifier then converts the AC power to DC power suitable for the battery.

    Greater efficiency in ferroresonant chargers can be achieved by incorporating hybrid technology to optimize the magnetic flux coupling in the transformer to improve power conversion efficiency. This technology significantly improves the efficiency of battery chargers

- Silicon-Controlled Rectifier (SCR)
  - SCR chargers can be made more efficient by reducing switching losses by incorporating higher switching frequencies.

    SCR chargers are likely to be supplanted by more technologically advanced and efficient high frequency, insulated gate bipolar transistors (IGBT) based chargers. High-frequency chargers have much lower switching losses and thus much better power conversion efficiency. Incorporating high efficiency switching significantly improves the efficiency of SCR battery chargers.

## Inductive chargers

Inductive chargers are a unique class of product. The key difference between inductive chargers and other chargers is in its wireless power supply. In some products, such as toothbrushes, wireless power delivery provides a great deal of utility, like avoiding contact corrosion products which are particularly exposed to water and chemicals. This method of power delivery is inherently less efficient than direct wiring. This applies to charge efficiency, maintenance mode, and no battery modes. To ensure the feasibility of implementing inductive charging in this specific case the Energy Commission staff have proposed alternative compliance options for inductive chargers.

The staff does not intend for this alternative compliance option to be used for inductive chargers that are implemented only as a matter of convenience and for which direct wire chargers are readily available. For this reason, the scope of the alternative compliance option is limited to small capacity batteries, similar to those that would be found in hygiene products.

## Legacy Systems

For some systems, the lifetime of the battery charger is shorter than the lifetime of the battery and/or end use product. The proposed regulations require that more efficient battery chargers replace the inefficient original chargers once they fail. Requiring replacement chargers to be efficient will enhance the life of the batteries, as described in the environment and safety section of this report. While efficient chargers are suitable for older products, just as they are for the new products, staff have determined that a five year replacement part exemption is appropriate to address unforeseen compatibility issues.

## Power Factor

An AC power supply draws power from the plug and converts it to DC. This draw of AC power results in significant loss of power in the building's distribution wiring that connects the breaker box and the outlet. Devices with a low power factor (especially non-linear switch mode power supplies) draw more current than is required. This results in more wiring loss as heat

Improving power factor is straightforward and relatively low cost for most battery charger systems. The technique is to reduce current and voltage distortion (created by the charger), as well as reduce the peak current (drawn by the charger).

With multiple devices on a circuit, the peak currents can easily be 20 to 30 amps during time of heavy usage. The $I^2R$ resistive losses would be 200 to 450 watts. These peaks have a rather small duty cycle, so the average power loss on a circuit may be 10 to 30 watts. Power factor losses of 11 to 57 watts per circuit have been measured for computers in commercial settings.[30] Considering a few circuits per household and several hours per day of heavy use, the total energy loss in California is likely between 500 and 2,000 GWh/yr. This could be reduced by 50 to 80 percent if all the devices were power factor corrected. Improved battery charger efficiency (even without improving power factor) will result in savings due to the lower total current being drawn. These savings are expected to be 50 to 200 GWh/yr.

In order to achieve these savings staff propose two levels of power factor correction. As mentioned above, power factor savings are directly related to the magnitude of current drawn by the device. Therefore, for devices which draw an average current of one amp or more will need to meet a power factor level of 0.9. Because devices which draw less power do not benefit as greatly from power factor, devices which draw less than one amp on average will need to meet a power factor level of 0.6.

## Techniques to Improve Power Factor

The power factor (pf) of an AC electric power system is defined as the ratio of the real power flowing to the load to the apparent power, and is a dimensionless number between 0 and 1 (frequently expressed as a percentage, for example, 0.5 pf = 50 percent pf). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Low power factors are a result of the fact that many battery chargers draw their input power in brief, high current spikes. This leads to significant loss in resistance because of extremely high current.

Power factor is a measure of the efficiency with which a load uses the current supplied to it. Many battery charger power supplies are non-linear devices, and these have a low power factor of ~0.4 and can easily improve. Devices that have a low power factor result in significant wiring power loss. It is essential to include requirements for a minimum power factor for some chargers, and therefore the Energy Commission has included proposed regulations to address power factor, which are estimated to save between 150 and 575 GWh per year.[31]

Two simple techniques to improve power factor are considered here. The first is selection of an appropriate filter capacitor. If manufacturers use a smaller capacitor and allow more ripple voltage [32]on the capacitor, the rectifier will conduct for a longer time, resulting in lower peak currents. Ripple voltage is a problem for linear power supplies, but not for switch mode supplies.

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[30] Fortenbery and Koomey 2006

[31] CASE Initiative Analysis of Standards Options for Battery Charger Systems

[32] The most common meaning of ripple in electrical science is the small unwanted residual

Since many of the battery chargers tested have power factors as low as 0.35, it is likely that this design option is not being used consistently and should be widely encouraged for even the smallest battery chargers. [33]

The second technique considered is to use 120 Hz pulse mode charging. The goal here is to achieve a power factor near unity. A unity power factor means that the load appears resistive and the input current is proportional to the input voltage. The input power should be 120 Hz sine-squared pulses.

# Battery Safety and Environmental Issues

Proper charging of a battery pack is essential to ensure the safe operation and efficient charging of portable electronic devices. Sufficient voltage and current at an appropriate charge must be supplied to the batteries so that cells can be fully charged and perform optimally. Too much charge delivered too quickly to a battery can cause permanent damage to the battery and makes some batteries unsafe due to overheating. An intelligent battery charger system design allows chargers to precisely and safely charge batteries and also allows chargers to efficiently use energy in both charge and maintenance modes.

Efficient charging may increase the lifespan of batteries because it reduces damage to battery cells caused by heat and undesirable electrochemical reactions associated with a constant trickle charge to the battery. Heat and undesirable electrochemical reaction result in battery material loss and chemical changes that affect the electrical performance of the battery cell and cause irreversible damage to the cell. Improving the lifespan of the battery helps in reducing the amount of chemical waste generated from batteries.

Today, most widely-used batteries in portable devices are nickel metal-hydride (NiMH), and lithium ion (Li-ion). This is partially because NiMH have become cheaper and Li ion are lighter weight than the formerly dominant nickel cadmium (NiCd) chemistry. NiCd and Sealed Lead Acid (SLA) batteries are still used in many applications and the material inside of them are hazardous and toxic. Li-ion and NiMH have low toxicity and are less hazardous. It is environmentally advantageous regardless of chemistry to increase the longevity of battery life and reduce the volume of batteries entering landfills or otherwise discarded.

The widespread use of batteries has created many environmental concerns, such as toxic metal pollution. In 1996, Congress passed the "Mercury-Containing and Rechargeable Battery Management Act." that banned the sale of mercury-containing batteries in the United States with an exception for small button cell batteries. California prohibits the disposal of rechargeable batteries in solid waste and requires recycling of cell phones. The rechargeable battery industry has nationwide recycling programs in the U.S., with drop-off points at many local retailers.

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[33] CASE Initiative Analysis of Standards Options for Battery Charger Systems Page 64

# Proposal for Battery Charger Regulations

Energy Commission staff have analyzed the approach proposed in the CASE report and evaluated the cost effectiveness and feasibility of implementing the regulation in California. Staff also determined that the fundamentally different approach outlined in DOE's TSD would lead to less energy savings in California than the proposed in this report. The dollar savings resulting from reduced energy consumption based on the proposal in the CASE report are greater than the cost of compliance as shown in the staff analysis in Appendix B. The proposed regulations are attainable through multiple off the shelf, inexpensive technologies as demonstrated in the technical feasibility section of this report. Based on these conclusions, the proposed regulations establish standards for the primary modes of operation which will result in a reduction of wasted energy.

As the proposed regulation has been determined to be cost effective, feasible, and will save significant energy staff did not consider standards that are less stringent than those proposed in the CASE report. The staff also did not consider standards that are significantly more stringent due to the broad scope of the standard. The proposed standards cover a wide variety of products and while a more stringent standard may be feasible for a subset of these products, there will be some products for which the standard is not cost effective. This would therefore violate the Energy Commission's statutory standards prescription criteria. Staff recognize that more stringent standard levels would yield higher energy savings. However, staff are concerned about the effect of more stringent regulations on technology neutrality, which would not be consistent with the goals of minimizing negative impacts on manufacturing.

