Electronic Products: Making Battery Chargers More Efficient

The Problem

Battery charger systems currently consume approximately 42 billion kilowatt-hours (kWh) nationally—about 14 percent of the total energy use of electronic devices. Field and lab research demonstrates that there is tremendous variation in the efficiency of battery chargers while they are charging or maintaining the charge of connected batteries and in the amount of power that chargers draw when no batteries are connected. Highly efficient existing technologies could sharply reduce power consumption—on the order of 2 billion kWh annually in California and 18 billion kWh nationwide—but there has been no widely accepted testing procedure for charger efficiency and no standards for charger efficiency currently exist.

The Solution

Ecos Consulting and EPRI Solutions (the Electric Power Research Institute) formed a team of researchers to come up with candidate efficiency standards for battery chargers. The first step was to create an efficiency-testing procedure that all stakeholders can agree upon. The project team consulted extensively with industry and other stakeholders to develop a simple and inexpensive procedure that would avoid the ambiguity of previous test procedures. The team then applied this consensus procedure to test a wide array of battery chargers varying in size from 2 to 50 watt-hours of battery capacity to demonstrate the broad range of available efficiencies.

Following efficiency testing, the team evaluated the battery chargers to identify the design choices that contributed to the demonstrated variation in charger efficiency. These findings were documented in a technical primer illustrating how manufacturers might improve the energy efficiency of conventional battery charging systems. Finally, the team suggested a possible framework for battery charger efficiency standards, though it noted that a broader characterization of the efficiencies of chargers on the market will be required before such standards can be set.

Features and Benefits

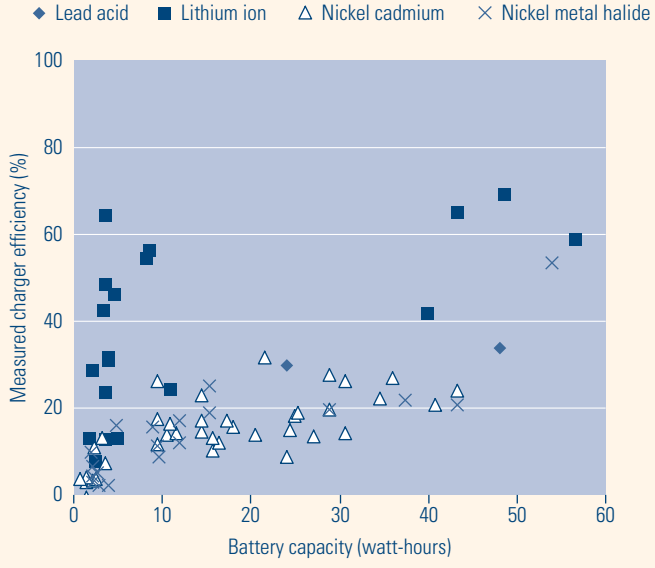
This project resulted in five major accomplishments that will help to advance battery charger efficiency.

A widely accepted, unambiguous test of charger efficiency. A prior test procedure developed by the Energy Star program addressed the charge maintenance and no-battery modes of battery chargers but did not include the charging mode. For many products, the transition between charge and maintenance modes is not obvious, creating ambiguity in efficiency assessments. So the team worked with stakeholders to develop a new procedure that does not require technicians to determine precisely when the transition from charging to maintenance mode occurs. This new procedure defines charger efficiency as the amount of energy extractable from the fully charged battery divided by the total alternating current (or AC) energy consumed by the charger over a 24-hour period. The test procedure also includes a measurement of a charger's power draw when no batteries are being charged.

Efficiency measurements of more than 60 battery chargers. To provide an initial characterization of the efficiencies of chargers on the market, the Ecos/EPRI team applied this test procedure to 62 chargers over a wide variety of applications and battery-energy capacities. This exercise demonstrated charger efficiencies ranging from 2 to over 60 percent (**Figure 1**) and no-battery power draw from 0.1 watt to over 200 watts. These data can provide insight to policy-makers about the existing range of efficiencies and the potential for improvement through standard setting.

Figure 1: Battery charger efficiency

The 62 products tested in this project exhibited a wide range of efficiencies, from as low as 2 percent to 69 percent.



Characterization of the battery charger market. Ecos researchers determined that there are currently more than 1 billion battery chargers in use in the United States, consuming almost 42 billion kWh per year. In California alone, about 130 million of these devices consume about 4.6 billion kWh annually. Improved charger design could reduce this consumption by as much as 2 billion kWh per year in California, or 16.3 billion kWh annually nationwide.

Battery charger technical primer. Ecos Consulting developed a technical primer on battery chargers. This document identifies design choices that affect charger efficiency and notes the following components or methods that can lead to higher efficiency in battery charger systems:

- Higher-voltage systems
- Efficient, switch-mode power supplies
- Improved semiconductor switches to stop charging when batteries are full
- Battery chemistries with higher coulombic efficiencies and lower self-discharge rates
- Lower current rate for charge and discharge cycles

The primer concludes that the technical path to higher efficiency is clear and that for this reason, the battery charger market is ready for efficiency standards. The primer is available on the Efficient Products web site described below.

Efficient Products web site. The project team has developed the web site www.efficientproducts.org, which presents energy-efficiency information on a variety of plug-load devices as well as the battery charging systems that many of these devices use. The site provides information about charger efficiency testing (including the finalized test procedure addressing the transition from charging to maintenance mode), a selection of products with efficient chargers, and policy developments in California and at the national level.

Applications

The results of the research in this project apply to virtually all portable, rechargeable-battery–powered consumer electronic devices and other products that use single-phase battery chargers with a nameplate rating of 2 kilowatts or less.

California Codes and Standards

Although no standards for battery charger efficiency currently exist, the California Energy Commission (CEC) is currently considering voluntary and mandatory standards. The Commission opened a rule-making process on this issue in January 2008 and could have standards in place by early 2010.

What's Next

Ecos Consulting is currently testing a wide variety of battery chargers to better characterize the efficiency of products on the market today. The test results will be used in the development of a mandatory efficiency standard by the Commission.

Collaborators

Ecos Consulting and EPRI Solutions worked together on this project.

For More Information

For more information on this project, please contact the California Energy Commission researcher listed below.

More PIER Technical Briefs can be found at www.energy.ca.gov/research/techbriefs.html.

Contacts

California Energy Commission, Bradley Meister, bmeister@energy.state.ca.us, 916-653-1594, www.energy.ca.gov/research/buildings

Ecos Consulting, Chris Calwell, ccalwell@ecosconsulting.com, 970-259-6801

About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) Program. PIER supports public interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

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