DEPARTMENT OF ENERGY

10 CFR Part 430

[Docket No. EERE–2009–BT–DET–0005]

RIN 1904–AB80

Energy Conservation Program for Consumer Products: Determination Concerning the Potential for Energy Conservation Standards for Non-Class A External Power Supplies

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Proposed determination.

SUMMARY: The Energy Policy and Conservation Act (EPCA or the Act), as amended, requires the U.S. Department of Energy (DOE) to issue a final rule by December 19, 2009, that determines whether energy conservation standards for non-Class A external power supplies (EPSs) are warranted.

In this document, DOE proposes to determine that energy conservation standards for non-Class A external power supplies are warranted. This document informs interested parties of the analysis underlying this proposal, which examines the potential energy savings and the direct economic costs and benefits that could result from a future standard. In this document, DOE also announces the availability of a technical support document (TSD), which provides additional analysis in support of the determination. The TSD is available from the Office of Energy Efficiency and Renewable Energy's Web site at *http://www.eere.energy.gov/buildings/appliance_standards/residential/battery_external.html*.

DATES: Written comments on this document and the TSD are welcome and must be submitted no later than December 18, 2009. For detailed instructions, see section VI, ''Public Participation.''

ADDRESSES: Interested parties may submit comments, identified by docket number EERE–2009–BT–DET–0005 and/or Regulation Identifier Number (RIN) 1904–AB80, by any of the following methods:

- *Federal eRulemaking Portal: http://www.regulations.gov.* Follow the instructions for submitting comments.
- *E-mail: EPS-2009-DET-0005@ee.doe.gov.* Include docket number EERE–2009–BT–DET–0005 and/or RIN 1904–AB80 in the subject line of the message.
- *Mail:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, Mailstop EE–2J, Technical Support Document for Non-Class A External Power Supplies, docket number EERE–2009–BT–DET–0005 and/or RIN 1904–AB80, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Please submit one signed paper original.
- *Hand Delivery/Courier:* Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Program, 6th Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024. Please submit one signed paper original.

For additional instruction on submitting comments, see section VI, ''Public Participation.''

Docket: For access to the docket to read background documents, the technical support document, or comments received, go to the U.S. Department of Energy, Resource Room of the Building Technologies Program, Sixth Floor, 950 L'Enfant Plaza, SW., Washington, DC 20024, (202) 586–2945, between 9 a.m. and 4 p.m., Monday through Friday, except Federal holidays. Please call Ms. Brenda Edwards at the above telephone number for additional information about visiting the Resource Room. You may also obtain copies of certain documents in this proceeding from the Office of Energy Efficiency and Renewable Energy's Web site at *http://www.eere.energy.gov/buildings/appliance_standards/residential/battery_external.html*.

FOR FURTHER INFORMATION CONTACT: Mr. Victor Petrolati, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Telephone: (202) 586–4549. E-mail: *Victor.Petrolati@ee.doe.gov*.

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For further information on how to submit or review public comments, contact Ms. Brenda Edwards, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Program, EE–2J, 1000 Independence Avenue, SW., Washington, DC 20585–0121. Telephone (202) 586–2945. E-mail: *Brenda.Edwards@ee.doe.gov*.

SUPPLEMENTARY INFORMATION:

I. Summary of the Proposed Determination

EPCA requires DOE to issue a final rule determining whether to issue energy efficiency standards for non-Class A EPSs. DOE has tentatively determined that such standards are technologically feasible and economically justified, and would result in significant energy savings. Thus, DOE proposes to issue a positive determination.

DOE analyzed multiple candidate standard levels for non-Class A EPSs and has determined that it is technologically feasible to manufacture

EPSs at some of these levels because EPSs with energy efficiencies meeting these levels are currently commercially available.

DOE further determined that standards for non-Class A EPSs could be economically justified from the perspective of an individual consumer and from that of the Nation as a whole. For all EPSs that DOE analyzed, at least one standard level could be set that would reduce the life-cycle cost (LCC) of ownership for the typical consumer; that is, any increase in equipment cost resulting from a standard would be more than offset by energy cost savings.

Standards could also be cost-effective from a national perspective. The national net present value (NPV) of standards could be as much as $512 million in 2008$, assuming an annual discount rate of 3 percent. This forecast considers only the direct financial costs and benefits to consumers of standards, specifically the increased equipment costs of EPSs purchased from 2013 to 2042 and the associated energy cost savings. In its determination analysis, DOE did not monetize or otherwise characterize any other potential costs and benefits of standards such as manufacturer impacts or power plant emission reductions. If the final determination is positive, then such impacts would be examined in a future analysis of the economic feasibility of particular standard levels in the context of a standards rulemaking.

DOE's analysis also indicates that standards would result in significant energy savings—as much as 0.14 quads of energy over 30 years (2013 to 2042). This is equivalent to the annual electricity needs of 1.1 million U.S. homes.

Further documentation supporting the analyses described in this notice is contained in a separate technical support document (TSD), available from the Office of Energy Efficiency and Renewable Energy's Web site at *http://www.eere.energy.gov/buildings/appliance_standards/residential/battery_external.html.*

This document's information and format are unique to this determination analysis and do not establish a precedent for future determination analyses of the Appliance Standards Program. The unique nature of this document results from the statutory requirement that the determination be published as a rule (*i.e.,* notice of proposed rulemaking (NOPR) and final rule). In addition, although Congress, through the Energy Independence and Security Act of 2007 (EISA 2007), Public Law 110–140 (Dec. 19, 2007), directed DOE to perform this analysis, some of the analyses and information contained in this document were developed earlier as part of the determination analysis required by EPACT 2005.

A. Background and Legal Authority

Title III of EPCA sets forth a variety of provisions designed to improve energy efficiency. Part A of Title III (42 U.S.C. 6291–6309) provides for the Energy Conservation Program for Consumer Products Other Than Automobiles. The Energy Policy Act of 2005 (EPACT 2005) amended EPCA to require DOE to issue a final rule determining whether to issue efficiency standards for battery chargers (BCs) and EPSs. DOE initiated this determination analysis rulemaking in 2006, which included a scoping workshop on January 24, 2007 at DOE headquarters in Washington, DC. The determination was under way and on schedule for issuance by August 8, 2008, as originally required by EPACT 2005.

However, EISA 2007 also amended EPCA by setting efficiency standards for certain types of EPSs (Class A) and modifying the statutory provision that directed DOE to perform the determination analysis (42 U.S.C. 6295(u)(1)(E)(i)(I), as amended). EISA 2007 removed BCs from the determination, leaving only EPSs, and changed the amount of time allotted to complete the determination to 2 years after the date of EISA 2007's enactment, *i.e.,* by December 19, 2009.

In addition to the existing general definition of EPS, EISA 2007 amended EPCA to define a ''Class A external power supply'' (42 U.S.C. 6291(36)(C)) and set efficiency standards for those products (42 U.S.C. 6295(u)(3)). As amended by EISA 2007, the statute further directs DOE to publish a final rule by July 1, 2011 to evaluate whether the standards set for Class A EPSs should be amended and, if so, include any amended standards as part of that final rule. The statute further directs DOE to publish a second final rule by July 1, 2015, to again determine whether the standards in effect should be amended and to include any amended standards as part of that final rule.

Because Congress has already set standards for Class A EPSs and separately required DOE to perform two rounds of rulemakings to consider amending efficiency standards for Class A EPSs, the determination analysis under 42 U.S.C. 6295(u)(1)(E)(i)(I) does not include these products. Therefore, DOE is interpreting 42 U.S.C. 6295(u)(1)(E)(i)(I) as a requirement for a determination analysis that will consider in its scope only EPSs outside of Class A, hence ''non-Class A EPSs.'' This determination is scheduled for issuance by December 19, 2009 and is the subject of this notice. The determination will address whether efficiency standards appear to be warranted for non-Class A EPSs, *i.e.,* whether it appears that such standards are technologically feasible and economically justified and would result in significant conservation of energy (42 U.S.C. 6295(o)(3)(B)).

EISA 2007 amendments to EPCA also require DOE to issue a final rule prescribing energy conservation standards for BCs, if technologically feasible and economically justified, by July 1, 2011 (42 U.S.C. 6295(u)(1)(E)(i)(II)). This rulemaking has been bundled with the rulemaking for Class A EPSs, given the related nature of such products and the fact that these provisions share the same statutory deadline. DOE initiated the energy conservation standards rulemaking for BCs and Class A EPSs by publishing a framework document on June 4, 2009, and holding a public meeting at DOE headquarters on July 16, 2009. If DOE issues a positive determination for EPSs falling outside of Class A, it may consider standards for these products within the context of the energy conservation standards rulemaking for BCs and Class A EPSs already underway.

In addition to the determination and energy conservation standards rulemakings, DOE has conducted test procedure rulemakings for BCs and EPSs. The test procedure for measuring the energy consumption of single-voltage EPSs is codified in 10 CFR part 430, subpart B, appendix Z, ''Uniform Test Method for Measuring the Energy Consumption of External Power Supplies.'' DOE modified this test procedure, per EISA 2007, to include standby and off modes. DOE proposed a test procedure for measuring the energy consumption of multiple-voltage EPSs in its NOPR published in the **Federal Register** on August 15, 2008. 73 FR 48054. DOE has set the target date of October 31, 2010 to finalize the test procedure for multiple-voltage EPSs.

For more information about DOE rulemakings concerning BCs and EPSs, see the Office of Energy Efficiency and Renewable Energy's Web site at *http://www.eere.energy.gov/buildings/appliance_standards/residential/battery_external.html.*

B. Scope

The present determination analysis considers only those EPSs outside of Class A, or non-Class A EPSs. EPCA, as amended by EPACT 2005, defines an EPS. See 42 U.S.C. 6291(36)(A).

EISA 2007 later amended EPCA, inserting a definition for Class A EPS. See 42 U.S.C. 6291(36)(C).

Thus, the determination analysis concerns those devices that fit the definition of an EPS (from EPACT 2005) but do not fit the definition of a Class A EPS (from EISA 2007).

Considering the above definitions, DOE identified four types of power conversion devices on the market to analyze for its determination on non-Class A EPSs: (1) Multiple-voltage EPSs—EPSs that can provide multiple output voltages simultaneously; (2) high-power EPSs—EPSs with nameplate output power greater than 250 watts; (3) medical EPSs—EPSs that power medical devices and EPSs that are themselves medical devices; and (4) EPSs for battery chargers (EPSs for BCs)—EPSs that power the chargers of detachable battery packs or charge the batteries of products that are fully or primarily motor operated.

Class A EPSs, by definition, may provide only one output voltage at a time and have nameplate output power no greater than 250 watts. Multiple-voltage and high-power EPSs fall outside this group. Medical EPSs and EPSs for battery chargers are specifically excluded from Class A and can be considered non-Class A EPSs.

DOE considers both EPSs that power medical devices and EPSs that are themselves medical devices to be non-Class A EPSs. A literal reading of EPCA would exclude from Class A only those EPSs that are themselves medical devices. As EPCA states, ''The term 'class A external power supply' does not include any device that requires Federal Food and Drug Administration listing and approval as a medical device in accordance with section 513 of the Federal Food, Drug, and Cosmetic Act (21 U.S.C. 360c).'' 42 U.S.C. 6291(36)(C) However, a search of FDA's product classification database for ''power supply'' reveals only one EPS that is a medical device—auxiliary power supply (alternating current (AC) or direct current (DC)) for external transcutaneous cardiac pacemakers. Furthermore, all EPSs used with medical devices must meet the special requirements of UL 60601 (Underwriters Laboratories standard for power supplies for medical devices), discussed further in section 2.2.3 of the TSD. Accordingly, because the exclusion applies to ''any device'' covered by the FDA's listing and approval requirements, DOE interprets EPCA to also exclude from Class A those EPSs that power medical devices. Consistent with this approach, DOE analyzed those EPSs that power medical devices that are consumer products for purposes of today's proposed determination.

Lastly, DOE considered EPSs that power the chargers of detachable battery packs or charge the batteries of products that are fully or primarily motor operated. DOE refers to these two groups of products collectively as ''EPSs for BCs.'' Products that are fully or primarily motor operated include portable rechargeable household appliances such as handheld vacuums, personal care products such as shavers, and power tools.

EPCA, as amended by EISA 2007, defines a detachable battery as ''a battery that is (A) contained in a separate enclosure from the product; and (B) intended to be removed or disconnected from the product for recharging.'' (42 U.S.C. 6291(52)) The phrase ''contained in a separate enclosure from the product'' appears earlier within the Class A EPS definition. In this context, the definition limits Class A EPSs to devices ''contained in a separate physical enclosure from the end-use product,'' *i.e.,* a separate component outside the physical boundaries of the end-use consumer product. (42 U.S.C. 6291(36)(C)(i)(IV)) Similarly, when applied to detachable batteries, this phrase can also be interpreted to mean ''wholly outside the physical boundaries of the end-use consumer product.'' BCEPS Framework Document, p. 21 (June 4, 2009), available at *http://www.eere.energy.gov/buildings/appliance_standards/residential/battery_external_std_2008.html.* This is in contrast to batteries contained in an enclosure wholly or partly inside the physical boundaries of the end-use consumer product (*e.g.,* inside a battery compartment).

Further, detachable batteries must be ''intended to be removed or disconnected from the product for recharging.'' (42 U.S.C. 6291(52)(B)) Thus, even if a battery is not contained inside the product, it may not be considered detachable unless it is also intended to be removed or disconnected from the product for recharging.

Several popular models of camcorders employ wall adapters that can be used to power the camcorder and charge its battery. Even though these batteries are not contained inside the product, it is not necessary to remove them for charging. Rather, the wall adapter plugs directly into the camcorder body or into a cradle that accepts the entire camcorder. Because the batteries do not need to be removed for recharging, DOE does not consider these batteries detachable. Accordingly, wall adapters for these camcorders are included in the Class A EPS definition (42 U.S.C. 6291(36)(C)(ii)(II)) and, therefore, are not analyzed in this determination.

The statute does not provide clear guidance for determining which, if any, of the devices that power battery-charged products are EPSs and leaves open the issue of how DOE should classify the wall adapters that are part of battery charging systems. Because ''external power supply'' has a specific legal meaning, the term ''wall adapter'' is used to refer to the potentially larger set of external power converters for consumer products. DOE's initial review of these products indicates that some of these wall adapters for battery chargers could be electrically equivalent to the wall adapters that power applications other than battery chargers. However, while all wall adapters ''convert household electric current into DC current or lower-voltage AC current,'' as stated in the statutory definition (42 U.S.C. 6291(36)(A)), at least some wall adapters for battery chargers also provide additional charge control functions necessary for battery charging. These additional functions may add to the cost and power consumption of the wall adapter. These wall adapters generally are not interchangeable, but are designed to be components of specific BCs.

DOE is considering adopting one of two approaches relevant to this determination analysis with respect to when a wall adapter would be categorized as an EPS. The approaches differ in their scope of coverage for EPSs. Under the first approach (Approach A), DOE would consider only those wall adapters that do not provide additional charge control functions to be EPSs. These EPSs have constant-voltage output that is electrically equivalent to Class A EPSs. Under the other approach (Approach D), DOE would consider wall adapters with and without charge control functions to be EPSs. These include EPSs with constant-voltage output equivalent to Class A EPSs as well as those that do not have constant-voltage output, which may indicate the presence of charge control. The approaches are described in greater detail in section 3.2.3.3 of DOE's framework document for the BC and EPS energy conservation standards rulemaking (available at *http://www.eere.energy.gov/buildings/appliance_standards/residential/battery_external_std_2008.html*). Interested parties are encouraged to refer to the framework document for more detail and provide input to DOE on the approaches. (Other approaches described in that document are not used in today's analysis because either they would conflict with statutory requirements, *i.e.*, Approach B, or would be equivalent in scope to Approach A, *i.e.*, Approach C.) DOE will consider all comments received in its selection of an approach.

The present determination analysis includes only those devices that are EPSs under Approach A (wall adapters without charge control). Under Approach A, this draft determination finds that energy efficiency standards are economically justified, technologically feasible, and would result in significant energy savings. Based on the data collected to date, the set of EPSs under Approach A is a subset of EPSs under Approach D. Thus, DOE believes that were it to adopt the broader Approach D, the energy savings potential from standards for non-Class A EPSs would be greater compared to Approach A. DOE seeks comment on whether Approach A reasonably estimates the minimum amount of significant energy savings under this analysis.

While the approaches noted above address the question of what is and is not an EPS, there are additional scoping issues unique to non-Class A EPSs. In particular, there are four criteria under which an EPS could be considered non-Class A: (1) Multiple output voltages, (2) high output power, (3) designed for medical use, and (4) designed for battery charging. This determination analysis examines EPSs that meet any one of these criteria, but not those EPSs that meet multiple criteria. These EPSs remain within the scope of the determination, however. For instance, this analysis does not evaluate EPSs such as the Astec Electronics power supply model DPT54–M, which has three simultaneous output voltages and UL 60601 medical certification, although it does address EPSs with either multiple output voltages or medical certification under UL 60601. Based on its review of the available data, DOE believes that there are few products that fall into this ''multiple criteria'' category. Accordingly, a separate analysis for these types of products was not conducted because the energy savings potential from incorporating these devices into the analysis would again be greater compared to the analysis under Approach A.

II. Methodology

A. Market Assessment

1. Introduction

To understand the present and future market for non-Class A EPSs, DOE gathered data on these EPSs and their associated applications. DOE also examined the industry composition, distribution channels, and regulatory and voluntary programs for non-Class A EPSs. The market assessment provides important inputs to the LCC analysis and national energy savings (NES)/NPV estimates.