Battery chargers were identified in Public Interest Energy Research (PIER) study conducted by Ecos Consulting as one of the products that wastes significant electricity and has large energy savings potential. The CASE report is based on battery charger active, maintenance, and no battery mode test data. Additionally, the CASE report analyzed battery chargers market data, product duty cycle, product design life and feasible technology analysis. The CASE report recommends that the Energy Commission adopt proposed standards, which are feasible, cost effective, and will save California consumers approximately 2,038 GWh a year. Commission staff analysis of the CASE report shows that the proposed regulations will improve overall battery charger efficiency by approximately 40 percent. Staff have conducted analysis of the available data and information and conclude that the proposed regulations are cost effective and feasible as is shown in the cost benefit analysis section of this report. There are many cost effective technology solutions and off the shelf parts available to manufacturer to comply with the proposed regulations. Staff is proposing a technology-neutral standard for large, small, and inductive battery chargers. A small charger standard would address both consumer and non-consumer chargers. If the Energy Commission adopts regulations by June, 2011, as is called for under the scheduled developed by staff, the efficiency standards would apply to products manufactured on or after as soon as July of 2012 . A separate standard for larger battery chargers would address non-consumer products and would be scheduled to take effect in two phases. Proposed Tier 1 regulation would be effective for products manufactured on or after July of 2012. Tier 2 regulations would be effective for products manufactured on or after July of

2013. Tier 2 would require operational efficiencies comparable to the most efficient designs currently in the marketplace.[34]

The proposed large battery charger regulations are outlined in Table 1 below. The first standard, called “Charge Return Factor,” measures the amount of energy applied to the battery versus the amount of energy extracted from that battery. This measures losses occurring in the battery during charging. The “Power Conversion Efficiency” is the charger’s efficiency in converting high voltage alternating current into lower voltage direct current and measures the losses occurring in the circuitry during charging. “Power Factor” is a measure of how well the charger is able to synchronize with the utility’s 60-Hertz cycle. Energy losses from poor synchronization occur in the wiring supplying power to the product. “Maintenance Power” is the amount of power the charger draws to keep a battery at full charge. Energy losses in maintenance mode are in both the charger circuitry and the battery. “No Battery Power” is the amount of power the charger draws when no battery is attached at all and the charger is in standby mode. The energy losses in no battery power mode occur in the charger circuitry.

**Table 3: Large Charger Proposed Regulations**

| Performance Parameter | | Tier 1 | Tier 2 |
|---|---|---|---|
| Charge Return Factor | 100 percent, 80 percent DOD | $C_{rf} \le 1.15$ | $C_{rf} \le 1.10$ |
| | 40 percent DOD | $C_{rf} \le 1.20$ | $C_{rf} \le 1.15$ |
| Power Conversion Efficiency | | Greater than or equal to: 84 percent | Greater than or equal to: 89 percent |
| Power Factor | | Greater than or equal to: 0.85 | Greater than or equal to: 0.95 |
| Maintenance Power | | Less than or equal to: 75 W | Less than or equal to: 10 W |
| No Battery Power | | Less than or equal to: 20 W | Less than or equal to: 10 W |

*DOD means depth of discharge.

The proposed regulations for small battery chargers are similar to those for large battery chargers. The power consumption limits are lower because of the smaller capacity of the chargers and batteries involved. In addition, the charge mode and maintenance mode of small battery chargers are measured together over a 24-hour period rather than separately as is measured for large battery chargers. During the pre-rulemaking process for battery chargers test method, the Energy Commission developed energy measurement criterion through stakeholder participation. Most stakeholders concluded that this was the best approach to

[34] CASE Initiative Analysis of Standards Options for Battery Charger Systems

reflect small battery charger consumption.[35] The proposed regulations for small battery chargers can be found in Table 2 below.

**Table 4: Small Charger Proposed Regulations**

| Performance Parameter | Standard |
|---|---|
| 24-hour charge and maintenance energy (Wh) | Less than or equal to: 12 +1.6$E_b$ ($E_b$ = battery capacity) |
| Maintenance Power | Less than or equal to: 0.5 W |
| No Battery Power | Less than or equal to : 0.3 W |
| Power Factor | Depends on rms (root mean square) input current |

The proposed regulations for inductive chargers are for the most part the same as those in Table 2. However, there are some products where inductive losses relative to battery capacity are high enough to make meeting the generic small charger regulations unrealistic. Therefore, this proposal includes an alternative compliance method for inductive chargers. Proposal has an alternative compliance method outlined in Table 3. This alternative compliance method is proposed based on the consideration that inductive chargers are commonly used in high moisture applications, such as personal care products, that are typically charged in bathrooms.

**Table 5: Inductive Proposed Regulations**

| Performance Parameter | Standard |
|---|---|
| 24-hour charge and maintenance energy (Wh) | 24 Wh |
| Maintenance Power | 1 W |
| No Battery Power | 1 W |

The efficiency standards for battery chargers are proposed to be effective for those products manufactured on or after July 1, 2012. This is sufficient time to incorporate off the shelf technologies in products to comply with those standards.

## Marking and Reporting

The Energy Commission requires certification of state- and federally-regulated products as part of compliance with the Appliance Efficiency Regulations. The certification process requires that manufacturers submit data specified in Section 1606 Table X for each unique model. However, there is an exception to this rule in case of external power supplies. Because of the large number of models, manufacturers, and designs associated with the products the Commission requires that these products be marked as meeting the regulations rather than certifying

[35] http://www.energy.ca.gov/appliances/battery_chargers/

compliance directly to the Commission. External power supply manufacturers are required to keep records of product testing in case any affected party challenges compliance. The external power supplies are required to place a "IV" mark on their products to indicate compliance with Sections 1605.1 and 1605.3.

The Energy Commission staff is proposing the same concept to small battery chargers as the proposed regulations include a similarly broad range of products. In this case the mark might be a small battery charger as "BC I," to signify that it is a battery charger that meets efficiency Tier 1, rather than the "IV" power supply mark. Commission staff estimates that marking requirements will reduce manufacturer costs, make it easier to determine if a product can be sold or offered for sale in California, and avoid the need to certify products through Commission's certification process. The currently proposed regulations do not include specific marking requirements but do include the data certification requirements. The Commission is proposing to use these marking requirements in place of certification and data collection.

## Lighting Controls

The Energy Commission is proposing to include regulations for lighting controls in the Title 20. Lighting control products have been required to be certified to the Commission under Title 24 for many years. Lighting controls regulated under Title 24 are currently being certified by manufacturers to the Commission and are included in the Commission's appliance efficiency database.[36]

Title 24 requires that both manual and automatic lighting controls be installed with lighting systems. Because the products are required to be certified under the provisions of Title 20, such products are not prohibited by law from being sold or offered for sale in California if they are not certified. By moving the lighting control regulations from Title 24 to Title 20, such products cannot be sold or offered for sale in California unless certified to the Commission and included in the Appliance Efficiency Database. This transfer will help to achieve the goals of Assembly Bill 1109, (Huffman and Feuer, chapter 534, status of 2007 (AB 1109) and other efficiency goals discussed in the policy section of this report.

Through discussions with the National Electrical Manufacturers Association's (NEMA) lighting control group, and other energy efficiency advocates, staff believes that industry supports moving the regulations for self-contained lighting control products from Title 24 to Title 20 to ensure that non-compliant products are not installed in buildings and homes. However, NEMA recommends that control systems consisting of many separate components should continue to be regulated under Title 24.

[36] http://www.appliances.energy.ca.gov/QuickSearch.aspx

# Appendix A: Proposed Regulations

Proposed new language appears as underline (example) and draft deletions appear as strikeout (~~example~~). Existing language appears as plain text. Three dots or "…" represents the substance of the regulations that exist between the proposed language and current language

**Section 1601. Scope.**

…

(v) Fluorescent Lamp Ballasts and Self contained lighting controls

~~Fluorescent Lamp Ballasts that are designed to:~~

~~1 operate at nominal input voltages of 120 or 277 volts,~~

~~2 operate with an input current frequency of 60 Hertz, and~~

~~3 be used with T5, T8, or T12 lamps; and mercury vapor lamp ballasts.~~

…

(w) Battery charger systems except those used to charge highway vehicles and excluding battery charger systems that are classified as devices for human use under the Federal Food, Drug, and Cosmetic Act and require U.S. Food and Drug Administration listing and approval as a medical device.

…

**Section 1602. Definitions.**

…

(j) **Fluorescent Lamp Ballasts and Self Contained lighting controls.**

"Astronomical time-switch control" means a lighting control device that controls lighting based on the time of day or based on astronomical events such as sunset and sunrise, accounting for geographic location and day of the year..

"Automatic time switch control" means a lighting control device that controls lighting based on the time of day.

"Demand responsive lighting control" means a lighting control device that reduces lighting power consumption based upon a demand response signal.

"Dimmer" means a lighting control device that varies the current through an electric light in order to control the level of illumination and the energy use..

"Dimmer, full range" means varying the light output of lamps over a continuous range from full light output to minimum light output.

"Dimmer, stepped" means varying the light output of lamps in one or more predetermined discrete steps between full light output and off.

"Lighting Control, Self Contained" means a unitary lighting control module where no additional components are required for a fully functional lighting control.

"Multi-Level Astronomical Time Switch" means an Astronomical Time Switch Control that reduces lighting power in multiple steps.

"Multi-Level Lighting Control" means a lighting control that reduces lighting power in multiple steps.

"Occupant Sensing Device" means a product that automatically controls light, allows for complete manual operation, and include the following devices:

Occupant Sensor, is used indoors, that automatically turns lights off when an area is vacated, and automatically turns the lights on when the area is occupied.

Motion Sensor, is used outdoors, that automatically turns lights off when an area is vacated, and automatically turns the lights on when the area is occupied.

Partial On, that automatically turns lights off when an area is vacated, capable of automatically turning on part of the lighting load and manually turning on part of the lighting load when an area is occupied.

Partial Off, that automatically turns off part of the lighting load when an area is vacated, and capable of automatically turning on the lighting load when an area is occupied.

Vacancy, that automatically turns lights off when an area is vacated and requires lighting loads to manually be turned on.

"Photo Control" means an automatic daylighting control device that automatically turns lights ON and OFF in response to the amount of daylight that is available. A Photo Control may also have the capability to provide a signal proportional to the amount of daylight to a Lighting Control System for the purpose of continuously dimming the electric lights.

(w) **Battery Charger Systems**

"~~Accumulated non-active~~ 24 hour charge and maintenance energy" means the sum of the energy, in watt-hours, consumed by the battery charger in battery-maintenance mode and ~~standby mode~~to charge the battery over time periods as defined in the applicable test method in Section 1604(w). This time period can exceed 24 hours.

~~"Active mode" means the condition in which the battery is receiving the main charge, equalizing cells, and performing other one-time or limited-time functions necessary for bringing the battery to the fully charged state.~~

"Battery" or "battery pack" means an assembly of one or more rechargeable cells intended to provide electrical energy to a consumer product, and may be in one of the following forms: (a) detachable battery: a battery that is contained in a separate enclosure from the consumer product and is intended to be removed or disconnected from the consumer product for recharging; or (b) integral battery: a battery that is contained within the consumer product and is not removed from the consumer product for charging purposes.

"Battery charger system" means a battery charger coupled with its batteries or battery chargers coupled with their batteries, which together are referred to as *battery charger systems*. This term covers all rechargeable batteries or devices incorporating a rechargeable battery and the chargers used with them. Battery charger systems include, but are not limited to:

i. electronic devices with a battery that are normally charged from AC line voltage or DC input voltage through an internal or external power supply and a dedicated battery charger;

ii. the battery and battery charger components of devices that are designed to run on battery power during part or all of their operations;

iii. dedicated battery systems primarily designed for electrical or emergency backup;

iv. devices whose primary function is to charge batteries, along with the batteries they are designed to charge. These units include chargers for power tool batteries and chargers for automotive, AA, AAA, C, D, or 9 V rechargeable batteries, as well as chargers for batteries used in larger industrial motive equipment.

v. The charging circuitry of battery charger systems may or may not be located within the housing of the end-use device itself. In many cases, the battery may be charged with a dedicated external charger and power supply combination that is separate from the device that runs on power from the battery.

"Battery energy" means the energy, in watt-hours, delivered by the battery under the specified discharge conditions as determined using the applicable test method in Section 1604(w).

"Battery maintenance mode (maintenance mode)" means the mode of operation when the battery charger is connected to the main electricity supply and the battery is fully charged, but is still connected to the charger.

"Energy ratio" or "non-active energy ratio" means the ratio of the accumulated non-active energy divided by the battery energy.

"Illuminated exit sign" means a sign that:

(1) Is designed to be permanently fixed in place to identify an exit; and

(2) Consists of:

(A) An electrically powered integral light source that illuminates the legend "EXIT" and any directional indicators; and

(B) Provides contrast between the legend, any directional indicators, and the background.

"Inductive charger" means a battery charger that transfers power from mains to the charger through magnetic or electric induction.

"Large battery charger" means a battery charger with a rated output power of more than 2 kilowatts.

"Multi-port charger" means a battery charger that is capable of simultaneously charging two or more batteries independently or charges multiple batteries at the same time with a single charge control circuitry. These chargers also may have multi-voltage capability, allowing two or more batteries of different voltages to charge simultaneously.

"Multi-voltage a la carte charger" means a separate battery charger that is individually packaged without batteries, and is able to charge a variety of batteries of different nominal voltages.

"No battery mode" means the mode of operation when the battery charger is connected to the main electricity supply and there are no batteries connected to the charger.

"Small battery charger" means a battery charger with a rated output power of 2 kilowatts or less. This category also includes golf cart battery chargers regardless of the output power.

"Standby mode (no-load mode)" means the mode of operation when the battery charger is connected to the main electricity supply and the battery is not connected to the charger.

…

**Section 1604. Test Methods for Specific Appliances.**

…

**(j) Fluorescent Lamp Ballasts and Self Contained Lighting Controls.**

…

**(k) Battery Charger Systems.**

(1) **Federal Test Method for Consumer Battery Chargers.** The test method for battery chargers is 10 CFR Section 430.23(aa) (Appendix Y to Subpart B of Part 430) (2008).

(2) **California Test Method for Battery Chargers.** The test procedure for battery charger systems is *Energy Efficiency Battery Charger System Test Procedure* version 2.2 dated ~~November 12, 2008~~ January 26, 2009 and published by ECOS and EPRI Solutions.

…

The following documents are incorporated by reference in Section 1604.

…

**ECOS CONSULTING**

| | |
|---|---|
| | Energy Efficiency Battery Charger System Test Procedure Version 2.2 dated ~~November 12, 2008~~ January 26, 2009 |
| Copies available from: | Ecos Consulting<br>1199 Main Avenue #242<br>Durango, CO 81301<br>http://www.efficientproducts.org/<br>Phone: (970) 259-6801<br>FAX: (970) 259-8585 |

…

**Section 1605.1. State Regulations for Federally-Regulated Appliances.**

…

(j) **Fluorescent Lamp Ballasts and Self Contained Lighting Controls ~~Replacement Fluorescent Lamp Ballasts~~.**

…

**Section 1605.2. Federal and State Regulations for Federally-Regulated Appliances.**

…

**(j) Fluorescent Lamp Ballasts and Self Contained Lighting Controls.**

…

**Section 1605.3. State Regulations for Non-Federally-Regulated Appliances.**

…

**(j) Fluorescent Lamp Ballasts and Self Contained Lighting Controls.**

**(1)** All lighting controls.

(A) A manufacturer shall provide step-by-step instructions for installation and start-up calibration of all lighting control devices.

(B) Indicator lights integral to lighting control devices shall consume no more than one watt of power per indicator light.

**(2) Automatic Time Switch Controls.**

(A) Residential and commercial automatic time switch controls shall have program backup capabilities that prevent the loss of the device's schedule for at least 7 days, and the device's date and time for at least 72 hours if power is interrupted.

(B) Commercial automatic time switch controls shall be capable of providing manual override to each connected load and shall resume normally scheduled operation after manual override is initiated within two hours for each connected load.

(C) Commercial automatic time switch controls shall incorporate an automatic holiday shutoff feature that turns off all connected loads for at least 24 hours and then resumes normally scheduled operation.

**(3) Astronomical Time Switch Control.**

(A) Shall meet the requirements of an automatic time switch control.

(B) Shall have sunrise and sunset prediction accuracy within +/- 15 minutes and timekeeping accuracy within 5 minutes per year.

(C) Shall be capable of displaying date, current time, sunrise time, sunset time, and switching times for each step during programming.

(D) Shall have an automatic daylight savings time adjustment.

(E) Shall have the ability to independently offset the on and off for each channel by at least 99 minutes before or after sunrise or sunset.

**(4) Automatic Daylighting Control.**

(A) Shall be capable of signaling or directly reducing the power consumption in response to measured daylighting.

(B) Shall comply with section 1605.3(j)(6)(ii) if the daylighting control is capable of directly dimming lamps.

(C) Shall automatically return to its most recent time delay settings within 60 minutes when put in calibration mode.