This notice is not intended to provide a general background on the market for all EPSs, but rather to present specific information for those EPSs outside of Class A. For additional background information on EPSs in general, see the framework document and the companion draft technical report published on June 4, 2009.

a. Overview

External power supplies are designed for use with an associated consumer product. The market for these consumer products drives the market for EPSs. References to an EPS application refer to the consumer product that the EPS powers and not the conversion function of the EPS itself. Energy savings potential for EPSs is thus a function of usage and sales volume of applications powered by EPSs, in addition to EPS efficiency.

Because EPSs are typically sold with their end-use application, shipment data for EPSs alone are not directly available. Therefore, DOE estimated EPS shipments based on applications known to use them. The amount of energy an application uses over the course of a year will directly affect the amount of savings that can be expected by improving the efficiency of the EPS. The product application determines the power requirements, usage profile, and load profile of the EPS.

For its market analysis, DOE first identified those applications known to use non-Class A EPSs. DOE then analyzed shipments and energy usage data for those applications to calculate shipments and energy usage of the associated EPSs. DOE considered applications for which publicly available data exist or for which industry and other interested parties provided data.

Applications for each of the four types of non-Class A EPS DOE identified are discussed below.

b. Multiple-Voltage External Power Supplies

The consumer product market for EPSs with multiple simultaneous outputs (multiple-voltage EPSs) is limited. For consumer products that require multiple voltages, most manufacturers indicated that it is more cost effective to specify a single output EPS and employ local DC–DC converters located within the application rather than a multiple-voltage EPS. Multiple-voltage EPSs are commonly used in only two circumstances:

(1) Low-volume applications, such as lab equipment and product prototypes, where designing and implementing an internal splitter would be cost-prohibitive. Because low-volume applications are, by definition, limited in market size, DOE will not consider EPSs for these products further.

(2) High-volume applications where space limitations may cause manufacturers to seek alternatives to an internal power supply with voltage splitting circuitry.

DOE has identified three consumer product applications that sometimes use multiple-voltage EPSs: Video game consoles, multi-function devices (MFDs), and home security systems.

The Xbox 360, manufactured by Microsoft Corporation, is one video game console that uses a multiple-voltage EPS. This EPS functions much like the internal power supply of a desktop computer, providing separate voltage levels for standby, monitoring, and processing functions. Competing systems such as the Nintendo Wii and Sony PlayStation 3 use internal power supplies.

Multi-function devices duplicate the functions of some or all of the following devices: Copiers, printers, scanners, and facsimile machines. These devices are also commonly referred to as ''all-in-one'' systems or multifunction printers. MFDs eliminate the need to purchase and maintain multiple pieces of office equipment and typically are used in small- or home-office settings. A single multiple-voltage EPS design can be used across multiple MFD models, eliminating the need to design and build several different internal splitters. Also, using a multiple-voltage EPS may allow the MFD to have a smaller form factor, which refers to the physical size of the application.

Security systems in homes may include entry detection, video and thermal detection, and emergency and fire alert systems. Such equipment is often used in conjunction with a security subscription through which a security services company monitors the equipment for the consumer. In this way, security equipment is distributed and used in a similar manner to cable set-top boxes and Internet modems provided by telecommunications companies. In comments submitted to DOE following the Standby and Off Mode Test Procedure NOPR Public Meeting on September 12, 2008, the Security Industry Association indicated that some of these products may be powered by multiple-voltage EPSs (Docket No. EERE–2008–BT–TP–0004. Security Industry Association, No. 7 at p. 2.). However, in a follow-up interview on March 19, 2009, SIA indicated that the equipment powered by these multiple-voltage EPSs is limited to fire alarm systems, specifically to power horns and strobe light control circuitry in commercial buildings, not homes. Based on this information, DOE did not analyze the multiple-voltage EPSs used to power security equipment as part of the draft analysis. DOE encourages interested parties to submit additional data on the use of multiple-voltage EPSs with home security equipment. DOE also encourages interested parties to submit information about any other consumer product applications for multiple-voltage EPSs they are aware of.

c. High Power External Power Supplies

High-power EPSs—those with output power greater than 250 watts—are rarely used to power consumer products. Internal power supplies are generally preferred for higher powered applications. Industry experts give three reasons for this preference. First, internal power supplies offer increased ventilation options, including fans, vent slats, and cooling fins, all of which would be difficult to include in most EPS designs without increasing bulk. Second, most applications that would require such a high power input will already be large, which means the increase in volume from the internal power supply would have a proportionally small effect. Third, power regulation and voltage drop are much easier to control with an internal supply due to the shorter transmission distances.

For these reasons, there are few circumstances in which an appliance uses a high-power EPS rather than an internal power supply. In fact, many appliances already use internal power supplies at a wide range of power levels. Major applications for high power internal power supplies include audio amplifiers, televisions, and computers.

Amateur radio equipment is the only consumer product application DOE identified as using high-power EPSs. (Other applications identified include laboratory testing equipment and other low-volume applications that were not considered for analysis.) Amateur radio operators typically use high-power EPSs when they need to power multiple components simultaneously and transmit at output powers between 100 and 200 watts. (Interview with the with the American Radio Relay League on August 18, 2008.) Operators typically use an EPS with nameplate output power greater than 250 watts to allow for a cushion should equipment requiring additional power be added to the set-up. This is often the case for portable transmission setups, such as those used at amateur radio fairs or in emergency situations. In both cases, the need to power multiple components while maintaining sufficient transmission power requires an EPS with a suitably high output.

However, in home or office use, most radio operators use a more standardized setup. In this environment, most amateur radio equipment, including transmission equipment, is designed to run directly off mains power, using internal power supplies. In addition, when transmitting at higher power, a radio operator will likely use a separate signal amplifier that contains an internal power supply. Therefore, EPSs are seldom used in fixed transmission setups.

d. External Power Supplies for Medical Devices

EPSs are used to power a wide variety of medical devices, from laboratory test equipment to home care devices. As discussed further in section 2.2.3 of the TSD, EPSs are required by the Federal Food and Drug Administration (FDA) to meet labeling, safety and durability requirements such as those included under UL 60601. To maintain certification, the medical device manufacturer must always use the same components in the device, including those used in the EPS. Therefore, once a device is certified, its EPS cannot be exchanged for a different EPS model without re-certification. An EPS model must also use the same individual components for the entirety of the production cycle. These requirements tend to lengthen the design cycles for medical device EPSs because after being designed they must be registered, which can take up to 2 years. Despite long design cycles, there are already medical device EPSs on the market that meet the energy efficiency standards for Class A EPSs that took effect on July 1, 2008. (SL Power Web site (Accessed October 30, 2008) *http://www.slpower.com/ProductDetails.aspx?CategoryID=46*.)

For this determination, DOE examined medical devices designed for in-home use that employ EPSs, specifically sleep therapy devices, nebulizers, portable oxygen concentrators, blood pressure monitors, and ventilators. EPSs for these medical devices exhibit a broad range of nameplate output powers, similar to those of Class A EPSs.

Sleep therapy devices include continuous positive airway pressure (CPAP), bi-level positive airway pressure (biPAP), automatic positive airway pressure (autoPAP), and similar machines used to treat obstructive sleep apnea. Some sleep therapy devices are battery powered, some plug directly into mains, and others are powered by EPSs, which typically have nameplate output power of approximately 30 to 35 watts. (Schirm, Jeffrey. Personal Communication. Philips Electronics, NV. Phone call with Matthew Jones, D&R International. December 15, 2008.)

Nebulizers administer liquid medication as a mist that can be inhaled into the lungs. They are commonly used to treat asthma and chronic obstructive pulmonary disease (COPD). The EPSs that provide power to nebulizers tend to have nameplate output power in the range of 10 to 20 watts. Of the 26 nebulizer models DOE identified, only four employ EPSs; the remainder use internal power supplies. (Models using EPSs include the PARI Trek S, Omron Comp Air Elite Model NE–C30, Omron Micro Air Model NE–U22VAC, and John Bunn Nano-Sonic Nebulizer Model JB0112–066. An EPS is an option for Omron Micro Air, which is typically powered with primary batteries. The EPS cannot charge these batteries. The other nebulizers are sold with an EPS to power the product but offer rechargeable battery packs as an optional accessory.)

Portable oxygen concentrators absorb nitrogen from the air to provide oxygen to the user at higher concentrations, eliminating the need for oxygen tanks. These devices typically use higher powered wall adapters ranging from 90 to 200 watts. The wall adapters are used to charge batteries, but can also operate the device directly.

Blood pressure monitors are used by those who must take frequent readings of their blood pressure. Most digital units operate with primary batteries; however, some units are also sold with an EPS or offer an optional EPS. (The Omron IntelliSense blood pressure meter, model HEM780, has an EPS rated at 6V and 500 mA but can also be powered by primary batteries (''AA,'' ''AAA,'' ''C,'' among others).) The EPSs for blood pressure monitors that DOE identified have a nameplate output power of 3 watts.

Though most commonly found in hospitals, ventilators are also available for home use. While most models have internal power supplies, some use EPSs with output power in the range of approximately 100 to 150 watts.

e. External Power Supplies for Certain Battery Chargers

This group is composed of EPSs for two types of battery chargers: (1) Battery chargers used to charge detachable battery packs, and (2) battery chargers that charge the batteries of products that are fully or primarily motor operated. The term ''detachable battery'' means a battery that is (A) contained in a separate enclosure from the product; and (B) intended to be removed or disconnected from the product for recharging. DOE's interpretation of ''detachable battery'' is explained in section I.B.

Under its interpretation of the term ''detachable battery,'' DOE has not identified any non-motor operated applications with an EPS that powers the charger of a detachable battery pack. DOE invites interested parties to submit any information they have about applications of this type that use non-Class A EPSs.

DOE identified a number of motor-operated, battery-charged products that use wall adapters. The applications DOE identified can be divided into two groups: rechargeable power tools and cordless rechargeable household appliances. The latter can be further subdivided into kitchen appliances (*e.g.*, can openers and electric knives), personal care appliances (*e.g.*, electric toothbrushes, shavers, and trimmers), and floor care appliances (*e.g.*, handheld vacuums and robotic vacuums).

Although there are many grades of cordless-rechargeable power tools—ranging from entry-level, do-it-yourself (DIY) tools intended for occasional homeowner use to high-end tools designed for frequent use by professionals—all can be purchased and used by consumers and, thus, are considered consumer products. However, it appears that very few, if any, professional-grade power tools use wall adapters. Instead, the charging base is plugged directly into mains. Thus, DOE only considered DIY tools.

DOE has included in the present determination analysis only those devices that are EPSs under Approach A (only those wall adapters that do not provide additional charge control functions are EPSs), with the understanding that the set of EPSs under Approach A is a subset of EPSs under Approach D (wall adapters with charge control functions are also EPSs). Thus, the analysis presents the minimum level of expected energy savings from a potential standard for these products. If DOE were to later adopt Approach D (*i.e.*, include coverage of wall adapters with charge control functions), the energy savings potential from standards for non-Class A EPSs would either increase or remain unchanged, but would not decrease below the current analysis' projected energy savings potential.

2. Shipments, Efficiency Distributions, and Market Growth

a. Overview

Based on its market analysis, DOE estimates that 11.3 million non-Class A EPSs are sold in the United States each year. For the national impact analysis, DOE also created forecasts of market size to 2032, the last year of sales in the analysis. Table II.1 summarizes DOE's estimates of market size and growth rate for each type of non-Class A EPS. These estimates are discussed in detail in the subsections that follow.

TABLE II.1—MARKET SIZE AND GROWTH PROSPECTS FOR NON-CLASS A EXTERNAL POWER SUPPLIES

Type of external power supply	Market size in 2008 (shipments per year)	Annual growth rate (percent)
Multiple-Voltage EPSs for Multifunction Devices	5,085,000	1
Multiple-Voltage EPSs for Xbox 360	4,000,000	3
High-Power EPSs	3,000	0
Medical EPSs	1,450,000	3
EPSs for Cordless Rechargeable Floor Care Appliances *	297,000	1
EPSs for Cordless Rechargeable Power Tools *	499,400	2
Total	11,334,400	

* DOE estimates that a maximum of 5 percent of the wall adapters that ship with products of this type are EPSs under Approach A.

Source: DOE estimated long-run growth rates by examining published shipments growth estimates (both past and projected) from the Consumer Electronics Association (CEA) (''U.S. Consumer Electronics Sales and Forecasts 2004–2009'', Consumer Electronics Association, July 2008), *Appliance Magazine* (''31st Annual Portrait of the U.S. Appliance Industry'', Appliance Magazine, September 2008) the Darnell Group (*External AC–DC Power Supplies Worldwide Forecasts, Third Edition.* Special estimate for North America, Darnell Group. May 2008), and others.

In addition to assessing the size of the market for each EPS type, DOE also assessed the efficiency of those EPSs. DOE defined four candidate standard levels (CSLs) for each EPS type and described market distribution in terms of efficiency across those levels (section II.C.4) DOE also created two base-case forecasts of efficiency distribution to 2032. These efficiency distributions describe the market in the absence of a standard and are required as a point of comparison in the national impact analysis. DOE's characterizations of present-day efficiency and its efficiency forecasts are also discussed in detail in the following subsections.

b. Multiple-Voltage External Power Supplies

EPSs for Multifunction Devices

In field research, DOE found that Hewlett-Packard (HP) manufactures all those MFDs that currently use multiple-voltage EPSs. In August 2008, DOE visited five retail outlets to determine which MFDs use multiple-voltage EPSs. DOE inspected 87 unique MFD models for sale at Best Buy, Circuit City, Office Depot, Staples, and Target. Of these 87 models, 16 used multiple-voltage EPSs; the remainder either had internal power supplies or used single-voltage EPSs. Many of these models were among the top-selling MFDs on Amazon.com, BestBuy.com, and CircuitCity.com.

In a written comment DOE received in October 2008 in connection with its Standby and Off Mode Test Procedure rulemaking, HP indicated that it plans to phase out multiple-voltage EPSs. It stated, ''About 45% of HP's total current usage of external-style power supplies is made up [multiple-voltage output power supplies (MVOPS)]. HP is planning to eliminate the use of MVOPS by early 2010. So our product designs will consist entirely of [single-voltage output power supplies].'' (Comment from Hewlett-Packard dated October 29, 2008. Docket Number EERE–2008–BT–

TP–0004. Comment #30.) Nevertheless, DOE is including multiple-voltage EPSs for MFDs in its analysis as some MFDs may continue to ship with multiple-voltage EPSs after 2010, or new applications with similar power requirements may be introduced.

Based on the available data, DOE estimated that 5,085,000 multiple-voltage EPSs for MFDs shipped for sale in the United States in 2008. Using data from Gartner Dataquest and the Consumer Electronics Association, DOE estimated that about 20 million inkjet printers and MFDs shipped in 2008. (Gartner Dataquest. ''Gartner Says United States Printer and MFP Shipments Declined 4 Percent in Second Quarter of 2006.'' August 2006. Last accessed February 27, 2009, *http://www.gartner.com/it/page.jsp?id=496184&format=print.*; Consumer Electronics Association. *U.S. Consumer Sales and Forecasts, 2004–2009.* July 2008. CEA: Arlington, VA.) According to Gartner Dataquest, HP controlled 56.4 percent of the inkjet printer/MFD market in the second quarter of 2006. DOE assumed HP's market share remained unchanged in 2008, resulting in shipments of 11.3 million HP inkjet printers and MFDs that year. As HP claimed that 45 percent of its EPSs are multiple-voltage EPSs, DOE estimated that 5,085,000 multiple-voltage EPSs for use with MFDs (45 percent of 11.3 million) were shipped in 2008. Given HP's stated intent to discontinue use of multiple-voltage EPSs, DOE assumed in its model a modest market growth rate of 1 percent annually.

DOE defined four CSLs for multiple-voltage EPSs for MFDs (Table II.2) DOE tested two multiple-voltage EPSs for MFDs, and neither unit tested above CSL 0. Thus, DOE assumed that all units on the market today are at CSL 0.

TABLE II.2—EFFICIENCY OF MULTIPLE-VOLTAGE EXTERNAL POWER SUPPLIES FOR MFDS

Candidate standard level (CSL)	Minimum active mode efficiency (percent)	Maximum no-load power (W)	Market share (percent)	Shipments
0. Current Level	81	0.50	100	5,085,000
1. Mid Level	86	0.45	0	0
2. High Level	90	0.31	0	0
3. Higher Level	91	0.20	0	0
All Levels	....	....	100	5,085,000

DOE estimated the market distribution across CSLs using test data from two units.

DOE examined two base case efficiency forecasts in its national impact analysis. In the first, efficiency does not improve during the period of analysis. In the second, which considered spillover effects from existing Class A EPS standards, non-Class A EPSs for MFDs gradually become more efficient throughout the period of analysis, with three-quarters of the market still at CSL 0 and the remainder at CSL 1 in 2032, the last year of sales.

EPSs for the Xbox 360

The NPD group estimates that since its release of the Xbox 360 in November 2005, more than 14 million units have been sold in the United States at an annual average of 4 million units. (NPD Group, reported from *http://www.joystiq.com* archives, last accessed February 28, 2009.) Because demand for a specific video game console is generally driven by novelty, the majority of shipments for a given model tend to occur early in its production cycle, with shipments generally decreasing over time as newer competing consoles or next-generation consoles become available. Therefore, DOE assumed a market size of 4 million units in the base year.