(D) Shall have a setpoint control that easily distinguishes settings to within 10 percent of full scale adjustment

(E) Shall have a light sensor that has a linear response within 5 percent accuracy over the range of illuminance measured by the light sensor.

(F) Shall have a light sensor that is physically separated from where the calibration adjustments are made, or is capable of being calibrated in a manner that the person initiating the calibration is remote from the sensor during calibration to avoid influencing calibration accuracy.

(G) Shall comply 1605.3(j)(5) if the device contains a photo control component.

**(5) Lighting Photo Control**

Lighting photo controls shall not have a mechanical device that permits disabling of the control

**(6) Dimmer Control**

(A) Shall be capable of reducing power consumption by a minimum of 65 percent when the dimmer is at its lowest level

(B) Dimmer controls that can directly control lamps shall provide electrical outputs to lamps for reduced flicker operation through the dimming range so that the light output has an amplitude modulation of less than 30 percent for frequencies less than 200 Hz without causing premature lamp failure.

(C) Wall box dimmers and associated switches designed for use in three way circuits shall be capable of turning lights off, and to the level set by the dimmer if the lights are off.

(D) Shall include an off position which produces a zero lumen output.

(E) Shall not consume more than 1 watt per lighting dimmer switch leg when in the off position.

**(7) Occupant sensing devices**

(A) All Occupant sensing devices shall:

i. be capable of automatically turning off all lights in the area no more than 30 minutes after the area has been vacated.

ii. Shall allow all lights to be manually turned off regardless of the status of occupancy.

iii. Shall have a visible status signal that indicates that the device is operating properly, or that it has failed or malfunctioned. The visible status signal may have an override switch that turns the signal off

iv. Devices which utilize ultrasonic radiation for detection of occupants shall submit a Radiation Safety Abbreviated Report to the Center for Devices and Radiological Health, Federal Food and Drug Administration per 21 CFR 1002.12 (1996) and to the California Energy Commission.

v. Devices which utilize ultrasonic radiation for detection of occupants shall emit no audible sound, and shall not emit ultrasound in excess of the decibel levels shown in table J-3 measured no more than five feet from the source, on axis.

**TABLE J-3 Ultrasound Maximum Decibel Values**

| Mid-frequency of Sound Pressure Third-Octave Band (in kHz) | Maximum db Level within third-Octave Band (in dB reference 20 micropascals) |
|---|---|
| Less than 20 | 80 |
| 20 or more to less than 25 | 105 |
| 25 or more to less than 31.5 | 110 |
| 31.5 or more | 115 |

vi. Devices which utilize microwave radiation for detection of occupants shall comply with 47 CFR Parts 2 and 15 (1996) and be marked with an approved Federal Communications Commission identifier. In addition they must have permanently affixed installation instructions recommending that it be installed at least 12 inches from any area normally used by room occupants.

vii. Devices which utilize microwave radiation for detection of occupants shall not emit radiation in excess of one miliwatt per square centimeter measured at no more than five centimeters from the emission surface of the device.

viii. Devices which shall not be capable of conversion by the user between manual and automatic on/off functionality in accordance with Section 1605.3(j)7( iv and vi) shall not incorporate dip switches or other manual means of conversion between manual and automatic functionality.

a. Occupant sensing devices incorporating dimming shall:

1. Be capable of automatically turning on the connected loads from the off state to no greater than 50 percent of power.

2. Be capable of automatically turning connected loads off.

b. Motion sensor shall be rated for outdoor use.

c. Partial On shall be capable of automatically turning on part of the connected lighting load and manually turning on part of the lighting load when an area is occupied, either through dimming functionality, or shall incorporate the following functionality:

1. Have two poles each with automatic-off functionality

2. Have one pole that is manual-on and shall not be capable of conversion by the user to automatic-on functionality

3. Have one pole that is automatic-on and shall not be capable of conversion by the user to manual-on functionality

d. Partial Off shall be capable of automatically turning off part of the lighting load when an area is vacated, and capable of automatically turning on the lighting load when an area is occupied either through dimming functionality, or shall incorporate the following functionality:

1. Have two poles

2. Have one pole that is manual-on and manual off

3. Have one pole that is automatic-on and automatic-off and shall not be capable of conversion by the user to manual-on only functionality.

e. Vacancy sensors shall

1. not turn on lighting automatically and shall not be capable of conversion by the user to automatic on functionality. Vacancy sensors may have a grace period of no more than 30 seconds and no less than 15 seconds to turn on lighting automatically after the sensor has timed out

2. Vacancy sensors shall not have an override switch that disables the sensor.

…

**(w) Battery Charger Systems.**

**(1)** **Large Battery Chargers** manufactured on or after July 1, 2012 shall meet the applicable Tier 1 performance values in Table W-1. Large battery chargers manufactured on or after July 1, 2014 shall meet the applicable Tier 2 performance values in Table W-1.

**Table W-1**

| Performance Parameter | | Tier 1 | Tier 2 |
|---|---|---|---|
| Charge Return Factor | 100 percent, 80 percent DOD | $C_{rf} \leq 1.15$ | $C_{rf} \leq 1.10$ |
| | 40 percent DOD | $C_{rf} \leq 1.20$ | $C_{rf} \leq 1.15$ |
| Power Conversion Efficiency | | Greater than or equal to: 84 percent | Greater than or equal to: 89 percent |
| Power Factor | | Greater than or equal to: 0.85 | Greater than or equal to: 0.95 |
| Maintenance Power | | Less than or equal to: 75 W | Less than or equal to: 10 W |
| No Battery Power | | Less than or equal to: 20 W | Less than or equal to: 10 W |

(2) **Small Battery Chargers** manufactured on or after July 1, 2012 shall meet the applicable performance values in Table W-2 except:

A small battery charger that is made available by a manufacturer directly to a consumer or to service or repair facility after and separate from the original sale of the product that requires the battery charger as a service part or spare part shall not be required to meet the small battery charger standards of Table W-2 until July 1, 2017

**Table W-2**

| **Performance Parameter** | **Standard** |
|---|---|
| **24 hour charge and maintenance energy (Wh)** | Less than or equal to:<br>**12 +1.6$E_b$** ($E_b$ = battery capacity) |
| **Maintenance Power** | Less than or equal to: **0.5 W** |
| **No Battery Power** | Less than or equal to : **0.3 W** |
| **Power Factor** | Depends on input current |

(3) **Inductive chargers** manufactured on or after July 1, 2012 shall meet the applicable performance values in Table W-2, or shall use less than one watt in all three performance parameters in table W-2, or both.

…

**Section 1606. Filing by Manufacturers; Listing of Appliances in Database.**

…

**Table X Continued - Data Submittal Requirements**

| | Appliance | Required Information | Permissible Answers |
|---|---|---|---|
| J | Lighting Control | Includes step by step installation and calibration instructions | Yes/no |
| | | Includes indicator lights which consume 1 watt or more | Yes/no |
| | | Meets the requirements of a time switch control | Yes/no |
| | | Meets the requirements of an astronomical time switch control | Yes/no |
| | | Meets the requirements of an motion sensor | Yes/no |
| | | Meets the requirements of an automatic daylight control | Yes/no |
| | | Is packaged with a photo-control | Yes/no |
| | | Meets the photo-control requirements | Yes/no |
| | | Meets the dimmer control requirements | Yes/no |
| | | Meets general occupancy sensor requirements | Yes/no |
| | | Is rated for outdoor use | Yes/no |
| | | Meets partial on requirements | Yes/no |
| | | Meets partial off requirements | Yes/no |
| | | Meets vacancy sensor requirements | Yes/no |
| | | Uses ultrasonic occupancy detection | Yes/no |
| | | Meets Requirements ultrasound requirements | Yes/no |
| | | Maximum dB level | |
| | | Uses electromagnetic radiation for occupancy detection | Yes/no |
| | | Electromagnetic irradiance at 5cm from emitter ($mW/cm^2$) | |

* "Identifier" information as described in Section 1602(a).
1 = Voluntary for federally-regulated appliances
2 = Voluntary for state-regulated appliances

…

**Table X Continued - Data Submittal Requirements**

| | Appliance | Required Information | Permissible Answers |
|---|---|---|---|
| w | Battery Charger Systems | none | |

* "Identifier" information as described in Section 1602(a).
1 = Voluntary for federally-regulated appliances
2 = Voluntary for state-regulated appliances

…

**(4) Declaration**

**(A)** Each statement shall include a declaration, executed under penalty of perjury of the laws of California, that:

…

**5.** all units of the appliance are marked as required by Section 1607, and, for the following appliances are marked as follows:

…

l. for lighting controls, each;

m. for battery charger systems

**…**

**Section 1607. Marking of Appliances.**

**…**

**(d)** Energy Performance Information.

…

**(12) Lighting Controls**

(A)

**(13) Battery Charger Systems**

(A) On or after July 1, 2012 Small Battery chargers shall be marked with a "SII" or higher mark according to the international marking protocol for battery chargers

(B) On or after July 1, 2012 Large Battery chargers shall be marked with a "LII" or higher mark according to the international marking protocol for battery chargers. On or after July 1, 2014 large battery chargers shall be marked with a "L III" or higher mark according to the international marking protocol for battery chargers.