The market for video game consoles, including the Xbox 360, has grown considerably in recent years, and analysts expect the market to continue growing annually at between 5 percent (''U.S. Consumer Electronics Sales and Forecasts 2004–2009,'' Consumer Electronics Association, July 2008) and 10 percent (''External AC–DC Power Supplies Worldwide Forecasts, Third Edition.'' Special estimate for North America by the Darnell Group. May 2008.) Because the market for the Xbox 360 represents a subset of the console market, DOE developed a conservative growth forecast for this market of 3 percent annual growth.

DOE defined four CSLs for multiple-voltage EPSs for the Xbox 360 (Table II.3). An estimated 95 percent of units on the market today—those units sold with the Xbox 360—have average active-mode efficiency of 86 percent and consume 0.4 watts in no-load mode. Replacement units, which have poorer energy performance, comprise the remaining 5 percent of the market.

TABLE II.3—EFFICIENCY OF MULTIPLE-VOLTAGE EXTERNAL POWER SUPPLIES FOR XBOX 360

Candidate standard level (CSL)	Minimum active mode efficiency (percent)	Maximum no-load power W	Market share (percent)	Shipments
0. Generic Replacement	82	12.33	5	200,000
1. Manufacturer Provided	86	0.40	95	3,800,000
2. EU Qualified Level	86	0.30	0	0
3. Higher Level	89	0.30	0	0
All Levels	....	....	100	4,000,000

DOE estimates are based on test data and market share of generic replacements for the Xbox 360 EPS.

DOE examined two base-case efficiency forecasts in its national impact analysis. In the first, efficiency does not improve during the period of analysis. In the second, EPSs for the Xbox 360 gradually become more efficient. No units remain at CSL 0 in 2018, the sixth year after the standard is assumed to take effect. By 2032, one-quarter of the market has moved up to CSL 2, while the remainder is at CSL 1.

c. High Output Power External Power Supplies

Due to the highly specialized and relatively uncommon application of high power external power supplies, only about 30,000 units are in use. (Communication with the American Radio Relay League (August 2008). Despite the inherent limitations of high-power EPSs and the increasing use of internal power supplies for home amateur radio equipment setups, DOE expects the market for high-power EPSs to remain level throughout the analysis period based on input from the Amateur Radio Relay League. Given an average lifetime of 10 years and assuming that the same number of new units is put into service each year that is taken out of service, it follows that approximately 3,000 new units are put into service each year. (DOE interview with manufacturer, September 15, 2008.)

Table II.4 shows the four CSLs DOE defined for high-power EPSs. Line frequency EPSs account for an estimated 60 percent of the market; switched-mode EPSs comprise the remaining 40 percent. Line frequency EPSs historically have been preferred over switched-mode EPSs for amateur radio applications. However, they are slowly losing market share to switched-mode EPSs, which are considerably more efficient and much less expensive.

TABLE II.4—EFFICIENCY OF HIGH POWER EXTERNAL POWER SUPPLIES

Candidate standard level (CSL)	Minimum active mode efficiency (percent)	Maximum no-load power (W)	Market share (percent)	Shipments
0. Line Frequency	62	15.43	60	1,800
1. Switched Mode—Low	81	6.01	40	1,200
2. Switched Mode—Mid	84	1.50	0	0
3. Switched Mode—High	85	0.50	0	0
All Levels	....	....	100	3,000

DOE estimates are based on test data and manufacturer interviews.

In the first base-case efficiency forecast in its national impact analysis, efficiency does not improve during the period of analysis. In the second forecast, increased consumer preference for switched-mode high-power EPSs and spillover effects from existing Class A EPS standards lead to efficiency improvements in high-power EPSs. In this second forecast, high-power EPSs at CSL 2 are introduced in 2010 and gradually become more efficient throughout the period of analysis. By 2032, 38 percent of units remain at CSL 0, 40 percent are at CSL 1, and the remaining 22 percent have reached CSL 2.

d. External Power Supplies for Medical Devices

DOE examined those medical devices that are used in home-care settings and employ an EPS. An estimated 1.45 million of these devices shipped in 2008. (*External AC–DC Power Supplies Worldwide Forecasts, Third Edition.* Special estimate for North America by the Darnell Group. May 2008.) This market is expected to grow at an average rate of 11.4 percent per year between 2008 and 2013. The reasons for this growth are numerous. Over this period, the population aged 65 and older is expected to grow at 2.5 percent per year, compared to 0.75 percent per year for the population under age 65. (U.S. Population Projections.'' U.S. Census Bureau. 2008.) Demand for home care devices is increasing as the high cost of hospital stays encourages home care. (''DME Market of the Future.'' *Home Care Magazine.* July 1, 2000.) Patients' demands for greater portability are also driving an increase in the number of medical devices that can operate on battery power, some of which require wall adapters. (''Oxygen Concentrator Market Opportunities, Strategies, and Forecasts, 2005 to 2011.'' Wintergreen Research. 2005.) Finally, in some cases, medical device manufacturers can bring new products to market faster by using an EPS. (Personal communication. Phone call with Marco Gonzalez, Director of Supplier Management for Power. Avnet Inc. September 30, 2008.) This last trend in particular is increasing the number of medical devices using EPSs with output power greater than 90 watts. DOE forecasts the long term growth rate of medical device EPSs for consumer products to be 3 percent per year.

Additionally, the market for sleep therapy devices shows significant potential for growth. Based on available studies, DOE estimates that approximately 20 million Americans experience a moderate form of obstructive sleep apnea, which causes the afflicted to stop breathing momentarily during sleep. (''What is Sleep Apnea?'' National Heart Lung and Blood Institute Diseases and Conditions Index. *http://www.nhlbi.nih.gov/health/dci/Diseases/SleepApnea/SleepApnea_WhatIs.html.*) As the number of diagnoses of obstructive sleep apnea increases, demand for sleep therapy devices, one of the most common treatments for the condition, increases as well. DOE estimates that approximately 50 percent of sleep therapy devices, or about 1 million new units annually, are powered by EPSs. (Schirm, Jeffrey. Personal communication. Philips Electronics, NV. Phone call with Matthew Jones, D&R International. December 15, 2008.)

Nebulizers are commonly used to treat asthma and chronic obstructive pulmonary disease (COPD). An estimated 22 million Americans have been diagnosed with asthma, and an additional 12 million Americans have been diagnosed with COPD. (''What is Asthma?'' National Heart Lung and Blood Institute Diseases and Conditions Index. *http://www.nhlbi.nih.gov/health/dci/Diseases/Asthma/Asthma_WhatIs.html.;* ''What is COPD?'' National Heart Lung and Blood Institute Diseases and Conditions Index. *http://www.nhlbi.nih.gov/health/dci/Diseases/Copd/Copd_WhatIs.html.*) The prevalence of COPD is increasing as the population ages. The incidence of asthma has also increased over time. A June 2005 report, ''U.S. Nebulizers and Markets,'' indicates that portable nebulizers, which are more likely to employ EPSs, have taken market share from non-portable units. (''U.S. Nebulizers and Markets.'' Frost & Sullivan. June, 2005.) From the available data, DOE estimates shipments of nebulizers to be 3 million units per year. However, DOE observed only a few examples that use EPSs. Accordingly, DOE assumes 15 percent of nebulizers, or 450,000 units per year, employ an EPS.

DOE did not consider the remaining three applications—ventilators, blood pressure monitors, and portable oxygen concentrators—further in the determination analysis. Very few ventilators or blood pressure monitors employ EPSs. Due to time constraints, DOE did not analyze or develop cost-efficiency curves for medical EPSs with high output power, so portable oxygen concentrators also were not included in the analysis. DOE may examine these products as part of a possible future standards rulemaking for medical EPSs.

DOE defined four CSLs for medical EPSs (Table II.5). DOE believes that roughly 66 percent of medical EPSs sold into the market today meet the Federal standard for Class A EPSs and could be labeled according to the international efficiency marking protocol with a ''IV''. The international efficiency marking protocol, initiated by the ENERGY STAR program and adopted by the U.S., Australia, China and Europe, provides a system for power supply manufacturers to designate the minimum efficiency performance of an external power supply, so that finished product manufacturers and government representatives can easily determine a unit's efficiency. Under this protocol manufacturers place a roman numeral from I (less efficient) to V (more efficient) on an EPS that corresponds to the EPS's efficiency. For instance, the mark of ''IV'' corresponds to the efficiency of the EISA 2007 standard. More information on the protocol can be found on the ENERGY STAR Web site at: *http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/International_Efficiency_Marking_Protocol.pdf.*

DOE based its view regarding the ability of medical EPSs to satisfy current Federal Class A standards enacted by Congress on available test results and its understanding that SL Power, a leading manufacturer of medical EPSs, is designing its EPSs for medical devices to meet the standard for Class A EPSs. Competing medical EPS manufacturers such as Elpac and GlobTek are also beginning to offer EPSs that meet the Class A standard. From this information, DOE assumes that 17 percent of units are less efficient and that the remaining 17 percent of units are more efficient.

TABLE II.5—EFFICIENCY OF MEDICAL EXTERNAL POWER SUPPLIES

Candidate standard level (CSL)	Minimum active mode efficiency (percent)	Maximum no-load power W	Market share (percent)	Shipments
0. Less than the II Mark	66	0.56	17	246,500
1. Meets the IV Mark	76	0.50	66	957,000
2. Meets the V Mark	80	0.30	17	246,500
3. Higher Level	85	0.15	0	0
All Levels			100	1,450,000

DOE estimated shipment distributions based on test results from six units.

In the first base-case efficiency forecast in the national impact analysis, efficiency does not improve during the period of analysis. In the second forecast, additional manufacturers adopt Class A EPS standards for medical device EPSs, which are projected to become gradually more efficient throughout the period of analysis. By 2032, 5 percent of units remain at CSL 0, 54 percent of the market is at CSL 1, and the remaining 41 percent of units are at CSL 2.

e. External Power Supplies for Certain Battery Chargers

As noted above, DOE identified several battery-powered applications that could potentially use non-Class A EPSs. Many of these applications were excluded from further consideration because DOE's analysis indicated they accounted for only a trivial amount of non-Class A EPS energy consumption. Battery-powered kitchen appliances were excluded because only a small number of units are sold annually. Personal care products were excluded because wall adapters used to power these products typically incorporate battery-charging circuitry and are unlikely to be EPSs under Approach A. Furthermore, personal care products that employ EPSs spend the vast majority of their time unplugged and stowed. (Comments on the Framework Document for Battery Chargers and External Power Supplies (74 FR 26816). Philips Electronics (Philips, No. 22 at p. 3).) Lawn mowers and yard trimmers were excluded because those models that have wall adapters are unlikely to be EPSs under Approach A. However, DOE did include two of these applications in the determination analysis: Floor care appliances and power tools.

Floor Care Appliances

DOE estimated that almost 6.5 million cordless rechargeable floor care appliances shipped in 2007. (Based on estimates of all stick vacuum and handheld vacuum shipments in ''31st Annual Portrait of the U.S. Appliance Industry,'' *Appliance Magazine,* September 2008.) DOE further estimates that approximately 90 percent or 5.9 million of those units use wall adapters. (Wayne Morris. Personal Communication. Association of Home Appliance Manufacturers. Letter to Victor Petrolati (DOE) and Michael Scholand (Navigant Consulting). August 11, 2006.) DOE lacks reliable data to determine what fraction of these wall adapters provide constant voltage and are therefore EPSs. In the absence of reliable data, DOE's preliminary estimate is that a maximum of 5 percent of these wall adapters, or 297,000 units per year, are EPSs (see Table II.6). DOE welcomes input on the accuracy of these estimates.

TABLE II.6—ANNUAL SHIPMENTS OF FLOOR CARE APPLIANCES

Type of floor care appliance	Total	Cordless rechargeable units		
		Total	With wall adapter	
			Total	Without charge control (EPS)
Handheld Vacuums	5,580,000	3,683,000	3,315,000	166,000
Stick Vacuums	4,500,000	1,800,000	1,620,000	81,000
Robotic Vacuums	1,000,000	1,000,000	1,000,000	50,000
All Types	11,080,000	6,483,000	5,935,000	297,000

Despite the stable market for floor care appliances, improvements in battery technology and the greater adoption of robotic vacuums may enable growth in the cordless rechargeable segment of the market. (''Robot Home Vacuum Cleaning, Cooking, Pool Cleaning, and Lawn Mowing Market Strategy, Market Shares, and Market Forecasts, 2008–2014.'' Electronics.ca Publications. January 2008.) Thus, DOE forecasts 1 percent annual growth in the size of the market for cordless rechargeable floor care appliances.

DOE defined four CSLs for EPSs that power the BCs of cordless rechargeable floor care appliances (Table II.7). Based on test data from 12 EPS units, DOE believes that three-quarters of EPSs for floor care appliances sold today meet or exceed the Federal standard for Class A EPSs and could be labeled according to the international efficiency marking protocol with a ''IV'' or ''V.'' DOE assumes that 8 percent of these units are somewhat less efficient, but could still be labeled with a ''II,'' while the remaining 17 percent of units are even less efficient.

TABLE II.7—EFFICIENCY OF EXTERNAL POWER SUPPLIES FOR CORDLESS RECHARGEABLE FLOOR CARE APPLIANCES

Candidate standard level (CSL)	Minimum active mode efficiency (percent)	Maximum no-load power (W)	Market share (percent)	Shipments
0. Less than the II Mark	24	1.85	17	50,490
1. Meets the II Mark	45	0.75	8	23,760
2. Meets the IV Mark	55	0.50	58	172,260
3. Meets the V Mark	66	0.30	17	50,490
All Levels			100	297,000

DOE estimated market distributions based on test data of 12 Class A EPSs.

In the first base-case efficiency forecast in the national impact analysis, efficiency does not improve during the period of analysis. In the second forecast, EPSs for BCs that power cordless rechargeable floor care appliances gradually become more efficient throughout the period of analysis. By 2032, 5 percent of units remain at CSL 0, 20 percent of units are at CSL 1, 52 percent of units are at CSL 2, and the remaining 23 percent of units are at CSL 3.

DIY Power Tools

DOE estimates that 499,400 wall adapters without charge control (EPSs) are sold annually for use with rechargeable power tools. This is a preliminary estimate based on the assumptions shown in Table II.8. As noted above, professional tools, which DOE assumed account for 50 percent of shipments, do not employ wall adapters. The remaining 50 percent, the DIY tools, can be divided into those with a detachable battery and those with an integral battery. DOE assumed that the former account for 30 percent and the latter 20 percent of the market. Based on data obtained from the Power Tool Institute, DOE estimated that 80 percent of DIY tools with detachable batteries and 100 percent of DIY tools with integral batteries employed wall adapters. DOE's preliminary estimate is that a maximum of 5 percent of those 9,990,000 wall adapters lack charge control and, thus, are considered EPSs under Approach A.

TABLE II.8—SHIPMENTS OF CORDLESS RECHARGEABLE POWER TOOLS

Type of power tool	Percent of shipments	Annual unit shipments	With wall adapter (percent)	With wall adapter	Wall adapter without charge control (percent)	Wall adapter without charge control
Professional	50	11,350,000	0			0
DIY with Detachable Battery	30	6,810,000	80	5,450,000	5	272,400
DIY with Integral Battery	20	4,540,000	100	4,540,000	5	227,000
All Tools	100	22,700,000		9,990,000		499,400

According to forecasts from the Darnell Group, the market for cordless rechargeable power tools will continue to grow at an average annual rate of 10.6 percent until 2013. This growth is attributed to a falling cost for increasingly powerful and flexible tools. DOE believes that short-term growth will be tempered by the slowdown in the construction and remodeling industries. Given these factors, DOE estimates long-term shipments growth of 2 percent per year.

DOE defined four CSLs for EPSs that power the BCs of cordless rechargeable power tools (Table II.9). Based on test data from 12 EPS units, DOE believes that three-quarters of power tool EPSs sold into the market today meet or exceed the Federal standard for Class A EPSs and could be labeled according to the international efficiency marking protocol with a ''IV'' or ''V.'' DOE assumes that 8 percent of units are somewhat less efficient, but could still be labeled with a ''II,'' while the remaining 17 percent of units are even less efficient.

TABLE II.9—EFFICIENCY OF EXTERNAL POWER SUPPLIES FOR RECHARGEABLE POWER TOOLS

Candidate standard level (CSL)	Minimum active mode efficiency (percent)	Maximum no-load power (W)	Market share (percent)	Shipments
0. Less than the II Mark	38	1.85	17	84,898
1. Meets the II Mark	56	0.75	8	39,952
2. Meets the IV Mark	64	0.50	17	84,898
3. Meets the V Mark	72	0.30	58	289,652
All Levels			100	499,400

DOE estimated market distributions based on test data of 12 EPSs.

In the first base-case efficiency forecast in the national impact analysis, efficiency does not improve during the period of analysis. In the second forecast, the less efficient EPSs for BCs that power cordless rechargeable power tools gradually become more efficient throughout the period of analysis. By 2032, 5 percent of units remain at CSL 0 and the market for units at CSL 1 increases to 20 percent. EPSs at CSL 2 and CSL 3 continue to comprise 17 percent and 58 percent of the market, respectively.

3. Product Lifetimes

a. Overview

DOE considers the lifetime of an EPS to be from the moment it is purchased for end-use up until the time when it is permanently retired from service. Because the typical EPS is purchased for use with a single associated application, DOE assumes that the EPS will remain in service for as long as the application does. High-power EPSs are the exception, as they are purchased separately, not as part of another end-use consumer product. Table II.10 shows the values for EPS lifetime that DOE used in its draft analysis. Where there are multiple applications with different lifetimes for a single type of EPS, DOE calculated a weighted-average lifetime for that EPS type using the applications' shipment volumes as weights. Additional detail on each EPS type is given in the subsections below. DOE seeks comments on its assumptions for product lifetime.

TABLE II.10—LIFETIME OF EXTERNAL POWER SUPPLIES BY TYPE

Type of EPS	Average lifetime years
Multiple-Voltage EPSs for MFDs	5
Multiple-Voltage EPSs for Xbox 360	5
High-Power EPSs	10
Medical EPSs	8
Wall Adapters for Certain Battery Chargers	5

DOE estimates are based on numerous sources. See subsections below for detail.

b. Multiple-Voltage External Power Supplies

For the Xbox 360, DOE assumed an average console lifetime of 5 years, which is roughly the time between console generations. While consoles, especially modern consoles, may have extremely long functional lifetimes, this may differ significantly from the length of time they will actually be used. When a new console is introduced, the industry stops developing and releasing new games for that console's predecessor. Consumers then begin retiring the older system in favor of the new one. Thus, while the console may in fact remain functional, it will no longer remain in use.

Based on availability dates for video game consoles from the current leaders in the console market (Nintendo, Sony, and Microsoft), DOE determined an average period of 5 years between generations of consoles. Table II.11 lists these consoles by manufacturer. In each line of consoles, DOE assumed that the effective run of a console ended upon release of the next generation of console. In many cases, the older consoles are still available for purchase, and some overlap will occur, as consumers continue to use older systems. However, DOE anticipates that within 2 years of release, the majority of consumers will prefer to use newer consoles. Therefore, DOE considers an estimate of 5 years to be a suitable value for the average effective lifetime for video game consoles, including the Xbox 360 and any subsequent console that may use a non-Class A EPS.

TABLE II.11—VIDEO GAME CONSOLE RELEASE DATES BY MANUFACTURER

Manufacturer	Console	North American release date	Years until subsequent release
Nintendo	Nintendo	1985	6.
	Super Nintendo	1991	5.
	Nintendo 64	1996	5.
	Game Cube	2001	5.

TABLE II.11—VIDEO GAME CONSOLE RELEASE DATES BY MANUFACTURER—Continued

Manufacturer	Console	North American release date	Years until subsequent release
	Wii	2006	Currently available.
Sony	Playstation	1995	5.
	Playstation 2	2000	6.
	Playstation 3	2006	Currently available.
Microsoft	Xbox	2001	4.
	Xbox 360	2005	Currently available.

Source: *http://www.thegameconsole.com/; http://www.gamespot.com/gamespot/features/video/hov/.*

In a recent interview, Robbie Bach, President of Entertainment and Devices Division at Microsoft, stated that, ''The life cycle for this generation of consoles—and I'm not just talking about Xbox, I'd include Wii and PS3 as well—is probably going to be a little longer than previous generations.'' (*http://xbox.joystiq.com/2009/01/12/xbox-360-life-cycle-to-be-a-little-longer-than-previous-generat*) It is unclear whether this statement would apply only to this particular generation of consoles, or to all future console development cycles generally. In light of this uncertainty, DOE considers 5 years to be an appropriate estimate for console lifetime.

Multifunction devices are also assumed to have an average useful lifetime of 5 years, according to *Appliance Magazine.* (''31st Annual Portrait of the U.S. Appliance Industry,'' Appliance Magazine, September 2008.)

c. High Output Power External Power Supplies

As described above, DOE normally calculates the life of an EPS based on the end-use application that the EPS is intended to power. High-power EPSs, however, are sold separately from their end-use applications. DOE cannot use the lifetime of the end-use application as a proxy, as the EPS may power different and multiple applications. Therefore, DOE based the lifetime of these EPSs on the functional lifetime of the EPS itself. Based on input from industry experts, DOE estimates that these EPSs have an average functional lifetime of 10 years. (Based on interviews conducted with the American Radio Relay League (August 2008) and Astron (December 2008).)

d. External Power Supplies for Medical Devices

DOE assumed an average lifetime of 8 years for medical device EPSs. According to a representative of SL Power, medical devices in general have an average lifetime of 11 years. (Tim Cassidy, SL Power. Committee Workshop before the California Energy Resources Conservation and Development Commission meeting transcript. 1/30/06 California Energy Commission.) However, this determination analysis focused on medical devices for use in home care settings, which generally have shorter lifetimes. Medicare guidelines state that durable medical equipment must have a lifetime of at least 5 years before a replacement is eligible to receive reimbursement. (Centers for Medicare and Medicaid Services. CMS Manual System Pub. 100–02 Medicare Benefit Policy, Transmittal 30, Change Request 3693. February 18, 2005.) The length of product warranties and comments from users in online discussion forums suggest that sleep therapy devices can last 7 to 12 years before replacement is necessary. (American Sleep Apnea Association. Apnea Support Forum discussion amongst users on sleep therapy device lifetimes. January 25, 2007. *http://www.apneasupport.org/about8124.html.*) Given the similarities in form and function, DOE assumes nebulizers have a comparable lifespan.

e. External Power Supplies for Certain Battery Chargers

Based on input from the Association of Home Appliance Manufacturers and the Power Tool Institute, DOE estimated an average lifetime of 5 years for EPSs for battery chargers for floor care appliances and DIY power tools. (Data for floor care products from ''31st Annual Portrait of the U.S. Appliance Industry,'' *Appliance Magazine,* September 2008. Data for power tools courtesy of the Power Tool Institute.)

4. Distribution Channels and Markups

In the LCC, payback period (PBP), and national impacts analyses, DOE compared the energy cost savings from standards with changes in purchase price due to increases in initial cost resulting from standards. DOE estimated the incremental consumer cost associated with setting a standard at CSLs 1–4.

To obtain end-user (consumer) product prices, DOE started by estimating the efficiency-related materials cost (ERMC) for each CSL. See section II.B.5 for a discussion of this cost. DOE marked up these costs to obtain factory price or manufacturer selling price (MSP) estimates, and then studied the distribution value chain for EPSs moving from manufacturer to end-user. From that analysis, which included volume estimates and typical markups applied by actors in the distribution chain, DOE calculated a manufacturer-to-retail markup to convert MSP estimates to retail price estimates. DOE then applied a sales tax estimate to the retail price estimates to arrive at end-user product prices.

Consumer product manufacturers, or original equipment manufacturers (OEMs), initiate the manufacture of most non-Class A EPSs. An OEM contracts with an EPS manufacturer to supply an EPS that meets the requirements of the OEM's consumer product. The EPS manufacturer then designs and assembles the device from component parts (*e.g.,* transformers, diodes, capacitors, semiconductors) made by various component manufacturers. The completed EPS is then sent to the OEM to be packaged and sold. While this process may be initially more expensive than using stock, off-the-shelf EPSs, OEMs prefer it since the EPS will then exactly fit the requirements of the intended application and the up-front design costs can be amortized over a large volume of sales. (Collon Lee. Personal Communication. Astec Power, Carlsbad, CA. February 16, 2006.) In addition, due to the special requirements of battery chargers and the design and registration process for medical devices, stock EPSs are not always available to meet the power requirements of these applications.

Table II.12 shows total markups for each type of non-Class A EPS. The total markup is the ratio of the after-tax consumer price to the ERMC or after-tax consumer price as a multiple of ERMC. The specific distribution channels and individual markups DOE used in its analysis for each type of non-Class A

EPS are discussed in section 1.2 of the TSD.

TABLE II.12—MARKUPS FOR NON-CLASS A EXTERNAL POWER SUPPLIES

Type of EPS	Total dollar markup (after-tax consumer price as a multiple of ERMC) $
Multiple-Voltage EPSs for MFDs	3.18
Multiple-Voltage EPSs for Xbox 360	3.15
High-Power EPSs	1.80
Medical EPSs	3.60
Wall Adapters for Certain Battery Chargers: Floor Care Appliances	3.69
Wall Adapters for Certain Battery Chargers: DIY Power Tools	4.14

5. Interested Parties

DOE has identified several organizations—mainly trade associations and energy efficiency advocates—that may have an interest in this determination. Energy efficiency advocacy organizations with a demonstrated interest in DOE's rulemakings on BCs and EPSs include the Appliance Standards Awareness Project, the American Council for an Energy-Efficient Economy, Earthjustice, Ecos Consulting, the Natural Resources Defense Council, and Pacific Gas and Electric Company, among others. Several trade associations with member companies manufacture non-Class A EPSs or the consumer products they power. Section 1.3 of the TSD lists some of these associations. Table 1.5 of the TSD identifies the types of non-Class A EPSs in which each group is likely to have an interest. Table 1.6 gives examples of each association's member companies.

6. Existing Energy Efficiency Programs

DOE has identified both voluntary and regulatory energy efficiency programs that may affect the efficiency of non-Class A EPSs sold in the United States. The five most important programs, summarized in Table II.13, include three domestic programs and two foreign programs. The three domestic programs are the Federal mandatory standard for Class A EPSs, the U.S. Environmental Protection Agency's voluntary ENERGY STAR standard for EPSs, and California's mandatory standard for so-called ''State Regulated EPSs.'' Among the many foreign programs, two from the European Union are particularly noteworthy—the ''Eco-design of Energy-using Products Initiative, Directive 2005/32/EC'' and the ''Code of Conduct on Efficiency of External Power Supplies, EU Standby Initiative.'' See section 1.4 of the TSD for a discussion of these programs.

TABLE II.13—SELECTED ENERGY EFFICIENCY PROGRAMS FOR EXTERNAL POWER SUPPLIES

Country/region	Authority	Program/institution
United States	Mandatory	Federal standard for Class A EPSs.
United States	Voluntary	ENERGY STAR for EPSs.
California	Mandatory	State standard for ''State Regulated EPSs''.
European Union	Mandatory	Eco-design of Energy-using Products (EuP) Initiative, Directive 2005/32/EC.
European Union	Voluntary	Code of Conduct on Efficiency of External Power Supplies, EU Standby Initiative.

B. Technology Assessment

1. Introduction

This technology assessment examines the technology behind the design of non-Class A EPSs and focuses on the components and subsystems that have the biggest impact on energy efficiency. (Note that the term ''technology assessment'' is different from ''technical support document.'' The TSD is the supporting document for this notice on a proposed determination for non-Class A EPSs. The technology assessment is a section within both this notice and the supporting TSD.)

a. Definitions

DOE is conducting a determination analysis for non-Class A external power supplies defined by EPCA, as amended by EPACT 2005. EPCA defines an external power supply as ''an external power supply circuit that is used to convert household electric current into DC current or lower-voltage AC current to operate a consumer product'' (42 U.S.C. 6291(36)(A)) but section 301 of EISA 2007 further amended this definition by creating a subset of EPSs called Class A External Power Supplies. EISA 2007 defined this subset as those external power supplies that, in addition to meeting several other requirements common to all external power supplies, are ''able to convert to only 1 AC or DC output voltage at a time'' and that have ''nameplate output power that is less than or equal to 250 watts.'' (42 U.S.C. 6291(36)(C)(i)) EPCA excludes an EPS from Class A if it ''requires Federal Food and Drug Administration listing and approval as a medical device'' or if it ''powers the charger of a detachable battery pack or charges the battery of a product that is fully or primarily motor operated.'' (42 U.S.C. 6291(36)(C)(ii)) This determination analysis only considers non-Class A external power supplies.

b. The Role of Power Converters

EPSs are power converters that support consumer products; hence, their operation and design is primarily governed by the consumer products they support (Figure II.1). Generally, an EPS supplies power at a constant output voltage and is interchangeable among consumer products with similar power requirements.

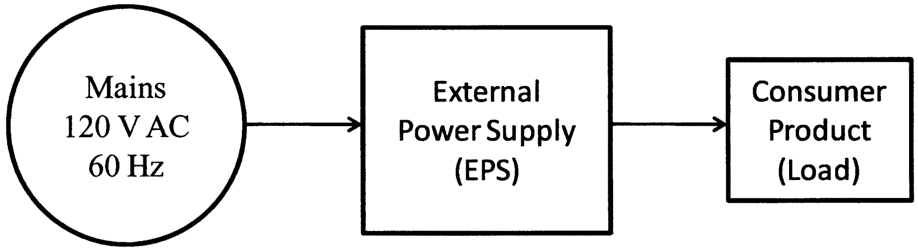


Figure II.1 Block Diagram of Power Flowing Through an External Power Supply

c. Functionality and Modes of Operation

The technology assessment begins by analyzing the modes in which EPSs operate and their functionality. Of these modes, active mode has the largest effect on the power converter's size and efficiency because the maximum amount of power passes through the EPS in active mode. In no-load mode the power converter is disconnected from the load; however, no-load power consumption is indicative of power consumption at low load. In each operational mode, the EPS is designed to provide certain functionality to the consumer product.

d. EPS Circuit Design

This section discusses how EPSs are designed, with specific consideration to the functionality requirements of the consumer applications that they power.

e. Efficiency Metrics

This section discusses the metrics used to measure and compare EPS efficiency.

f. Product Classes

This section discusses how DOE groups products into ''product classes'' for different energy-efficiency standards when a product's characteristics constrain its energy efficiency.

g. Technology Options for Efficiency Improvement

The final section of the technology assessment evaluates technology options for improving energy efficiency. DOE analyzed the components in the power converter that consume significant power, such as transformers, or influence power consumption of other components, such as integrated circuits (ICs). By identifying sources of power loss and possible methods for improvement, the technology assessment discusses technology options that would allow a manufacturer to design a power converter with similar design characteristics to have the same functionality but with improved efficiency.

h. Overlapping Terminology

The technology assessment discusses external power supplies with terminology that occasionally overlaps. This is because EPSs are used with a broad array of products with use in many different applications. In particular, ''class'' is discussed in this document in four different contexts:

- ''Class A'' and ''non-Class A.'' EPCA defines a subset of external power supplies as ''Class A'' based on criteria discussed in section II.B.1.a. External power supplies outside of the definition of Class A, are termed ''non-Class A.''
- ''Product class.'' DOE uses ''product class'' as a term of art in conducting energy efficiency rulemakings to delineate groups of products (discussed further in section II.B.4).
- ''Class I'' and ''Class II.'' Safety rating agencies use Class I and II to differentiate among products with and without a connection to ground, respectively. This issue particularly affects medical EPSs, discussed in the TSD.
- ''Class B digital devices.'' The Federal Communications Commission (FCC) regulates products for electromagnetic interference based on whether the product is used for non-residential or residential purposes, designated as Class A or Class B, respectively. (For information regarding the FCC definitions of Class A and Class B digital devices, see *http://www.arrl.org/tis/info/part15.html#Definitions.*) Electromagnetic interference particularly affects high-power EPSs, discussed in the TSD.

2. Modes of Operation

a. Active Mode

For the determination analysis, DOE used the definition of active mode codified in 10 CFR part 430, subpart B, appendix Z: ''Active mode is the mode of operation when the external power supply is connected to the main electricity supply and the output is connected to a load.''

In this mode, EPS efficiency is the conversion efficiency when the load draws some or all of the maximum rated output power of the EPS. In addition to providing that output power, the EPS also consumes power due to internal losses as well as overhead circuitry. The amount of power the EPS consumes varies with the power demands of the load; together, those two parameters define the EPS's efficiency at a particular loading point:

$$\eta_{EPS} = \frac{P_{out}}{P_{in}} = \frac{P_{out}}{P_{out} + P_{EPS\_consumption}} \qquad \text{Eq. II.1}$$

Where η_{EPS} is the EPS efficiency,
$P_{EPS\_consumption}$ is the power consumed by the external power supply itself,
P_{in} is the power from mains into the external power supply, and
P_{out} is the power out of the external power supply to the consumer product.

EPS active mode efficiency varies with the amount of output power (Figure II.2). Typically, EPSs are inefficient at low load (0 percent to 20 percent of maximum rated output power of the EPS) and more efficient at larger loads (between 20 and 100 percent of maximum rated output power), which occurs when the consumer product is fully functional and demanding more power. The lower efficiency at lower output current is due to the proportionally larger power consumption of internal EPS components relative to output power. At higher power, EPS losses are proportionally not as great and therefore have less impact on EPS efficiency. The EPS test procedure evaluates active mode conversion efficiency at four loading points: 25 percent, 50 percent, 75 percent, and 100 percent of maximum rated output power, which captures a general picture of EPS efficiency. Figure II.2 shows an example of a typical efficiency curve for an EPS in active mode.