**…**

# Appendix B: Model for Battery Charger Standards

Appendix B discusses the information and calculations used to characterize battery charger products in the state, their current energy use, and potential savings. The source of information for the tables to follow is the CASE report. After careful review, staff have altered some of the figures from the CASE report as appropriate to fit staff's approach to energy consumption and savings and to reflect preemption scenarios.

## Stock and Sales

The 2009 stock, 2009 sales, 2010-estimated CAGR, and 2013-estimated CAGR were taken from the CASE report. The CASE report collected these numbers from a wide variety of sources and these numbers are based on industry censuses and forecasts.

**Table B-1 Stock and Sales**

| Product | Stock 2009 (million) | Sales 2009 (million) | CAGR Sales 2010 | CAGR Sales 2013 | Sales 2010 (million) | Sales 2013 (million) | Stock 2013 (million) |
|---|---|---|---|---|---|---|---|
| Auto/Marine/RV | 1.8 | 0.18 | 3% | 3% | 0.19 | 0.20 | 2.09 |
| Cell phones | 47.9 | 28.27 | 19% | 2% | 33.64 | 41.65 | 59.10 |
| Cordless phones | 20.5 | 3.21 | -10% | -9% | 2.89 | 2.15 | 13.30 |
| Personal audio electronics | 29.8 | 10.52 | 12% | 2% | 11.78 | 13.73 | 31.60 |
| Emergency systems | 5.3 | 1.3 | 0% | 0% | 1.30 | 1.30 | 5.40 |
| Laptops | 16 | 4.57 | 29% | 12% | 5.90 | 9.54 | 24.40 |
| Personal care | 8.7 | 1.84 | 4% | 3% | 1.91 | 2.11 | 9.68 |
| Personal electric vehicles | 0.1 | 0.04 | 18% | 24% | 0.05 | 0.09 | 0.220 |
| Portable electronics | 10.3 | 2 | 9% | 18% | 2.18 | 3.31 | 18.50 |
| Portable lighting | 1.2 | 0.01 | 1% | 1% | 0.01 | 0.01 | 1.20 |
| Power tools | 15.3 | 2.87 | 5% | 5% | 3.01 | 3.49 | 18.60 |
| Universal battery charger | 0.9 | 0.11 | 3% | 3% | 0.11 | 0.12 | 1.00 |
| Golf cart/ electric carts | 0.175 | 0.017 | 16% | 11% | 0.02 | 0.03 | 0.248 |
| Emergency backup lighting | 7.9 | 2 | 0% | 0% | 2.00 | 2.00 | 7.85 |
| Handheld barcode scanners | 2.4 | 0.38 | 6% | 7% | 0.40 | 0.49 | 3.35 |
| Two-way radios | 0.6 | 0.028 | 0% | 0% | 0.03 | 0.03 | 0.600 |
| Single phase lift-trucks | 0.029 | 0.002 | 7% | 1% | 0.00 | 0.00 | 0.0298 |
| Three phase lift trucks | 0.074 | 0.005 | 7% | 1% | 0.01 | 0.01 | 0.0754 |

The sales for 2010 and 2013 are estimated by using the CAGR rates and 2009 sales. The 2010 sales are calculated by applying the 2010 CAGR to the 2009 sales figures. The 2013 sales are estimated by using the 2010 CAGR for the years 2010 and 2011 and the 2013 CAGR for the years 2012 and 2013. The equations can be expressed as follows:

$$Sales_{2010} = Sales_{2009} \times (1 + CAGR_{2010})$$

$$Sales_{2013} = Sales_{2009} \times (1 + CAGR_{2010})^2 \times (1 + CAGR_{2013})^2$$

## Compliance Rates

The staff report incorporates the compliance rates estimated by the CASE report without any alterations. These values are as follows

**Table B-2 Compliance Rates**

| Market Segment | Product | Compliance |
|---|---|---|
| Small Charger | Auto/Marine/RV | 0% |
| Small Charger | Cell Phones | 50% |
| Small Charger | Cordless Phones | 0% |
| Small Charger | Personal Audio Electronics | 90% |
| Small Charger | Emergency Systems | 10% |
| Small Charger | Laptops | 10% |
| Small Charger | Personal Care | 0% |
| Small Charger | Personal Electric Vehicles | 10% |
| Small Charger | Portable Electronics | 10% |
| Small Charger | Portable Lighting | 0% |
| Small Charger | Power Tools | 10% |
| Small Charger | Universal Battery Charger | 50% |
| Small Charger | Golf Cart/ Electric Carts | 50% |
| Small NC | Emergency Backup Lighting | 50% |
| Small NC | Handheld Barcode Scanners | 50% |
| Small NC | Two-Way Radios | 50% |
| Large charger | Single Phase Lift-Trucks | 0% |
| Large Charger | Three Phase Lift Trucks | 0% |

## Design Life

The design life is an estimate of the length of a product's typical operation usefulness is. The design life figures were taken from the CASE report and are shown below.

**Table B-3 Design Life**

| Battery Charger Size | Type | Design Life/years |
|---|---|---|
| Small Charger | Auto/Marine/RV | 10 |
| Small Charger | Cell Phones | 2 |
| Small Charger | Cordless Phones | 5 |
| Small Charger | Personal Audio Electronics | 3 |
| Small Charger | Emergency Systems | 7 |
| Small Charger | Laptops | 4 |
| Small Charger | Personal Care | 5 |
| Small Charger | Personal Electric Vehicles | 9.7 |
| Small Charger | Portable Electronics | 5.2 |
| Small Charger | Portable Lighting | 10 |
| Small Charger | Power Tools | 6.5 |
| Small Charger | Universal Battery Charger | 8 |
| Small Charger | Golf Cart/ Electric Carts | 10 |
| Small NC | Emergency Backup Lighting | 10 |
| Small NC | Handheld Barcode Scanners | 8 |
| Small NC | Two-Way Radios | 8 |
| Large Charger | Single Phase Lift-Trucks | 15 |
| Large Charger | Three Phase Lift Trucks | 15 |

## Duty Cycle

The duty cycle is an estimate of consumer behavior for battery chargers. It is directly tied to how often a product is used and how long it takes to charge the battery. For some products that use backup batteries, it is assumed that the battery will only rarely be charged as the product nearly always is connected to a power line and only in rare cases of emergency needs to be recharged. The duty cycles used for this staff report are slightly altered from the figures in the CASE report.

The duty cycles represent current average usage in order to make meaningful estimates of product energy consumption and savings. These figures rely on metering and behavior studies where possible, and use reasonable estimates where this type of information is unavailable.

**Table B-4 Duty Cycle**

| Product | Charge % | Maintenance % | No Battery % | Unplugged % |
|---|---|---|---|---|
| Auto/Marine/RV | 6% | 42% | 46% | 6% |
| Cell Phones | 5% | 30% | 19% | 46% |
| Cordless Phones | 31% | 56% | 9% | 4% |
| Personal Audio Electronics | 6% | 25% | 35% | 33% |
| Emergency Systems | 0% | 99% | 0% | 0% |
| Laptops | 6% | 56% | 30% | 8% |
| Personal Care | 12% | 86% | 3% | 0% |
| Personal Electric Vehicles | 37% | 28% | 35% | 0% |
| Portable Electronics | 2% | 11% | 4% | 84% |
| Portable Lighting | 1% | 99% | 0% | 0% |
| Power Tools | 4% | 48% | 15% | 32% |
| Universal Battery Charger | 1% | 66% | 17% | 17% |
| Golf Cart/ Electric Carts | 37% | 47% | 16% | 0% |
| Emergency Backup Lighting | 0% | 99% | 0% | 0% |
| Handheld Barcode Scanners | 13% | 52% | 35% | 0% |
| Two-Way Radios | 19% | 31% | 50% | 0% |
| Single Phase Lift-Trucks | 45% | 32% | 24% | 0% |
| Three Phase Lift Trucks | 98% | 0% | 2% | 0% |

## Baseline Energy Use

The power consumption assumptions for battery charger categories are derived from the CASE report. The CASE report relies on extensive product testing done by Ecos Consulting on existing battery chargers. The charge mode power has been slightly altered from the CASE report to better match the test data that is reported in 24-hour energy into instantaneous power. Estimated annual energy consumption per product is derived using a combination of the power of the various modes and the duty cycles of those modes. For example, the annual energy consumption of charge mode is calculated by multiplying charge mode power by charge mode duty cycle and by the number of hours in a year. The annual energy consumption for a given product was thus calculated as follows:

$$E_{annual} = \left(P_{charge} \times D_{charge}\right) + \left(P_{maint} \times D_{maint}\right) + \left(P_{no\ bat} \times D_{no\ bat}\right)$$

Note: unplugged duty cycle and power are not included because they do not contribute to annual energy use. Because the unplugged power is always zero, the factor is not relevant to the equation.

**Table B-5 Base line Energy Use**

| Product | Charge (W) | Maintenance (W) | No Battery (W) | Percent At Peak | Annual Energy Consumption (Kwh Per Device) |
|---|---|---|---|---|---|
| Auto/Marine/RV | 214 | 41.9 | 49.3 | 21% | 460.17 |
| Cell Phones | 3.9 | 0.5 | 0.3 | 28% | 3.48 |
| Cordless Phones | 2.7 | 2.2 | 1.7 | 95% | 19.46 |
| Personal Audio Electronics | 2.1 | 0.5 | 0.1 | 16% | 2.50 |
| Emergency Systems | 7 | 2.9 | 2.5 | 100% | 25.38 |
| Laptops | 27.1 | 3 | 1.9 | 32% | 33.52 |
| Personal Care | 1.2 | 1 | 0.9 | 80% | 9.00 |
| Personal Electric Vehicles | 230 | 34.1 | 33.9 | 31% | 931.17 |
| Portable Electronics | 9.2 | 2.5 | 0.9 | 6% | 4.20 |
| Portable Lighting | 1.8 | 1.6 | 0.4 | 70% | 13.98 |
| Power Tools | 17.5 | 3.5 | 1.8 | 30% | 23.35 |
| Universal Battery Charger | 7.1 | 1.1 | 0.9 | 26% | 8.16 |
| Golf Cart/ Electric Carts | 600 | 103 | 1.6 | 14% | 2,374.99 |
| Emergency Backup Lighting | 2.2 | 1.6 | 1.6 | 100% | 13.99 |
| Handheld Barcode Scanners | 11.2 | 3 | 0.2 | 46% | 26.59 |
| Two-Way Radios | 5.3 | 2 | 0.9 | 6% | 18.09 |
| Single Phase Lift-Trucks | 2000 | 50 | 50 | 19% | 8,169 |
| Three Phase Lift Trucks | 5600 | 88.5 | 33.5 | 100% | 48,038 |
| **Total GWh/yr** | | | | | **7128** |

## Compliant Energy Use

The power consumption of compliant products is estimated based on minimum requirements to meet the proposed regulations. For example, the proposed maintenance mode standard is 0.5W so products were assumed to consume exactly the bare minimum to accomplish this standard. It should be noted that in a few cases, the baseline power for a given mode was already less than the standard. In these cases, the report does not assume that power will increase, but rather that it will remain the same. The annual energy consumption is calculated using the same methodology as baseline energy use.

**Table B-6 Compliant Energy Use**

| Product | Charge (W) | Maintenance (W) | No Battery (W) | Annual Energy Consumption (Kwh/Device) |
|---|---|---|---|---|
| Auto/Marine/RV | 153 | 0.5 | 0.3 | 79.80 |
| Cell Phones | 2.7 | 0.5 | 0.3 | 2.97 |
| Cordless Phones | 1 | 0.5 | 0.3 | 5.40 |
| Personal Audio Electronics | 1.1 | 0.5 | 0.1 | 1.98 |
| Emergency Systems | 4 | 0.5 | 0.3 | 4.45 |
| Laptops | 24.6 | 0.5 | 0.3 | 15.78 |
| Personal Care | 0.6 | 0.5 | 0.3 | 4.46 |
| Personal Electric Vehicles | 164 | 0.5 | 0.3 | 532.36 |
| Portable Electronics | 6.6 | 0.5 | 0.3 | 1.65 |
| Portable Lighting | 1.3 | 0.5 | 0.3 | 4.41 |
| Power Tools | 12.5 | 0.5 | 0.3 | 6.95 |
| Universal Battery Charger | 3.9 | 0.5 | 0.3 | 3.59 |
| Golf Cart/ Electric Carts | 523 | 0.5 | 0.3 | 1,701.07 |
| Emergency Backup Lighting | 1 | 0.5 | 0.3 | 4.38 |
| Handheld Barcode Scanners | 3.2 | 0.5 | 0.2 | 6.41 |
| Two-Way Radios | 2.2 | 0.5 | 0.3 | 6.29 |
| Single Phase Lift-Trucks | 1770 | 10 | 10 | 7,063.54 |
| Three Phase Lift Trucks | 5111 | 10 | 10 | 43,839.52 |

## Costs and Savings

The cost assumptions for this table are from the CASE report. The unit energy savings are calculated by subtracting the compliant energy use from the baseline energy use.

$$E_{annual\ savings} = E_{annual\ baseline} - E_{annual\ compliant}$$

Unit cost savings (benefits) are calculated by multiplying the annual energy savings by $0.14 per kWh and by the discounted design life.

$$B_{energy\ savings} = \$0.14 \times E_{annual\ savings} \times L_{discounted\ design}$$

Net unit savings are calculated by subtracting costs from benefits.

$$B_{net} = B_{energy\ savings} - C_{compliance}$$

Current stock consumption is calculated for each product by multiplying its annual baseline energy consumption by its 2009 stock.

$$E_{stock} = E_{annual\ baseline} \times N_{2009\ stock}$$

Stock energy savings is calculated for each product by multiplying its unit energy savings by its 2009 stock and by its non-compliance rate. The non-compliance rate is 100% minus its compliance rate.

$$B_{stock} = B_{energy\ savings} \times N_{2009\ stock} \times (1 - R_{compliance})$$

The energy savings of first year sales is calculated in a similar manner to stock energy savings except by using 2010 sales rather than 2009 stock.

$$B_{stock} = B_{energy\ savings} \times N_{2010\ Sales} \times (1 - R_{compliance})$$

Benefit to cost ratio is calculated by dividing the unit cost savings by the unit cost of compliance.

**Table B-6 Costs and Savings**

| Product | Unit Cost To Comply | Unit Energy Savings (Kwh/Yr) | Unit Cost Savings | Net Unit Savings | Current Stock Consumption | Stock Energy Savings (Gwh/yr) | Energy Savings Of First Year Sales (Gwh) | Benefit/Cost |
|---|---|---|---|---|---|---|---|---|
| Auto/Marine/RV | $10.00 | 380.37 | $466.09 | $456.09 | 828.31 | 684.67 | 70.52 | 46.6 |
| Cell Phones | $0.00 | 0.51 | $0.14 | $0.14 | 166.76 | 12.29 | 8.63 | N/A |
| Cordless Phones | $0.40 | 14.06 | $9.27 | $8.87 | 399.00 | 288.21 | 40.62 | 23.2 |
| Personal Audio Electronics | $0.00 | 0.52 | $0.21 | $0.21 | 74.47 | 1.56 | 0.62 | N/A |
| Emergency Systems | $3.00 | 20.94 | $18.76 | $15.76 | 134.52 | 99.86 | 24.49 | 6.3 |
| Laptops | $0.00 | 17.74 | $9.50 | $9.50 | 536.34 | 255.50 | 94.14 | N/A |
| Personal Care | $0.40 | 4.54 | $2.99 | $2.59 | 78.31 | 39.50 | 8.69 | 7.5 |
| Personal Electric Vehicles | $2.00 | 398.81 | $488.68 | $486.68 | 93.12 | 35.89 | 16.94 | 244.3 |
| Portable Electronics | $0.00 | 2.55 | $1.68 | $1.68 | 43.26 | 23.63 | 5.00 | N/A |
| Portable Lighting | $0.40 | 9.57 | $11.72 | $11.32 | 16.77 | 11.48 | 0.10 | 29.3 |
| Power Tools | $0.55 | 16.40 | $12.78 | $12.23 | 357.22 | 225.79 | 44.47 | 23.2 |
| Universal Battery Charger | $0.00 | 4.57 | $4.61 | $4.61 | 7.35 | 2.06 | 0.26 | N/A |
| Golf Cart/ Electric Carts | $200.00 | 673.92 | $825.79 | $625.79 | 415.62 | 58.97 | 6.64 | 4.1 |
| Emergency Backup Lighting | $3.00 | 9.61 | $11.77 | $8.77 | 110.53 | 37.95 | 9.61 | 3.9 |
| Handheld Barcode Scanners | $0.50 | 20.18 | $20.37 | $19.87 | 63.83 | 24.22 | 4.06 | 40.7 |
| Two-Way Radios | $0.50 | 11.80 | $11.91 | $11.41 | 10.85 | 3.54 | 0.17 | 23.8 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Single Phase Lift-Trucks | $200.00 | $1,105.64 | $1,892.29 | $1,692.29 | 236.91 | 32.06 | 2.37 | 9.5 |
| Three Phase Lift Trucks | $400.00 | $4,198.51 | $7,185.73 | $6,785.73 | 3,554.81 | 310.69 | 22.46 | 18.0 |