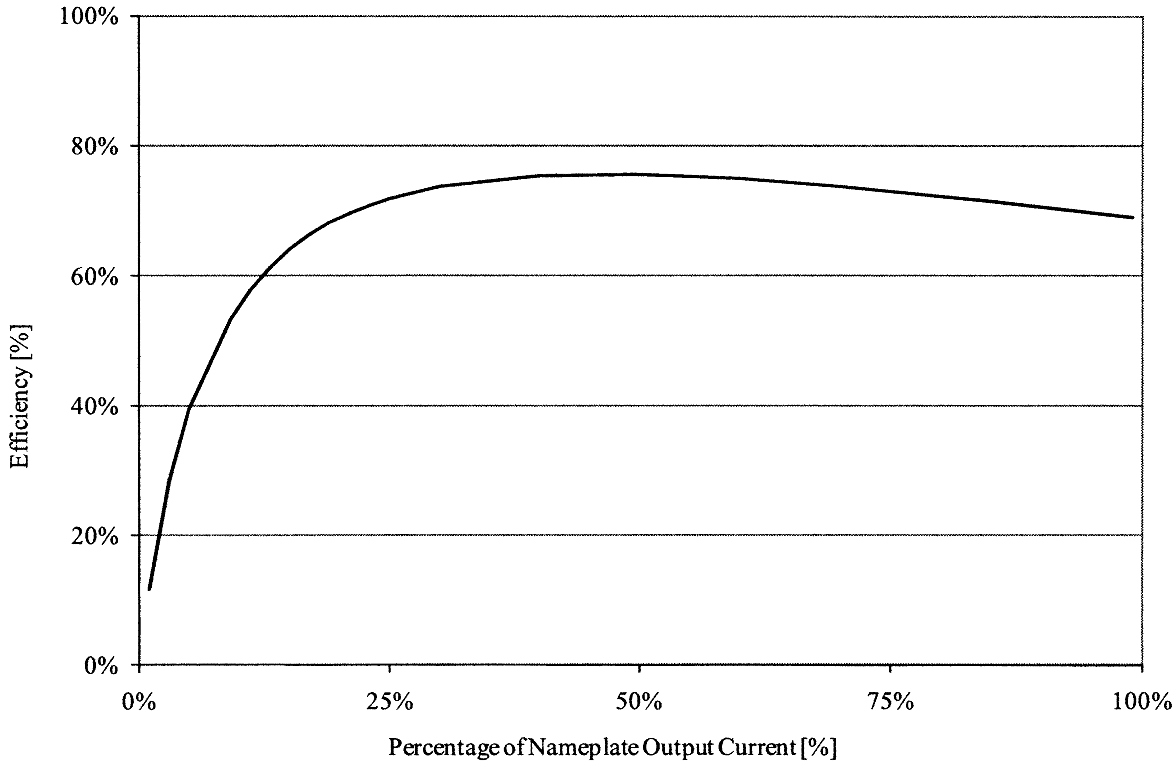


Figure II.2 Example of an Efficiency Curve of a Single-Voltage EPS in Active Mode

b. No-Load Mode

For the determination analysis, DOE used the definition of no-load mode codified in 10 CFR part 430, subpart B, appendix Z: ''No load mode means the mode of operation when the external power supply is connected to the main electricity supply and the output is not connected to a load.''

EPS consumption in no-load is a measure of EPS internal power consumption, since the EPS is not connected to the load. However, the EPS might provide functionality. For example, certain consumer products may require the EPS to deliver output power within moments of being connected. Thus, the EPS may consume power to provide the useful function of reduced start-up time. Nonetheless, EPS power consumption can still be low (less than 1 watt) in no-load mode for non-Class A EPSs.

c. Standby and Off Modes

As directed by EISA 2007, DOE amended its test procedures for battery chargers and external power supplies to address standby and off modes on March 27, 2009. (74 FR 13318) In those test procedures, DOE defines standby mode and off mode. Standby mode is the condition in which the EPS is in no-load mode and, with products equipped with manual on-off switches, all such switches are turned on. Off mode is also only applicable to those EPSs that have a manual on-off switch, and is defined as the time when the EPS is (1) connected to the main electricity supply; (2) the output is not connected to any load; and (3) all manual on-off switches are turned off.

3. Functionality and Circuit Designs of Non-Class A EPSs

Non-Class A EPSs are designed to provide certain types of functionality, for which they have particular circuit designs. The TSD discusses these aspects of non-Class A EPSs in detail.

4. Product Classes

DOE divides covered products into classes by the type of energy used, the capacity of the product, and any other performance-related feature that justifies different standard levels, such as features affecting consumer utility. (42 U.S.C. 6295(q)) For example, when compared with a standard device, a device with additional functionality that provides extra utility to the consumer would be grouped in a separate product class if the additional functionality affects its efficiency. DOE then conducts its analysis and considers establishing or amending standards to provide separate standard levels for each product class. Because output power and output voltage have the largest impact on achievable EPS efficiency, DOE considered both criteria when developing EPS product classes for the determination analysis.

a. Product Class Distinctions for Multiple-Voltage EPSs

There is a small market for multiple-voltage EPSs, which are primarily used in printing and video game console applications. Accordingly, DOE is considering dividing multiple-voltage EPSs into two product classes, listed in

Table II.14, to account for these separate applications.

TABLE II.14—PRODUCT CLASSES FOR MULTIPLE-VOLTAGE EPSS

	Nameplate output power	
	< 100 watts	≥100 watts
Product Class	Multiple-Voltage Product Class 1	Multiple-Voltage Product Class 2.

Multiple-Voltage Product Class 1 relates to multiple-voltage EPSs for printing applications. These EPSs tend to have an even distribution of power between the outputs. Multiple-Voltage Product Class 2 relates to multiple-voltage EPSs for video game applications. These EPSs tend to have an uneven distribution of power between the outputs, where one output accounts for most of the output power. These product classes also have different nameplate output power ratings. Multiple-Voltage Product Class 1 is representative of units that are less than 100 watts. Multiple-Voltage Product Class 2 is representative of units that are greater than or equal to 100 watts.

b. Product Class Distinctions for High-Power EPSs

There is a small market for high-power EPSs which have one primary application: ham radios. There are few technical differences among these EPSs that affect efficiency, none of which are significant for the current analysis. Therefore, DOE is considering placing high-power EPSs into one product class, listed in Table II.15.

TABLE II.15—PRODUCT CLASSES FOR HIGH-POWER EPSS

	Nameplate output power
	> 250 watts
Product Class	High Power Product Class 1.

High-Power Product Class 1 relates to high-power EPSs for ham radios, which all have nameplate output voltage at 13.8 volts. Unlike higher-power Class A EPSs, High-Power Product Class 1 EPSs typically require more overhead circuitry. These EPSs often include two integrated circuits; Class A EPSs often have one. The second IC generally becomes necessary for EPSs around 170 watts.

c. Product Class Distinctions for Medical EPSs

Both medical and Class A EPSs have diverse markets with many end-use applications. The primary difference is that medical EPSs have additional safety requirements that result in higher costs. However, those requirements have a negligible effect on their efficiency. Therefore, DOE is considering placing medical EPSs in the same product classes as Class A EPSs, listed in Table II.16.

TABLE II.16—PRODUCT CLASSES FOR MEDICAL EPSS

Nameplate output voltage	Nameplate output power		
	<4 watts	4–60 watts	>60 watts
≤12 volts	Medical Product Class 1	Medical Product Class 2	Medical Product Class 3.
>12 volts	Medical Product Class 4	Medical Product Class 5	Medical Product Class 6.

Two variables in combination define A product class for medical EPSs: nameplate output voltage and nameplate output power. There are two variations on nameplate output voltage and three variations on nameplate output power, which results in six total product classes (Table III.16).

DOE is considering criteria for product classes for medical EPSs. Output power and output voltage are the leading criteria, as with Class A EPSs. Additional criteria are specific to medical EPSs, including the number of output voltages and output cable length. DOE is aware of very few medical EPSs with multiple-voltage outputs (section II.B.5) and is not considering a separate product class for these EPSs at this time. Medical device EPSs used with liquids may require long output cables for safety reasons, which will constrain EPS efficiency because longer cables have higher resistance and are therefore less efficient.

d. Product Class Distinctions for EPSs for BCs

EPSs for BCs and Class A EPSs also have diverse markets with many end-use applications. The primary difference is that EPSs for BCs are specifically used with battery-charging applications. However, under Approach A, EPSs for BCs are viewed as electrically equivalent to Class A EPSs. Therefore, DOE is considering dividing EPSs for BCs into the same product classes as Class A EPSs, listed in Table II.17.

TABLE II.17—PRODUCT CLASSES FOR EPSS FOR BCS

Nameplate output voltage	Nameplate output power		
	<4 watts	4–60 watts	>60 watts
≤12 volts	EPS for BC Product Class 1	EPS for BC Product Class 2	EPS for BC Product Class 3.
>12 volts	EPS for BC Product Class 4	EPS for BC Product Class 5	EPS for BC Product Class 6.

Similar to medical EPSs, two variables in combination define six product classes for EPSs for BCs: Nameplate output voltage and nameplate output power.

5. Technology Options for Improving Energy Efficiency

DOE considered several technology options that may improve the efficiency of Class A and non-Class A EPSs (discussed in further detail in the TSD):

Improved Transformers. In line-frequency EPSs, the transformer has the largest effect on efficiency. Transformer efficiency can be improved by using cores and windings with lower-loss material, such as lower electrical resistance, or by adding extra material.

Switched-Mode Power Supply. Line-frequency EPSs often use linear regulators to maintain a constant output voltage. By using a switched-mode circuit architecture, a designer can limit both losses associated with the transformer and the regulator. The differences between the two EPS types are discussed in the TSD.

Low-Power Integrated Circuits. The efficiency of the EPS can be further improved by substituting low-power IC controllers to drive the switching transistor, which can switch more efficiently in active mode and reduce power consumption in no-load mode. For instance, the IC can turn off its start-up current (sourced from the primary side of the power supply) once the output voltage is stable. This increases conversion efficiency and decreases no-load power consumption. In addition, when in no-load mode, the IC can turn off the switching transistor for extended periods of time (termed ''cycle-skipping'').

Multi-Mode Integrated Circuits. These ICs combine current limiting, temperature limiting, over-voltage, and under-voltage functions, which allow the controller to adjust to a wide range of loads. At full loads, the IC works in a high frequency pulse-width modulation mode. As the load decreases, the IC can shift into a variable frequency mode and at no load the IC can use a fixed peak current, multi-cycle modulation scheme.

Schottky Diodes and Synchronous Rectification. Both line-frequency and switched-mode EPSs use diodes to rectify output voltage. Schottky diodes and synchronous rectification can also replace standard diodes to reduce rectification losses, which are increasingly significant at low output voltage. Schottky diodes have a lower voltage drop than standard diodes and thus result in less power loss. Synchronous rectification replaces the diodes with a transistor for even less power loss.

Low-Loss Transistors. The switching transistor dissipates energy due to its drain-to-source resistance (R_{DS_ON}) when the current flows through the transistor to the transformer. Using transistors with low R_{DS_ON} can reduce this loss.

Resonant Switching. In addition to reducing the R_{DS_ON} of the transistor, power consumption can be lowered further by the IC controller decreasing switching voltage transients (the sharp changes in voltage that come from opening or closing the circuit with a transistor) through zero-voltage or zero-current switching. The power consumption of the transistor (as it switches from on to off or vice versa) is influenced by the product of the transitional voltage across the R_{DS_ON} and the transitional current flowing through it. An IC can control the timing of switching to minimize the presence of significant current and voltage at the same time, although some components are typically needed in addition to the IC to achieve the desired resonance or quasi resonance.

Resonant (''Lossless'') Snubbers. In switched-mode EPSs, a common snubber protects the switching transistor from the high voltage spike that occurs after the transistor turns off by dissipating that power as heat. A resonant or lossless snubber recycles that energy rather than dissipating it.

C. Engineering Analysis

1. Introduction

The purpose of this engineering analysis is to determine the relationship between a non-Class A EPS's efficiency and its ERMC. (The efficiency-related materials cost includes all of the efficiency-related raw materials listed in the bill of materials but not the direct labor and overhead needed to create the final product. The materials cost forms the basis for the price consumers eventually pay.) This relationship serves as the basis for the underlying costs and benefits to individual consumers (section II.B) and the Nation (life-cycle cost analysis and national impacts analysis). The output of the engineering analysis provides the ERMC at selected, discrete levels of efficiency for six EPSs ''representative'' of non-Class A EPSs. This section details the development of this analysis and includes descriptions of the analysis structure, inputs, and outputs with supporting material in the TSD. DOE welcomes comments from interested parties on all aspects of this analysis.

To develop this analysis, DOE gathered data by interviewing manufacturers, conducting independent testing and research, and commissioning EPS teardowns. Through interviews, manufacturers provided information on the relative popularity of EPS models and the cost of increasing their efficiency. To validate the information provided by manufacturers, DOE performed its own market research and testing. To independently establish the cost of some of the tested units, DOE contracted iSuppli Corp., an industry leader in the field of electronics cost estimation. For a detailed discussion of these data sources, see section II.C.2.

In section II.C.3, DOE presents representative product classes and representative units, which allows DOE to focus its analysis on a few specific power converters and subsequently transfer the results to all units. DOE began the engineering analysis by identifying the representative product classes and selecting one representative unit for analysis from each of the representative product classes. The representative product classes are a subset of the product classes identified in section II.B. The representative units, in turn, are theoretical idealized models of popular or typical devices within the representative product classes.

Although the efficiency of power converters in the market forms an almost continuous spectrum, DOE focused its analysis at select CSLs (section II.C.4). In the engineering analysis, DOE examined the cost of meeting each CSL for each representative unit. The resulting relationship was termed an ''engineering curve'' or ''cost-efficiency curve.'' The outputs of this analysis are the cost-efficiency points that define those curves and are presented in section II.C.6.

2. Data Sources

a. Manufacturer Interviews

In 2008, on behalf of DOE, Navigant Consulting, Inc. (Navigant Consulting) interviewed nine manufacturers to obtain data on what makes non-Class A EPSs unique in terms of market and technical requirements as well as their possible efficiencies and resultant costs. At the request of some manufacturers, Navigant Consulting entered into non-disclosure agreements whereby it can present to DOE general information about the non-Class A EPS market and technology, but no confidential data specific to any individual manufacturer. These interviews enabled Navigant Consulting to obtain general information about the non-Class A EPS market and technology to conduct the analysis but without attributing any particular data to an individual manufacturer. The interviews were generally structured to elicit information similar to the information DOE presents in the TSD. DOE continues to seek input from interested parties regarding all aspects of the rulemaking, cost and efficiency data in particular.

Because of the limited markets for multiple-voltage EPSs, Navigant Consulting identified two manufacturers in addition to Microsoft that produce EPSs for the Xbox 360, but they had limited availability for interviews. Although Microsoft speculated on two discrete steps to improve the efficiency of multiple-voltage EPSs and their costs, none of the manufacturers provided detailed cost-efficiency points for a wide range of efficiencies. For the other application of multiple-voltage EPSs, multiple-function devices, both an OEM and its EPS supplier provided market and cost-efficiency data.

For high-power EPSs, DOE identified 10 manufacturers of EPSs for ham radios. Of these, LHV Power and Diamond Antenna agreed to be interviewed; the other manufacturers of high-power EPSs are based in Asia, and their U.S.-based sales staff declined to participate in the interviews. The manufacturers that did participate provided discrete cost-efficiency points, but did not provide comprehensive data for the high-power EPS CSLs presented in section II.C.4.

The market for medical EPSs has various manufacturers and of these, four agreed to be interviewed, while other companies were contacted but were not responsive to requests for an interview. The interviews focused on the different technical and legal requirements for medical EPSs, in contrast to Class A EPSs. Although none of the manufacturers provided a complete cost-efficiency curve, some were able to cite the differences in technology options and costs for EPSs that did and did not meet EISA 2007 standards (section II.C.6.c). The other manufacturers discussed the technical requirements for medical EPSs, but did not provide cost information.

DOE is analyzing EPSs for BCs that are wall adapters without charge control that are used with certain battery charging applications, as explained in section I.B and discussed in the TSD. Navigant Consulting has not yet identified and interviewed manufacturers of EPSs for BCs, relying instead on teardowns of Class A EPSs.

DOE welcomes additional data from interested parties on any non-Class A EPSs.

b. Independent Testing and Research

DOE reviewed online distributor catalogs to independently assess the market for non-Class A EPSs. DOE used this information in choosing representative product classes, presented in section II.C.3.

To independently verify efficiency data, DOE obtained and measured the efficiency of 18 non-Class A EPSs (Table II.18). All EPSs were bought online through distributors' Web sites, except one multiple-voltage EPS that a manufacturer loaned to DOE contractors for testing. For comparison, DOE also examined 16 Class A EPSs with characteristics similar to the medical EPSs and EPSs for BCs under consideration. EPSs with a single output voltage were subjected to the DOE test procedure for EPSs. (10 CFR 430, subpart B, appendix Z) EPSs with multiple output voltages were subjected to the test procedure that DOE had previously proposed (but has not yet adopted) for multiple-voltage EPSs. (73 FR 48079–83)

TABLE II.18—NON-CLASS A EPSS TESTED FOR EFFICIENCY BY DOE, SORTED BY TYPE AND EFFICIENCY

Index	Type	Topology	Nameplate output power *W*	Nameplate output voltage *V*	Average active-mode efficiency (percent)	No-load power *W*	Efficiency-related materials cost	
							$	Source
218	Multiple Voltage	Switched-mode	40	16, 32	84	0.26	$2.77	DOE.
217	Multiple Voltage	Switched-mode	40	16, 32	86	0.27	2.99	DOE.
216	Multiple Voltage	Switched-mode	203	5, 12	81	5.16		
213	Multiple Voltage	Switched-mode	203	5, 12	82	12.33	6.45	iSuppli.
214	Multiple Voltage	Switched-mode	203	5, 12	85	0.40		
203	Multiple Voltage	Switched-mode	203	5, 12	86	3.29	9.08	iSuppli.
404	High Power	Linear regulated	345	13.8	51	12.60		
401	High Power	Linear regulated	345	13.8	62	15.43	115.32	iSuppli.
402	High Power	Switched-mode	345	13.8	81	6.01	33.64	iSuppli.
403	High Power	Switched-mode	345	13.8	84	6.65		
301	Medical	Switched-mode	18	12	78	0.33	2.23	iSuppli.
302	Medical	Switched-mode	20	12	80	0.29	2.27	iSuppli.
130	Class A	Linear regulated	14.4	12	64	0.56	1.49	DOE.
117	Class A	Switched-mode	18	12	78	0.65	2.00	iSuppli.
120	Class A	Switched-mode	18	12	78	0.56	2.22	iSuppli.
118	Class A	Switched-mode	18	12	81	0.27	1.96	iSuppli.
106	Class A	Switched-mode	2.5	5	63	0.13	1.13	iSuppli.
105	Class A	Switched-mode	2.5	5	67	0.13	0.75	iSuppli.
103	Class A	Switched-mode	1.75	5	74	0.12	0.77	iSuppli.
17	Class A	Line-frequency, linear regulated.	5	5	36	1.85	1.16	DOE.
27	Class A	Line-frequency, switched-mode regulated.	5	5	49	1.42	1.54	DOE.
22	Class A	Switched-mode	5	5	59	0.42	1.29	DOE.
25	Class A	Switched-mode	5	5	66	0.64	1.45	DOE.
37	Class A	Switched-mode	5	5	66	0.66	1.50	DOE.
18	Class A	Switched-mode	5	5	70	0.54	1.46	DOE.
21	Class A	Switched-mode	5.2	5.2	71	0.10	1.63	DOE.
24	Class A	Switched-mode	5	5	72	0.11	1.34	DOE.
8	Class A	Switched-mode	5	5	73	0.11	1.06	DOE.

c. Teardown Cost Estimates

DOE contracted iSuppli Corp. to tear down and estimate the materials cost for select units. For this analysis, DOE only considered the materials cost of components related to efficiency: the ERMC. Direct labor and overhead as well as non-production costs are accounted for in the markup from ERMC to efficiency-related manufacturer's selling price (MSP), as in Figure II.3. These cost estimates also account for the typical number of units produced by the manufacturer as well as the manufacturer's location (and associated labor rates). Table II.18 shows the results of the cost estimates.