# Appendix C: Staff Response to Comments

This section of the report discusses and addresses responses to comments received as a result of the October 11, 2010, staff workshop on battery charger systems and publication of the CASE report. The Energy Commission received 15 comment letters from stakeholders, which can be found on the Commission's website. [37] Commission staff have developed the below summary comments from several stakeholder letters, or in some instances used a representative excerpt, to capture the general themes that were identified in the comment letters. A more thorough response to comments document will be developed based on stakeholder comments received during the 45-day review period required by the Administrative Procedure Act as part of a formal rulemaking procedure.

1. Comment: Has Ecos looked at any issues that may occur with some of those technologies having to do with Intellectual Property?

   Response: The solutions that Ecos looked at were not proprietary. The proposed standards can be met with commonly available technologies.

2. Comment: Battery chargers and power supplies are separate appliances and power supplies should not be a part of this regulation.

   Response: Battery charger power supplies are currently exempt from the Energy Commission and federal EPS standards and therefore will not be regulated as both an EPS and a battery charger. An EPS cannot be separated from the battery charger because it is integrated into the battery charger test method which requires that testing be conducted from the wall plug to the battery. To create an even playing field for all products, the EPS is included as part of a battery charger so that there is no compliance advantage for products which use internal power supplies versus external power supplies.

3. Comment: Staff should consider the cost of the actual redesign of the products, that is, the engineering hours that have to be put forward into the situation, as well as the capital costs – Wahl Clipper alluded to this in terms of remanufacturing molds – molds depend upon volume, for some high volume products, molds can cost in some cases upwards of hundreds of thousands of dollars, that's a significant capital cost that manufacturers would have to put into place in order to meet these new requirements

   Response: The cost effectiveness analysis provided by Ecos includes the cost of redesign in the incremental cost to meet the standard. Based on staff analysis, this proposed standard would require replacement of charge current limiter with comparator and an

[37] http://www.energy.ca.gov/appliances/battery_chargers/documents/2010-10-11_workshop/comments/

active mode on/off switch of approximately the same dimensions as existing systems; case design should not need to be changed to comply.

4. Comment: Every individual battery charger will have to be tested by the safety agencies individually according to its individual needs, which means every one of these new designs, hundreds and hundreds of them, as the Department of Energy has put forward in the TSD, will have to have safety certification. Those safety certification costs are significant. They can range anywhere from $20,000 to $50,000 per product, they are unique to every individual model, and I would ask that, as the staff considers the cost increases, that they would allow for the cost of the testing safety certification, as well.

   Response: Battery chargers are similar to EPS and therefore the same practice and process will apply. EPS manufacturers went through the same process when EPS standards were first implemented, and staff did not receive any information supporting the conclusion that there was a high cost to comply with the EPS standard. In addition, staff research into the UL process found that minor alterations of design do not require the expensive certification process outlined in the comment. The component changes necessary to meet this regulation can be certified with UL using the shorter and less expensive existing test criteria for electronics. Also, if manufacturers have to reapply for UL certification, this cost will be incurred regardless due to impending DOE regulations.

5. Comment: DOE and probably California will require outside third-party certification for the energy efficiency of the product, which is another cost on top of this.

   Response: California does not require third-party certification.

6. Comment: Ecos appears to have made assumptions about the quantities of components which will be purchased. As some quantities of shipments of certain classes of products are low and some are high, we would like to know what quantities were assumed for each class in order to move from the component part cost to the MSP.

   Response: The proposed battery chargers standards are technology neutral and as such do not require the use of any one particular technology. Furthermore, available components for meeting the proposed standards are basic electronic components and are available at the cost of less than a dollar even at low volume.[38] Therefore, even at a low volume, replacement parts for meeting the proposed standards prove to be cost effective.

7. For small voltage products (for example 1.2 to 1.5 V), did Ecos assume that the voltage to run some IC chips are not available at very low voltages? Did Ecos assume that the

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38 http://www.analog.com/en/amplifiers-and-comparators/current-sense-amplifiers/adm4073/products/product.html (Example: comparator d circuit has more functions than what is needed to control the charge current. Cost per unit is $0.99 ¢ based on an order of 1000 units)

energy to the system would need more voltage to drive the IC chips than is needed to charge the battery?

Response: The ICs do not run off of the device's batteries, and therefore the 1.2 and 1.5V limitations do not exist.

8. Comment: For those devices that are federally regulated as medical devices, does the proposed timeline include time for FDA approval, including queue time?

   Response: Stakeholders have not submitted documentation that the redesign of battery chargers to meet the proposed standards would require recertification to the FDA.

9. Comment: Did Ecos verify that the technology to meet the proposed regulation is acceptable as it is to meet all the strict safety and electro-magnetic compatibility (EMC) requirements for medical devices? If so, please provide the report that confirms this.

   Response: The existing battery chargers charge current limiter circuitry will be replaced with a charge controller and/or on/off switch. It is a basic electric engineering principal and universally known engineering fact that replacing an electronic charge current limiter or resistor with an on/off switch does not add EMC to the circuit. Stakeholders have not provided evidence or technical details to show that replacing a charge current limiter or a resistor with active on/off switch would alter the operation of medical devices and alter EMC. And finally, if EMC is an issue with medical devices, staff would presume that these devices should already have EMC protection.

10. Comment: CASE study, Table 6 includes information on the percentage of time that a product is unplugged. Would Ecos provide to us the information on which this estimate is made, especially for personal care appliances? Is this assumed on all the market or a percentage? If it is a portion, then how was this percentage arrived at?

    Response: This information is based on the following study. The document provides the details:
    http://www.efficientproducts.org/reports/plugload/Plug_Loads_CA_Field_Research_Report_Ecos_2006.pdf

    The percentage of time that a particular device is plugged in is assumed for the entire market. Appendix B lists all of the duty cycles used in the energy and cost effectiveness analysis. Duty cycle data was derived from a variety of sources including Ecos' 2006 Battery Charger Census (Herb and Porter 2006) and 2006 Final Field Research Report (Porter, Moorefield et al. 2006).

    For example, cell phones, cordless phones, laptop, forklift etc., are charged daily. The duty cycle for various product categories has been provided in Table 6 of the CASE report. Estimates are based on the best data available.

11. Comment: For the data in figure 5 in the CASE report, only the Lithium ion products meet the proposed regulation. Was it assumed that all cell chemistries could use the

same technology to meet the proposed regulation? If so were the costs increases to the product also based on this technology?

Response: In figure 5, at least one compliant product existed for NiCD, NiMH, and lead acid. The technical feasibility portion of this staff report discusses the chemistry neutral approach to the regulation. There are solutions, some of them shared between chemistries that can be used to bring products into compliance. The incremental cost for each category is estimated by implementing the cheapest solution that does not impair product performance. In many cases, the cost of these replacement components is less than a dollar.

12. Comment: For the Maintenance and No Battery Modes, the graph provided shows a proposed standard of max 0.5 W and 0.3 W respectfully. These numbers are on a straight line and do not follow the trend of all the data provided on the graph. It is not clear why this data would be collected and graphed yet the trend line was not established which would be considered a standard way to develop limits within the data provided. In fact, it appears that the data supplied on this chart was ignored for the most part and a level was established on some other bases [sic]. This methodology of setting limits which are not directly related to the data provided would tend to result in being very sever [sic] for some product categories while having minimal impact for other product categories.