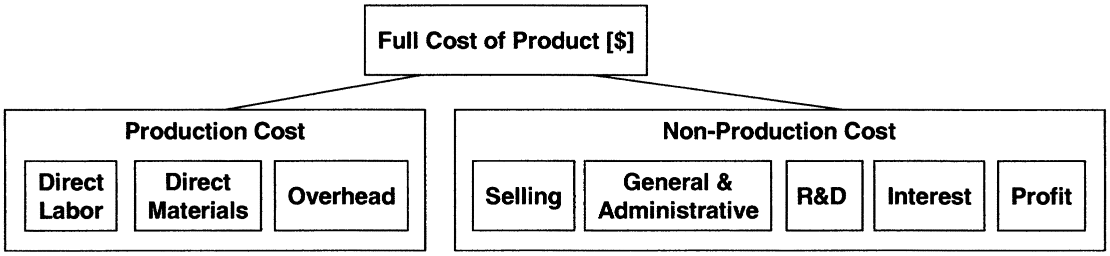


Figure II.3 Full Cost of Product: Breakdown of Production and Non-Production Costs

iSuppli provided DOE with a complete list of components, referred to as the "bill of materials," for each product. DOE grouped components into three categories based on their impact on cost and efficiency: directly related, secondarily related, or not related to efficiency (Table II.19). For example, components such as transistors and capacitors are considered to have a direct effect on efficiency. DOE grouped enclosures and printed circuit boards (PCBs) as secondary since they tend to vary with efficiency, but do not directly affect it. Components such as labels and screws that have no relation to efficiency were considered not related. DOE used costs for components with a direct relation to efficiency to generate cost estimates (listed in Table II.18). Secondary components are not included in the efficiency-related cost estimate because DOE does not believe that they should be included in the cost of materials affecting efficiency. In developing the cost-efficiency curves in section II.C.3, DOE only considered the efficiency-related costs.

DOE seeks input on which of the components listed in Table II.19 should be included in the efficiency-related cost estimates, in particular the secondary components.

TABLE II.19—COMPONENT CATEGORIZATION FOR BILL OF MATERIALS ANALYSIS

Component family	Component type	Efficiency grouping	Efficiency impact
Batteries	Disposable	Battery pack	Not related.
Batteries	Other	Battery pack	Not related.
Batteries	Rechargeable	Battery pack	Secondary.
Discrete Semiconductor	Other	Electronics	Direct.
Discrete Semiconductor	Rectifier	Electronics	Direct.
Discrete Semiconductor	Thyristor	Electronics	Direct.
Discrete Semiconductor	Diode	Electronics	Direct.
Discrete Semiconductor	Diode—Schottky	Electronics	Direct.
Discrete Semiconductor	Transistor	Electronics	Direct.
Display	Color LCD	Other	Not related.
Display	Monochrome LCD	Other	Not related.
Display	Color OLED	Other	Not related.
Display	Monochrome OLED	Other	Not related.
Display	Other	Other	Not related.
Electro-Mechanical	Antenna	Other	Not related.
Electro-Mechanical	Connector	Other	Not related.
Electro-Mechanical	Connector (output cord only)	Output cord—Secondary	Secondary.
Electro-Mechanical	Other	Other	Not related.
Electro-Mechanical	PCB	PCB—Secondary.	Secondary.
Electro-Mechanical	Relay	Other	Not related.
Electro-Mechanical	Switch	Other	Not related.
Mechanical	Plastics & Elastomers—consumer product parts.	Other	Not related.
Mechanical	Plastics & Elastomers—wall adapter case only.	Case—Secondary	Secondary.
Mechanical	Metal	Other	Not related.
Mechanical	Metal—case only	Case—Secondary	Secondary.
Mechanical	Metal—heatsinks only	Heatsinks	Direct.
Mechanical	Other	Other	Not related.
Integrated Circuit	Analog	Electronics—IC	Direct.
Integrated Circuit	Logic	Electronics—IC	Direct.
Integrated Circuit	Memory	Electronics—IC	Direct.
Integrated Circuit	Multi-Chip IC	Electronics—IC	Direct.
Integrated Circuit	Other	Electronics—IC	Direct.
Optical Semiconductor	LEDs	Electronics	Direct.
Passive	Capacitor	Electronics	Direct.

TABLE II.19—COMPONENT CATEGORIZATION FOR BILL OF MATERIALS ANALYSIS—Continued

Component family	Component type	Efficiency grouping	Efficiency impact
Passive	Coupler/Balun	Electronics	Direct.
Passive	Crystal	Electronics	Direct.
Passive	Filter	Electronics	Direct.
Passive	Isolators/Circulator	Electronics	Direct.
Passive	Magnetic	Electronics	Direct.
Passive	Magnetic (transformer only)	Electronics—Transformer	Direct.
Passive	Oscillator	Electronics	Direct.
Passive	Piezoelectric Component	Electronics	Direct.
Passive	Resistor	Electronics	Direct.
Passive	Resonator	Electronics	Direct.
Passive	Sensor	Electronics	Direct.
Passive	Tuner	Electronics	Direct.
Passive	Other	Electronics	Direct.
Miscellaneous	Box Packaging, Printed Matter	Other	Not related.
Miscellaneous	Other	Other	Not related.

In addition to the units that iSuppli tore down, DOE purchased and created estimated ERMCs for two 40-watt multiple-voltage EPSs, one 14.4-watt Class A EPSs, and nine approximately 5-watt Class A EPSs (Table II.18). Rather than have iSuppli tear down these units, DOE chose to perform its own teardowns due to budget and time constraints. To create the ERMCs, DOE subject matter experts cataloged the efficiency-related components to create a bill of materials. DOE used the bill of materials and resources on component prices such as parts catalogs and iSuppli component prices to develop the ERMCs (section II.C.5.a and chapter 4 of the TSD. Lastly, DOE scaled the ERMCs from the test unit values to representative unit values using techniques presented in section II.C.5.d

3. Representative Product Classes and Representative Units

Based on the product classes for each type of non-Class A EPS, DOE selected representative product classes and representative units. DOE focused on representative product classes in its analysis. Results from representative product classes can be scaled to other product classes not analyzed. Representative units are theoretical versions of EPSs where all of an EPS's characteristics are defined, except efficiency and cost. By varying the efficiency of the representative units, DOE can evaluate the resultant costs to determine the cost-efficiency relationship.

Table II.20 lists the application, nameplate output power, nameplate output voltage(s), and production volume that specify non-Class A representative units. Output power affects both efficiency and cost. At higher powers, fixed losses in the EPS are proportionally smaller, making it cheaper for manufacturers to build EPSs with higher efficiencies. However, larger components that are necessary at higher powers result in higher costs. Output voltage affects efficiency but not cost, because EPSs with higher output voltage have consequently lower output current and associated losses. Production volume is the number of units a manufacturer annually produces for an EPS design. Higher production volumes allow manufacturers to leverage greater economies of scale, resulting in lower per-component and overall costs for the EPS. See chapter 4 of the TSD for a detailed discussion of each representative unit and its characteristics.

TABLE II.20—LIST OF NON-CLASS A REPRESENTATIVE UNITS

Type of non-Class A EPS	Application	Output power *W*	Output voltage *V*	Second output voltage *V*	Production volume *units/year*
Multiple Voltage	Multi-Function Device	40	16	32	1,000,000
Multiple Voltage	Video Game	203	5	12	4,000,000
High Power	Ham Radio	345	13.8		1,000
Medical	Nebulizer *	18	12		10,000
EPSs for BCs	Vacuum	1.8	6		1,000,000
EPSs for BCs	DIY Power Tool	4.8	24		1,000,000

* "A nebulizer is a device used to administer medication to people in the form of a mist inhaled into the lungs. It is commonly used in treating cystic fibrosis, asthma, and other respiratory diseases." Wikipedia. "Nebulizer." 2008. (Last accessed December 17, 2008.) *http://en.wikipedia.org/wiki/Nebulizer*

4. Selection of Candidate Standard Levels

Selection of CSLs followed the identification of representative product classes and representative units. Although the ERMC of a unit appears in the aggregate as a continuous function of efficiency, for analysis purposes, DOE focused on discrete CSLs. Note that the term "CSL" implies an eventual standard, although standard setting is beyond the scope of this determination analysis. DOE uses the term "candidate standard level" because it is a term of art for these discrete levels and because the CSLs may eventually lead to a specific standard level. DOE developed CSLs based on the data sources discussed in section II.C.2.

For each of the six representative units, DOE created four CSLs, although it may create more levels in future analysis or in response to comments from interested parties. These CSLs are intended to reflect the efficiencies in the market, although they do not necessarily include the highest efficiencies. The CSLs in this analysis are sufficient to demonstrate whether DOE should conduct a standards rulemaking because they allow DOE to show the possibility of savings at a CSL above the baseline, which is the key criterion of the determination analysis. In future analysis, DOE may include a max-tech CSL to reflect the highest achievable efficiency.

Specifically in this analysis, CSLs are based on (1) EPSs that have been tested and torn down, (2) data points provided in manufacturer interviews, and (3) the International Efficiency Marking Protocol for External Power Supplies. (Energy Star. ''International Efficiency Marking Protocol for External Power Supplies.'' 2008. (Last accessed November 18, 2008.) *http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/International_Efficiency_Marking_Protocol.pdf*) In choosing the basis for CSLs, DOE gave the highest priority to units that were torn down and tested because DOE had complete data for efficiency and cost. If test and teardown data were not available, then DOE used data points from manufacturers. If no data were directly available, DOE referred to the International Marking Protocol. DOE presents a detailed discussion of the CSLs in chapter 3 of the TSD.

5. Methodology and Data Implementation

As mentioned previously, DOE purchased, tested, and tore down EPS units to obtain data to identify the cost-efficiency relationship for non-Class A EPSs. DOE subject matter experts measured the efficiency of all units using the appropriate DOE test procedure and a Yokogawa WT210 power meter. DOE contracted iSuppli Corporation to determine the ERMC for most of the tested units. Due to budgetary and time constraints, DOE developed a methodology to estimate the ERMC for other tested units, as discussed in section II.C.5.a.

In some cases, after DOE obtained cost and efficiency data for the test units, the data did not always directly apply because of differences between the test unit and the representative unit. DOE attempted to purchase units for testing and teardown that have all the characteristics of the representative units. Nonetheless, this was not always possible due to limited product availability in the market and changes to the representative units' characteristics. As a result, the costs and efficiencies of certain test units are not directly applicable to the representative units. DOE developed a methodology to scale cost and efficiency data for test units to estimate what those values would be if the test units had the characteristics of the representative units.

Nameplate output power, nameplate output voltage, and production volume all influence the cost and efficiency of an EPS in various degrees. For example, manufacturers often offer EPSs that share a common design and have the same nameplate output power, but differ in voltage. These differences in voltage will result in differences in achievable efficiency, but will not affect cost. Table II.21 outlines the impacts of changes to the three characteristics on cost and efficiency and the models that were developed to account for them.

TABLE II.21—IMPACT OF EPS CHARACTERISTICS ON COST AND EFFICIENCY

	Cost	Efficiency
Output Voltage	No impact	Efficiency increases with voltage; see model in section II.C.5.c.
Output Power	Cost increases with power but decreases with volume; see combined model in section II.C.5.d.	Efficiency increases with power; see model in section II.C.5.b.
Production Volume	Cost increases with power but decreases with volume; see combined model in section II.C.5.d.	No impact.

a. DOE Method for Estimating Efficiency-Related Materials Cost

DOE contracted with iSuppli to tear down and obtain high-volume production-cost estimates for 12 EPSs when developing non-Class A cost-efficiency curves. To obtain further cost-efficiency points, DOE tore down additional EPSs and estimated their high-volume materials costs. DOE used results from its cost estimates to develop portions of the cost-efficiency curves for the 18-watt medical EPS, the 40-watt multiple-voltage EPS, and the 1.8-watt and 4.8-watt EPSs for BCs representative units.

To estimate the cost of an EPS, DOE first created a bill of materials for the EPS's efficiency-related components and estimated the prices of the components at volumes consistent with the iSuppli teardown prices. DOE used two sources of information to develop its cost estimates: (1) High-volume component prices from iSuppli bills of materials, and (2) low-volume component prices from distributor catalogs. iSuppli provided DOE with a spreadsheet containing high-volume cost estimates for almost 1,000 individual components. To supplement that data, DOE also reviewed online catalog prices for components at volumes of 500 units. Depending on the information available, DOE used one of four methods to determine the price for each component (Table II.22). These methods allowed DOE to estimate with reasonable accuracy the high-volume materials costs for a larger number of units than would have been possible using the iSuppli teardowns alone. See chapter 5 of the TSD for more detailed information on these methods.

TABLE II.22—ILLUSTRATION OF LOW-VOLUME TO HIGH-VOLUME COMPONENT COST SCALING METHODS USED IN THE NON-CLASS A ENGINEERING ANALYSIS

Component type	Method used	Cost estimate for specific component		Variation of iSuppli cost across component category	Category-average for iSuppli cost	Ratio of averages: iSuppli cost to catalog cost	Basis for cost estimate
		High-volume iSuppli	Low-volume catalog				
0603 Capacitor	1	Available	Available				Direct iSuppli cost.
Optocoupler	2	Not Available	Available	Acceptable	Calculated		Average iSuppli cost.

TABLE II.22—ILLUSTRATION OF LOW-VOLUME TO HIGH-VOLUME COMPONENT COST SCALING METHODS USED IN THE NON-CLASS A ENGINEERING ANALYSIS—Continued

Component type	Method used	Cost estimate for specific component		Variation of iSuppli cost across component category	Category-average for iSuppli cost	Ratio of averages: iSuppli cost to catalog cost	Basis for cost estimate
		High-volume iSuppli	Low-volume catalog				
Field-Effect Transistor.	3	Not Available	Available	Excessive		Calculated	Scaled low-volume cost.
Unidentified Integrated Circuit.	4	Not Available	Not Available	Excessive	Calculated		Average iSuppli cost.

In this example, DOE had a component cost for the 0603 capacitor directly from the iSuppli database. The 0603 capacitor is a surface-mount capacitor often found on printed circuit boards. DOE used Method 1 (direct substitution) to estimate the component's cost. This method is the simplest and most accurate because it relies on a one-to-one match between components in the two bills of materials.

DOE did not have iSuppli component costs for direct substitution for the optocoupler in Table II.22, but did have iSuppli cost data for similar components. To account for this situation, DOE used Method 2, which estimated the cost of the optocoupler as the average iSuppli costs of similar components. In this method, DOE grouped the components from the high-volume iSuppli bills of materials into categories by component family, type, subtype, and any other relevant categories, and calculated an average materials cost for each category. To ensure that the averages were valid, DOE only used this approach if there were more than five cost estimates and a standard deviation less than $0.02. In this case, DOE substituted the category-average high-volume cost for the optocoupler.

DOE also did not have direct iSuppli component costs for direct substitution for the field effect transistor (FET). Further, the average iSuppli component cost did not meet DOE's criteria for validity (sufficient number of data points and low variation). As a result, DOE did not estimate the true cost using the category-average cost because might not have been accurate. However, DOE was able to estimate the low-volume cost of the FET using catalogs. Although the high-volume cost estimate varied excessively, the ratios of high-volume to low-volume cost estimates did not. DOE averaged these ratios and then scaled the low-volume cost estimate for the FET. Using this method, DOE was able to obtain a more accurate high-volume cost estimate than would have been possible through direct substitution of category-average costs.

In the final example of an ''unidentified integrated circuit,'' DOE did not have direct cost information from iSuppli or component catalogs. In this case, DOE substituted the category-average costs directly from the high-volume iSuppli bill of materials. Although this method had the potential to decrease the accuracy of the EPS cost estimates, it was used only for a limited set of components and only for the 40-watt multiple-voltage EPS. Chapter 4 of the TSD contains detailed information on all of these costing methods.

b. Efficiency Scaling by Output Power

The practically achievable efficiency of an EPS depends on its nameplate output power, with lower-power EPSs tending to exhibit lower active-mode efficiencies than their higher-power counterparts. (Changes in output power do not affect the no-load power consumption.) However, some of the EPSs that DOE analyzed for the non-Class A engineering analysis differ in output power from the representative units for their product class. This led DOE to develop a model for estimating the change in active mode efficiency when the output power of an EPS shifts to that of the representative unit.

DOE used market information to develop its model. By examining the distribution of Class A EPS efficiencies in the market, DOE was able to observe that achievable efficiency increases with power and that there is a wider range of efficiency at lower output powers. Any shift of a manufacturer's unit to the representative unit output power should take into account both effects, preserving a unit's relative standing in terms of efficiency among other units in the market.

A unit's relative standing could be calculated by comparing its efficiency to the level specified in the ENERGY STAR EPS Guidelines Version 1.1 (2005), as well as the best-in-market level, defined as the curve-fit of the highest-efficiency units in the ENERGY STAR qualifying products database for Class A EPSs. Because of the fundamental similarities in the design of Class A and non-Class A EPSs, DOE extended these same relationships and datasets to model the impacts on non-Class A EPS efficiency.

The model DOE used in the non-Class A engineering analysis reflects the above market dynamics by keeping constant the ratios among a unit's efficiency, the ENERGY STAR level, and the best-in-market level as the unit's output power is shifted to the level of the representative unit. Because the ratios are kept constant while the ENERGY STAR and best-in-market levels change with output power, the unit efficiency must also change. This updated unit efficiency is further adjusted to account for any differences in output voltage between the EPS and the representative unit, as explained in the following sections. (See chapter 5 of the TSD for further details on the mechanics of the model.)

c. Efficiency Scaling by Output Voltage

Together with the nameplate output power, the nameplate output voltage constrains a power supply's achievable efficiency. Given two EPSs with an identical design but different output voltages, the lower-voltage unit will be less efficient, primarily due to two factors:

• *Resistive losses:* Outputting the same power at a lower voltage requires higher output current, increasing the resistive losses, which are proportional to the square of the current.

• *Rectifier losses:* The voltage drop across the output rectifier increases with higher current, so that at a lower voltage more power (the amount of current multiplied by the voltage drop across the rectifier) will be dissipated, decreasing the efficiency of the power supply.

In addition to these losses, the EPS also experiences fixed losses that do not depend on the output voltage. These losses are associated with, for example, the quiescent current of the controller IC for switched-mode designs or the core magnetization losses for line-frequency designs and are equal to the no-load power consumption of the power supply. Figure II.4 summarizes the loss mechanisms described above.

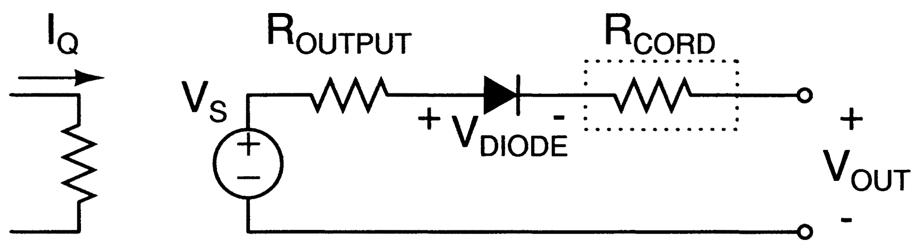


Figure II.4 Schematic of EPS Loss Model Used for Scaling Efficiency with Voltage

When scaling the efficiency of a power supply with voltage, DOE first calculated the typical losses according to the model presented in Figure II.4. Because the characteristics of each component in the loss model were fixed, the losses calculated using the model depended only on the output current and voltage, not the design specifics of the EPS. In short, the model returned the same losses for any two EPSs with the same output characteristics, regardless of their designs.

However, because each EPS has its own specific design, the actual losses of the power supply differ from those calculated according to this generic model. This difference between the modeled and actual losses does not depend on the output power or voltage, but is correlated with the active mode efficiency and no-load power of the EPS. Thus, the actual losses of an EPS can be said to be the sum of two components: (1) Generic losses, dependent on output power and voltage and modeled as described above; and (2) additional losses, dependent on the design of the EPS. Because the additional losses reflect the EPS design and the purpose of scaling was to estimate the losses of a particular design at the representative-unit output power and voltage, the additional losses were held constant between the original EPS and the representative unit to which it was being scaled.

Having obtained the generic losses for the original EPS using the model and its technology-dependent additional losses, DOE calculated the generic losses for the representative unit. DOE added the generic losses to the technology-dependent additional losses, resulting in an estimate of the total losses of the EPS design at the output power and voltage of the representative unit. The efficiency of the representative unit was finally calculated as the ratio of output power to the sum of the output power and the estimated losses.

d. Efficiency-Related Materials Cost Scaling by Nameplate Output Power and Sales Volume

To compare costs and efficiencies in order to develop cost-efficiency curves, DOE had to account for variations in nameplate output power and sales volume across the EPSs it analyzed. To do this, DOE developed a scaling model to determine what the ERMC of a tested EPS would be if it were produced in the same sales volume and had the same nameplate output power as the representative unit in its product class. DOE began the model development by assessing two datasets. The first dataset consisted of confidential production cost data for EPSs with nameplate output powers from 5 to 65 watts at a sales volume of 5,000 units, provided to Navigant Consulting. From this information, DOE observed a linear statistical relationship between EPS output power and EPS production cost in the dataset. The second dataset was public manufacturer data submitted to the California Energy Commission (CEC) in support of CEC's 2006 appliance standards rulemaking (available at *http://www.energy.ca.gov/appliances/archive/2006rulemaking2/documents/comments/NRDC.PDF*; last accessed March 2, 2009). This dataset contained EPS production cost vs. sales volume for 2-watt and 5-watt EPSs. The relationship between production cost and sales volume appeared to be nonlinear.

Based on observed relationships in the datasets, DOE determined that the ERMC of an EPS is roughly a linear function of output power and a nonlinear function of sales volume. DOE used these observations to develop a statistical model that relates output powers, ERMCs, and sales volumes of tested EPSs with the output power and sales volume of a representative unit in a product class. The model estimates the scaled ERMC of the tested unit using the test unit ERMC, sales volume, and output power, as well as the representative unit sales volume and output power as inputs. See chapter 4 of the TSD for further information.

6. Relationships Between Cost and Efficiency

Based on the data sources discussed in section II.C.2, DOE developed cost-efficiency curves for each representative unit by estimating the cost to reach each CSL. The primary data source for these curves comes from DOE measuring the efficiencies of 20 units and iSuppli tearing down and estimating costs for 13 of those units (Table II.18).

a. The Cost-Efficiency Relationships for Multiple-Voltage EPSs

DOE developed cost-efficiency data for the 40-watt multiple-voltage representative unit primarily based on manufacturer data. To verify and scale manufacturer interview data, DOE also tore down two multiple-voltage EPSs for multiple-function devices. These EPSs were at the same output power (40 watts) and sales volume (1,000,000 units per year) as the representative unit. Their output voltages (16 volts and 32 volts) were also the same as the output voltages of the representative unit, which made scaling unnecessary. Table II.23 shows the characteristics of the torn-down EPSs.

TABLE II.23—CHARACTERISTICS OF TORN-DOWN MULTIPLE-VOLTAGE EPSS FOR MULTIPLE-FUNCTION DEVICES

ID	Topology	Maximum output power	Output voltages	Average active-mode efficiency	Maximum no-load power consumption	ERMC	Sales volume *units/year*
		W	*V*	*%*	*W*	*2008$*	*units/year*
217	Switch Mode	40	16, 32	86	0.27	2.99	1,000,000
218	Switch Mode	40	16, 32	84	0.26	2.77	1,000,000

In interviews, manufacturers provided data for 12 cost-efficiency points. One manufacturer described specific changes that would be necessary to improve active-mode efficiency from 80 to 90 percent and no-load power consumption from 0.5 watts to 0.2 watts. These components included different transistors and IC controllers, Schottky output diodes, different common-mode chokes, and transformers with lower losses. Their usage increased the cost of the EPSs up to 38 percent over the 80-percent efficient EPS.

The manufacturers stated costs relative to a baseline value of 1.00X for the 80-percent efficient EPS up to 90 percent efficiency at relative costs of 1.38X. DOE used the ERMCs from the test and teardown results for the two EPSs in Table II.23 to determine the absolute cost of the manufacturer data. Specifically, DOE averaged the results for the EPSs to determine an average efficiency (85 percent) and ERMC ($2.88). In the manufacturer data, an 85-percent efficient EPS had a relative cost of 1.10X, which DOE set equal to $2.88. DOE was then able to calculate ERMCs for all 12 cost-efficiency points obtained in manufacturer interviews.

One manufacturer provided matched pairs of efficiency and no-load power consumption, which DOE used as the basis of the four CSLs. See section II.C.4 for further information. The corresponding ERMCs for these active-mode efficiencies are shown in Table II.24. These costs range from $2.66 at 81-percent efficiency to $3.67 at 91-percent efficiency. Figure II.5 shows the cost-efficiency curve for a multiple-voltage EPS for multiple-function devices along with the two torn-down EPSs.

TABLE II.24—COST-EFFICIENCY POINTS FOR A 40-WATT MULTIPLE-VOLTAGE EPS FOR A MULTIPLE-FUNCTION DEVICE

Level	Reference point for level	Minimum active-mode efficiency	Maximum no-load power consumption	Efficiency-related materials cost	Basis
		%	*W*	*2008$*	
0	Less Than EISA 2007	81	0.5	2.66	Manufacturer interview data.
1	Current Market	86	0.45	2.98	Manufacturer interview data.
2	High Level	90	0.31	3.54	Manufacturer interview data.
3	Higher Level	91	0.2	3.67	Manufacturer interview data.

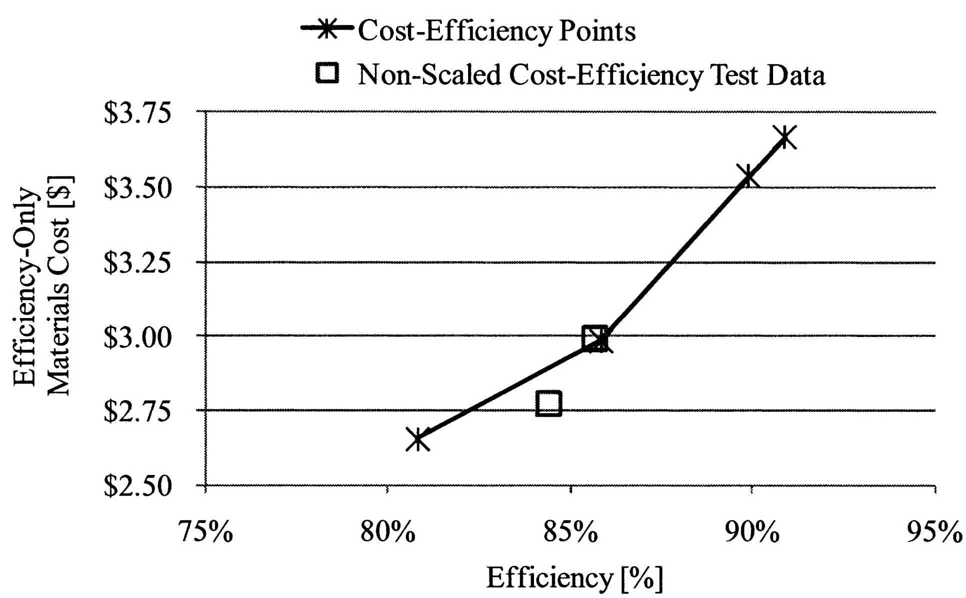


Figure II.5 Cost-Efficiency Curve for a Multiple-Voltage EPS for Multiple-Function Devices

In addition to the 40-watt multiple-voltage EPS, DOE also estimated costs for a 203-watt multiple-voltage EPS for a video game console. DOE based the cost-efficiency points on test data for four EPSs, teardown data for two EPSs, and two data points from manufacturer interviews. The torn-down EPSs had the same output voltages (5 volts and 12 volts) and output power (203 watts) as the representative unit. However, both EPSs had a different sales volume than the representative unit (4,000,000 units per year). Thus, DOE scaled the ERMC of these EPSs based on the scaling model in section II.C.5.d. The characteristics of the torn-down EPSs before and after scaling are shown in Table II.25 and Table II.26, respectively. Scaled characteristics are highlighted in gray.

Table II.25 Characteristics of Torn-Down Multiple-Voltage EPSs for Video Game Consoles Before Scaling

ID	Topology	Maximum Output Power W	Output Voltages V	Average Active-Mode Efficiency %	Maximum No-Load Power Consumption W	ERMC 2008$	Sales Volume units/year
203	Switch Mode	203	5, 12	86	3.29	9.08	2,500,000
213	Switch Mode	203	5, 12	82	12.33	6.45	1,000,000

Table II.26 Characteristics of Torn-Down Multiple-Voltage EPSs for Video Game Consoles After Scaling (Scaled Characteristics Highlighted in Gray)

ID	Topology	Maximum Output Power W	Output Voltages V	Average Active-Mode Efficiency %	Maximum No-Load Power Consumption W	ERMC 2008$	Sales Volume units/year
203	Switch Mode	203	5, 12	86	3.29	8.93	4,000,000
213	Switch Mode	203	5, 12	82	12.33	6.06	4,000,000

For CSL 0 and CSL 1, DOE used the efficiencies and scaled ERMCs of EPSs #213 and #203, respectively. DOE selected an active-mode efficiency of 86 percent for CSL 2 but required a lower no-load power consumption of 0.3 watts. The reduction in no-load power consumption can be achieved by reducing iron losses in the transformer, changing the switching frequency, and optimizing other elements of the circuitry at a cost increase of $0.13 over the CSL 1 EPS.

DOE chose an active-mode efficiency of 89 percent for CSL 3. This efficiency could be achieved using MOSFETs with reduced R_{DS_ON} and replacing a particular Schottky diode with a synchronous circuit at a cost of $3.11 over the CSL 2 EPS. See section II.C.4 for further information on how DOE chose the CSLs.

Table II.27 shows the cost-efficiency points for the 203-watt multiple-voltage EPS for a video game console based on the cost of making the improvements described previously. Figure II.6 shows the corresponding cost-efficiency curve along with the two torn-down units. There is a vertical portion of the cost-efficiency curve between CSL 1 and CSL 2. This corresponds to the decrease in no-load power consumption from 0.4 watts to 0.3 watts while the conversion efficiency remains constant at 86 percent between the two CSLs. The two dashed vertical lines mark the efficiencies of the torn-down EPSs.

TABLE II.27—COST-EFFICIENCY POINTS FOR A 203-WATT MULTIPLE-VOLTAGE EPS FOR A VIDEO GAME CONSOLE

Level	Reference point for level	Minimum active-mode efficiency	Maximum no-load power consumption	Efficiency-related materials cost	Basis
		%	W	2008$	
0	Generic Replacement	82	12.33	6.06	Test and teardown data.
1	Manufacturer Provided	86	0.4	8.93	Test and teardown data.
2	EU Qualified Level	86	0.3	9.05	Manufacturer interview data.
3	Higher Level	89	0.3	12.16	Manufacturer interview data.

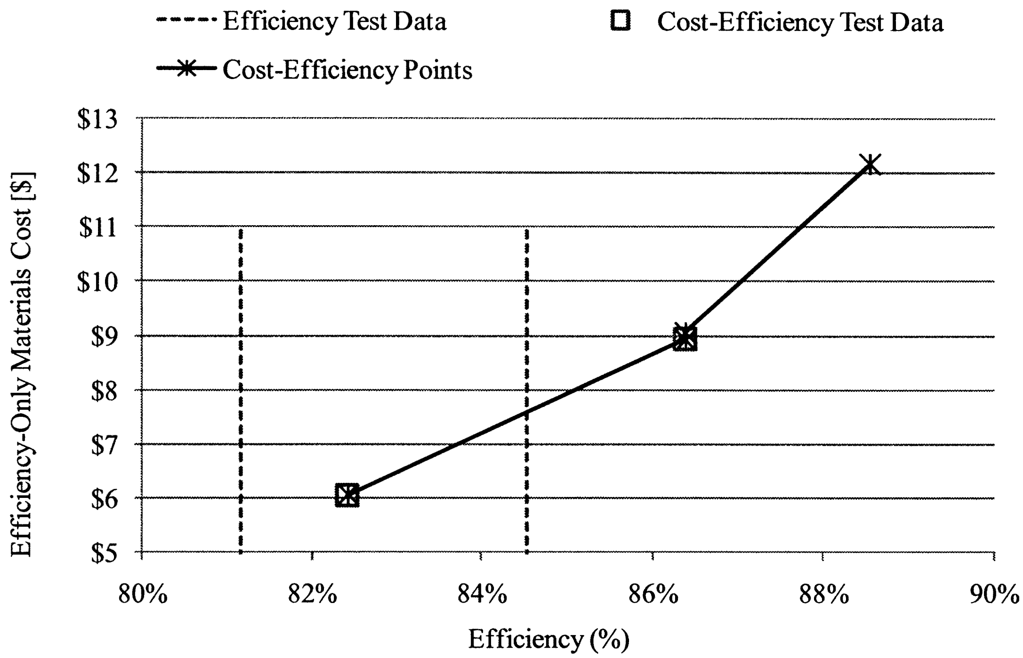


Figure II.6 Cost-Efficiency Curve for a 203-Watt Multiple-Voltage EPS for a Video Game Console

b. The Cost-Efficiency Relationship for High-Power EPSs

DOE developed cost-efficiency points for the 345-watt high-power EPS representative unit based on testing data for four units, teardown cost data for two units, and manufacturer interviews. Table II.28 shows the ERMCs for the torn-down units. Because they were at the same output power (345 watts) and the same sales volume (1,000 units per year) as the representative unit, DOE did not need to scale the ERMCs based on output power or sales volume. DOE also did not need to scale the efficiencies of the torn-down units because their output voltages and powers were the same as those of the representative unit.