Response: The data shows that there are a large number of inefficient chargers being sold in the market. These inefficient battery charges can meet the proposed battery charger standards with the available technologies in a cost effective way. The reason for most of the inefficient battery chargers not meeting the standard is that they use a charge current limiter or a resistor to draw the charge current from the power source. Inefficient battery chargers continuously provide charge current and remain on after batteries are fully charged resulting in significant loss of energy. For reasons discussed in technical feasibility portion of the staff report, it is reasonable to require the proposed maintenance mode and no battery mode power standards.

13. Comment: In preliminary testing, it has been demonstrated that most of our ENERGY STAR approved chargers, representing a majority of our product line, will fail the limits set forth in this latest proposal. This is very troubling since it is known that the ENERGY STAR products are considered to be in the top 20% of high efficiency performers in any particular product category. The testing has indicated that these ENERGY STAR approved chargers will fail the Active, Maintenance and the No Battery modes. This information points to the fact that the energy efficient levels that have been chosen in the proposal are to [sic] severe and do not properly represent the power tool battery charger category. It would appear that the CEC would be concerned with the fact that ENERGY STAR approved products will not pass, yet the state of California supports ENERGY STAR by encouraging the people to purchase ENERGY STAR® products with cash rebates. In addition, the minimal Wh gain by making the changes to the charger designs do not seem to have the payback benefits the CEC is looking for when making this a requirement. In some cases, a minimum of 0.017 Watt is the

difference between passing or failing the limits proposed however, the wattage savings in these cases would be minimal and should not require the redesign of a product line.

Response: ENERGY STAR, as a voluntary program, cannot be used as a basis for meeting California statutory requirements or policy goals. California efficiency standards are a key strategy for meeting GHG reduction targets and for reducing energy consumption. In addition, in regard to the proposed battery charger standards, the ENERGY STAR program does not have requirements that are directly comparable to the proposed standards in the CASE report. In addition, the test methodology implemented by the ENERGY STAR program is different from what the Energy Commission has adopted. The Commission does not have access to manufacturer test results used to certify with ENERGY STAR. If this information is critical to the rulemaking process manufacturers should provide it with their comments. The Commission does not provide rebates on ENERGY STAR compliant battery chargers. Products, which are extremely close to meeting the standards, will also incur a lower cost of compliance. The Commission staff analysis shows that the proposed standards in the CASE report are cost effective feasible and save energy.

14. Comment: Ecos was to provide the technical details of the power tool battery charger conversion described on page 20 of the CASE document where a transformer was replaced by a capacitor. A schematic would be the best way to describe this.

Response: http://www.efficientproducts.org/reports/bchargers/1270_BatteryChargerTechincalPrimer_FINAL_29Sep2006.pdf

15. Comment: Public safety and emergency response entities have high standards for reliability, durability, and functionality in their communications equipment. Because performance in extreme conditions varies by battery chemistry, certain battery chemistries have improved cycle-life performance and can operate over wider temperature ranges, both of which are important to public safety activities.

Response: It is feasible to meet the proposed regulations with any battery chemistry. Efficient battery chargers require less energy to charge the batteries. The changes necessary to meet the proposed standards are in the battery charger circuitry and not in the battery. This extends the battery and charger life and therefore enhances performance of mission critical equipment. Turning off the chargers after the batteries are fully charged will reduce the heat produced in the batteries.

16. Comment: As identified in the proposal standards, transformer-based, line-frequency battery charger designs (SCR, hybrid, and ferroresonant) are moderately less efficient than switch-mode designs. However, in many industrial and commercial applications, benefits inherent in these products outweigh efficiency disadvantage.

Response: The Energy Commission does not dictate which technology is used to achieve the proposed efficiency standards, allowing industry to weigh tradeoffs in design, but believes that design can be more efficient and cost effective on a lifetime basis. Staff has reviewed the CASE study and finds that it is cost effective to implement the proposed efficiency standards and that consumers will save money on their energy bills.

17. Comment: Because of the increased labor required to assemble switch-mode battery chargers, as compared with transformer-based, line-frequency products, it is cost prohibitive to manufacture these products in the U.S. This is demonstrated in the fact that nearly all-global external power supply manufacturing takes place in Asia, as DOE notes in similar battery charger efficiency regulation proposal documentation. Therefore, following implementation of the proposed regulations, nearly all production of battery charging products will be performed in low-cost Asian countries. Correspondingly, manufacturing jobs will be lost as a direct result of these proposals, if implemented.

    Response: The Energy Commission has not been provided information establishing that the regulations will increase production costs and thereby ship jobs overseas. More specifically, the Commission has not been provided with any data or analysis that would show how the proposed standards would result in U.S. or California job losses. In addition, while of concern, this issue is not a determining factor in the cost effectiveness analysis under California statute. And finally, it has not been established that compliance cannot be achieved with the transformer-based or line-frequency products.

18. Comment: The proposed Tier 1 and Tier 2 charge return factor requirements for large battery charger systems of 1.05 – 1.15 and 1.05 – 1.10, respectively, for 100 and 80 percent depth of discharge will be detrimental to lead-acid battery life because certain battery types, compositions, and constructions require charge return factors greater than 1.15. A single charge return factor is appropriate for all lead-acid battery types (wet/flooded, AGM, gel, etc.) and battery chemistries (lead-acid, nickel-cadmium, lithium-ion, etc.).

    In order to maximize lead-acid battery life, the charge return factor has to scale with battery cycles and total amp-hours discharged.

    Response: The proposed standard upper limits are reasonable and the lower limits have been removed to make appropriate for all chemistries.

19. Comment: Cobra would also like to comment on the no load specification of 300mw for No Battery Power for Small Battery Chargers. For those companies which use EPS's as the source of DC current from the mains this could be a difficult standard to ensure 100% of the time because it is the same specification as a standard energy level V EPS. This leaves no power available for use in battery charge control when using a standard energy level 5 EPS. Consequently, companies will have to request EPS's from their suppliers that are a little better than an energy level V EPS (in order to accommodate any charge control circuitry that they may have in the system). It would make much more sense for the CEC to consider a specification slightly above the 300mw level to accommodate this charge control circuitry while allowing suppliers to use standard energy level V EPS's. Although Cobra has not had the time to study this, it seems that 75 mw would allow 5 milliamp to be taken from a 12V EPS reliably while not significantly effecting the energy consumption.

Response: The Battery Chargers Power Supply (BCPS) is excluded from the federal and state EPS standards. Consequently, the current EPS standard does not apply to BCPS. The BC standard is technically feasible and appropriately requires the use of an efficient power supply, whether it is internal or external. The Commenter's proposal, while also technically feasible, would result in less efficient battery chargers.

20. Comment: The proposed limits on power consumption in maintenance and no-battery mode are too low. External power supplies meeting the current California appliance efficiency requirements are allowed a no-load power of 0.5W. Meeting the maintenance and no battery power levels of 0.5W and 0.3W in the BCS CASE proposal may not be possible with external power supplies meeting the California requirements, since compliant external power supplies may consume the entire allowed power for the system, with no power margin left for the battery charger itself. Even in maintenance and no battery mode, many applications, such as public safety, require the use of LED indicator lights to ensure units are functioning. Motorola proposes that the maintenance and no battery power levels for small battery charger systems be increased to take this into account.

Response: The proposed standards are feasible, cost effective and save energy. The BCPS is excluded from the federal and state EPS standards. The current EPS standard does not apply to BCPS. The BC test method includes the BCPS testing and the proposed standard is feasible and cost effective. LED display functionality can be turned off or disconnected during testing. In addition, the current maximum power use for external power supplies is 0.5 W and level V is 0.3 W. The market penetration of level V external power supplies has grown to the point that the ENERGY STAR® program has dropped its symbol from use at this level. There are therefore power supplies that use less than 0.3 W in no load mode, giving room for the battery charger power requirements mentioned in the comment.

The battery charging display indicator described by the commenter stays on only when batteries are charging. It is a part of the charge control circuit. LED display indicators use small current in the milliamp range. The proposed standards are set at much higher level and allow such a function to be installed without hindering the mission critical operations. These additional functions can be turned off or disconnected during testing.

21. Comment: The current proposal makes no allowance for Multi-port Chargers. Maintenance Mode power is consumed by the battery, charging circuitry and charge status indicators (typically LEDs for commercial/industrial products). Required Maintenance power increases in proportion to the number of occupied ports on a multi-port charger (industrial and mission critical customers require one indicator per port – they need updates on every battery in a charger "at a glance").

Response: The charger does not need to be tested with all bays occupied. Only one bay needs to be tested, and therefore the energy use of the additional bays should not significantly impact the ability of products to meet the proposed standards.