TABLE II.28—CHARACTERISTICS OF TORN-DOWN HIGH-POWER EPSS

ID	Topology	Maximum output power	Output voltage	Average active-mode efficiency	Maximum no-load power consumption	ERMC	Sales volume
		W	*V*	*%*	*W*	*2008$*	*units/year*
401	Line Frequency	345	14	62	15.43	115.32	1,000
402	Switch Mode	345	14	81	6.01	33.64	1,000

DOE developed the ERMC for CSL 0 based on the ERMC of the torn-down line-frequency high-power EPS shown as EPS #401 in Table II.28. The data show that this line-frequency EPS is expensive mainly due to the materials costs for its transformer. The ERMC at CSL 1 was developed based on the torn-down switched-mode EPS shown as EPS #402. Because high-power line-frequency transformers need more material than high-power high-frequency transformers, the ERMC of the switched-mode EPS used to develop CSL 1 is significantly lower than the ERMC of the line-frequency EPS at CSL 0 ($115.32 vs. $33.64).

To develop the ERMC at CSL 2 for high-power EPSs, DOE used the ERMC of the torn-down EPS #402 and manufacturer interview data. One manufacturer representative stated that the efficiency and no-load power consumption of a high-power switched-mode EPS could be improved by 3 percent by changing the IC that controls the switching, with a cost increase of approximately $3.00. Thus, DOE created an ERMC of $36.64 for the EPS at CSL 2.

DOE developed the ERMC at CSL 3 for high-power EPSs by using the EPS modeled at CSL 2 along with manufacturer interview data and EPS test data. A manufacturer representative stated that additional increases in average active-mode efficiency beyond CSL 2 would cause a 10- to 20-percent increase in ERMC per efficiency point due to the usage of Schottky diodes for rectification. DOE observed that the average active-mode efficiency of 85 percent can be achieved by products already on the market by testing the efficiency of an available EPS. This EPS was a percentage point higher than the EPS used for CSL 2, and DOE created its ERMC accordingly.

The cost-efficiency points for the 345-watt high-power EPS ranged from $115.32 for a 62-percent efficient line-frequency EPS to $42.32 for an 85-percent efficient switched-mode EPS. In the case of high-power EPSs assessed by DOE, the more efficient switched-mode EPSs are substantially less expensive than the least efficient line-frequency

EPS at CSL 0. However, cost increases with efficiency among the switched-mode EPSs DOE assessed. The cost-efficiency data is shown in Table II.29 and Figure II.7. The vertical lines in the figure represent the efficiencies of the two torn-down EPSs.

TABLE II.29—COST-EFFICIENCY POINTS FOR A 345-WATT HIGH-POWER EPS FOR A HAM RADIO

Level	Reference point for level	Minimum active-mode efficiency	Maximum no-load power consumption	Efficiency-related materials cost	Basis
		%	W	2008%	
0	Line Frequency	62	15.43	115.32	Test and teardown data.
1	Switched-Mode—Low Level	81	6.01	33.64	Test and teardown data.
2	Switched-Mode—Mid Level	84	1.50	36.64	Manufacturer interview data.
3	Switched-Mode—High Level	85	0.50	42.32	Manufacturer interview data.

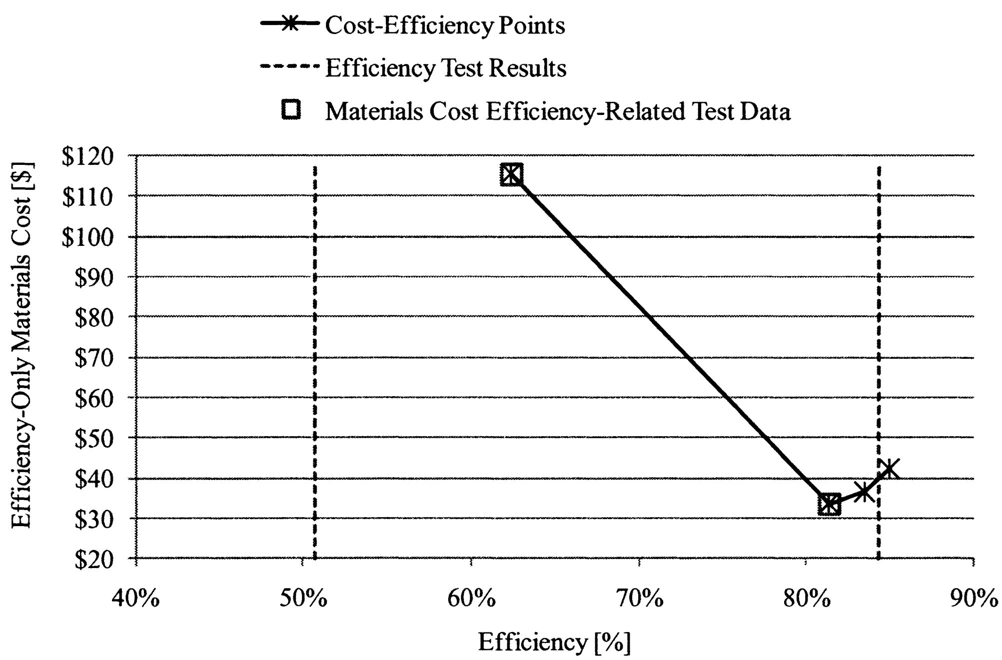


Figure II.7 Cost-Efficiency Curve for a 345-Watt High-Power EPS for a Ham Radio

c. The Cost-Efficiency Relationship for Medical Device EPSs

DOE developed the cost-efficiency points for the 18-watt medical device EPS representative unit based on test and teardown data for two medical EPSs and four Class A EPSs, along with five data points from manufacturer interviews. DOE included Class A EPSs in this analysis because the efficiency-related materials costs for medical device EPSs appear to be the same as Class A EPSs. This situation became evident during manufacturer interviews.

DOE tore down EPSs at a range of sales volumes and nameplate output powers, all close to 18 watts. The representative unit in the medical device EPS product class had a nameplate output power of 18 watts and a sales volume of 10,000 units per year, so DOE needed to scale the ERMCs of the torn-down units based on the model described in section II.C.5.d. DOE also needed to scale the active-mode efficiencies of the units based on the model described in section II.C.5.b. Table II.30 shows characteristics of the EPSs before scaling, and Table II.31 shows the same EPSs with the scaled characteristics highlighted in gray. EPSs #301 and #302 are used in medical devices; the other EPSs are Class A EPSs.

Table II.30 Characteristics of Medical EPSs and Class A EPSs Before Scaling

ID	Topology	Maximum Output Power W	Output Voltage V	Average Active-Mode Efficiency %	Maximum No-Load Power Consumption W	ERMC 2008$	Sales Volume units/year
301	Switched Mode	18	12	78	0.33	2.23	220,000
302	Switched Mode	20	12	80	0.29	2.27	220,000
117	Switched Mode	18	12	78	0.65	2.00	225,000
118	Switch Mode	18	12	81	0.27	1.96	225,000
120	Switched Mode	18	12	78	0.56	2.22	225,000
130	Linear Regulated	14	12	64	0.56	1.49	225,000

Table II.31 Characteristics of Medical EPSs and Class A EPSs After Scaling (Scaled Characteristics Highlighted in Gray)

ID	Topology	Maximum Output Power W	Output Voltage V	Average Active-Mode Efficiency %	Maximum No-Load Power Consumption W	ERMC 2008$	Sales Volume units/year
301	Switch Mode	18	12	78	0.33	3.83	10,000
302	Switch Mode	18	12	79	0.29	3.63	10,000
117	Switch Mode	18	12	78	0.65	3.44	10,000
118	Switch Mode	18	12	81	0.27	3.37	10,000
120	Switch Mode	18	12	78	0.56	3.82	10,000
130	Linear Regulated	18	12	66	0.56	2.95	10,000

DOE used the scaled ERMC of the linear-regulated EPS #130 as the ERMC for CSL 0. This is the only linear-regulated EPS that DOE tore down for this product class. DOE observed the market of available EPSs and noted the wide range of efficiencies and lack of correlations with ERMC over the efficiency range. In light of this observation, DOE chose to average the scaled ERMCs of the switched-mode EPSs to create the ERMCs for units at CSL 1 and CSL 2. The average active-mode efficiencies of the units at CSL 1 and CSL 2 are 76 percent and 80 percent, respectively. These efficiencies correspond to the international efficiency protocol levels Mark IV and Mark V (see section II.C.4) DOE believes that ERMC does not increase between Mark II and Mark V, but selected the efficiency range between Mark IV and Mark V to best reflect available EPS market data.

To develop the ERMC for CSL 3, DOE interviewed a manufacturer that described the components needed to create an EPS with an efficiency of 85 percent and a no-load power consumption of 0.15 watts. These design options included a quasi-resonant PWM controller, a primary FET and secondary synchronous rectifier circuit with low voltage drops, a planar transformer, and wiring with a higher gauge. The manufacturer estimated that these components would increase the ERMC of the EPS at CSL 2 by approximately $2.36, although DOE currently has no testing or teardown data to verify this point.

Table II.32 lists the cost-efficiency points for the 18-watt medical device EPS, ranging from $2.95 for a 66-percent-efficient EPS to $5.70 for an 85-percent-efficient EPS. See section II.C.4 for further information on how the active-mode efficiency and no-load power requirements for medical device EPSs were developed. Figure II.8 shows the cost-efficiency curve for the 18-watt medical device EPS along with data points for the medical device and Class A EPSs that DOE tore down.

TABLE II.32—COST-EFFICIENCY POINTS FOR AN 18-WATT MEDICAL DEVICE EPS FOR A NEBULIZER

Level	Reference point for level	Minimum active-mode efficiency %	Maximum no-load power consumption W	Efficiency-related materials cost	Basis
		%	W	*2008$*	
0	Less Than the IV Mark	66.0	0.557	2.95	Scaled ERMC of EPS #130.

TABLE II.32—COST-EFFICIENCY POINTS FOR AN 18-WATT MEDICAL DEVICE EPS FOR A NEBULIZER—Continued

Level	Reference point for level	Minimum active-mode efficiency %	Maximum no-load power consumption W	Efficiency-related materials cost	Basis
		%	W	*2008$*	
1	Meets the IV Mark	76.0	0.5	3.62	Average ERMC of switched-mode EPSs.
2	Meets the V Mark	80.3	0.3	3.62	Average ERMC of switched-mode EPSs.
3	Higher Level	85.0	0.15	5.70	Manufacturer interview data.

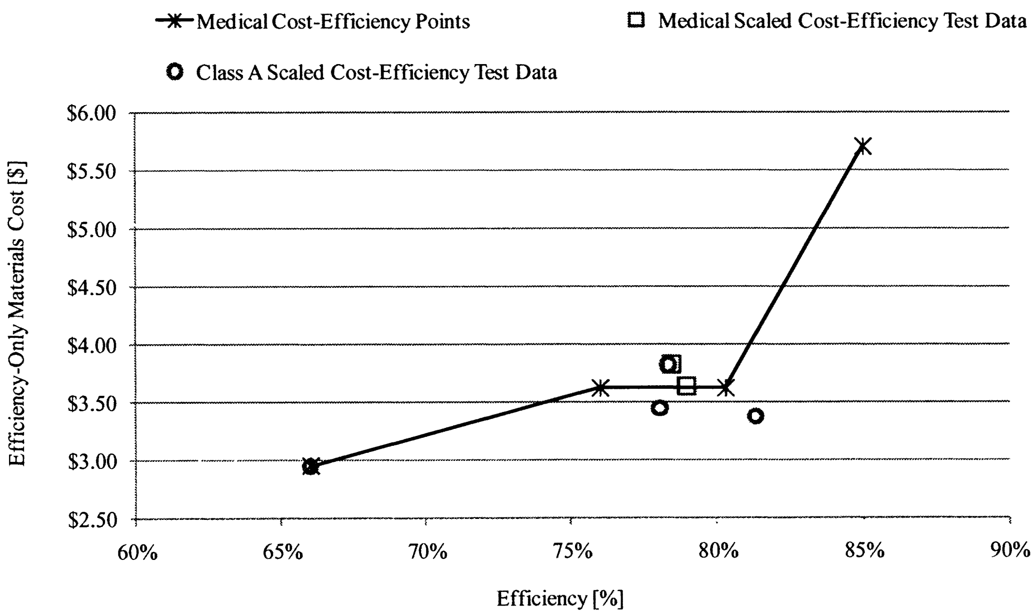


Figure II.8 Cost-Efficiency Curve for an 18-Watt Medical EPS for a Nebulizer

d. The Cost-Efficiency Relationships for EPSs for BCs

DOE developed the cost-efficiency points for the 1.8-watt and 4.8-watt EPS for BC representative units based on efficiency test data and cost estimates for 12 Class A EPSs. EPSs for BCs appear to be able to achieve the same range of efficiencies as Class A EPSs at the same costs. The majority of the torn-down EPSs were produced in nameplate output powers, output voltages, and sales volumes that differed from those of the representative unit (1.8 watts, 6 volts, and 1,000,000 units per year, respectively). Thus, DOE scaled the ERMCs and active-mode efficiencies of the torn-down EPSs using the models described in section II.C.3. The original and scaled characteristics of the torn-down EPSs and additional 5-watt EPSs are shown in Table II.33 and Table II.34, respectively, with the scaled characteristics highlighted in gray.

Table II.33 Characteristics of Torn-Down Class A EPSs Analyzed for a BC for a Vacuum, Before Scaling

ID	Topology	Maximum Output Power W	Output Voltage V	Average Active-Mode Efficiency %	Maximum No-Load Power Consumption W	ERMC 2008$	Sales Volume units/year
103	Switch Mode	1.75	5	74	0.12	0.77	1,000,000
105	Switch Mode	2.5	5	67	0.13	0.75	1,000,000
106	Switch Mode	2.5	5	63	0.13	1.13	1,000,000
17	Line-Frequency Linear Regulated	5	5	36	1.85	1.16	225,000
27	Line-Frequency Switching Regulated	5	5	49	1.42	1.54	225,000
22	Switch Mode	5	5	59	0.42	1.29	225,000
25	Switch Mode	5	5	66	0.64	1.45	225,000
37	Switch Mode	5	5	66	0.66	1.50	225,000
18	Switch Mode	5	5	70	0.54	1.46	225,000
21	Switch Mode	5.2	5.2	71	0.10	1.63	225,000
24	Switch Mode	5	5	72	0.11	1.34	225,000
8	Switch Mode	5	5	73	0.11	1.06	225,000

Table II.34 Characteristics of Torn-Down Class A EPSs Analyzed for a BC for a Vacuum, After Scaling (Scaled Characteristics Highlighted in Gray)

ID	Topology	Maximum Output Power W	Output Voltage V	Average Active-Mode Efficiency %	Maximum No-Load Power Consumption W	ERMC 2008$	Sales Volume units/year
103	Switch Mode	1.8	6	75	0.12	0.78	1,000,000
105	Switch Mode	1.8	6	65	0.13	0.71	1,000,000
106	Switch Mode	1.8	6	61	0.13	1.07	1,000,000
17	Line-Frequency Linear Regulated	1.8	6	24	1.85	0.83	1,000,000
27	Line-Frequency Switching Regulated	1.8	6	39	1.42	1.11	1,000,000
22	Switch Mode	1.8	6	50	0.42	0.93	1,000,000
25	Switch Mode	1.8	6	57	0.64	1.04	1,000,000
37	Switch Mode	1.8	6	58	0.66	1.08	1,000,000
18	Switch Mode	1.8	6	62	0.54	1.05	1,000,000
21	Switch Mode	1.8	6	63	0.10	1.16	1,000,000
24	Switch Mode	1.8	6	64	0.11	0.96	1,000,000
8	Switch Mode	1.8	6	66	0.11	0.76	1,000,000

DOE used the scaled ERMC of the line-frequency EPS #17 as the ERMC for the CSL 0. For CSLs 1 through 3, DOE chose to use the average of the scaled ERMCs of all switched-mode units shown in Table II.34. This is because DOE observed no clear correlation between the average active-mode efficiencies of the switched-mode EPSs and their ERMCs. See section II.C.4 for more information on how the active-mode efficiency and no-load power consumption requirements were chosen for these CSLs.

Table II.35 lists the cost-efficiency points for the 1.8-watt EPS for a BC for a vacuum, ranging from $0.83 for a 24-percent-efficient EPS to $0.95 for a 66-percent-efficient EPS.

Figure II.9 shows the cost-efficiency curve for the EPS along with data for the Class A EPSs that DOE analyzed.

TABLE II.35—COST-EFFICIENCY POINTS FOR A 1.8–WATT EPS FOR BC FOR A VACUUM

Level	Reference point for level	Minimum active-mode efficiency %	Maximum no-load power consumption W	Efficiency-related materials cost	Basis
		%	W	*2008$*	
0	Less than the II Mark	24	1.85	$0.83	Scaled ERMC of EPS #17.
1	Meets the II Mark	45	0.75	$0.95	Average of switched-mode test data.
2	Meets the IV Mark	55	0.50	$0.95	Average of switched-mode test data.
3	Meets the V Mark	66	0.30	$0.95	Average of switched-mode test data.

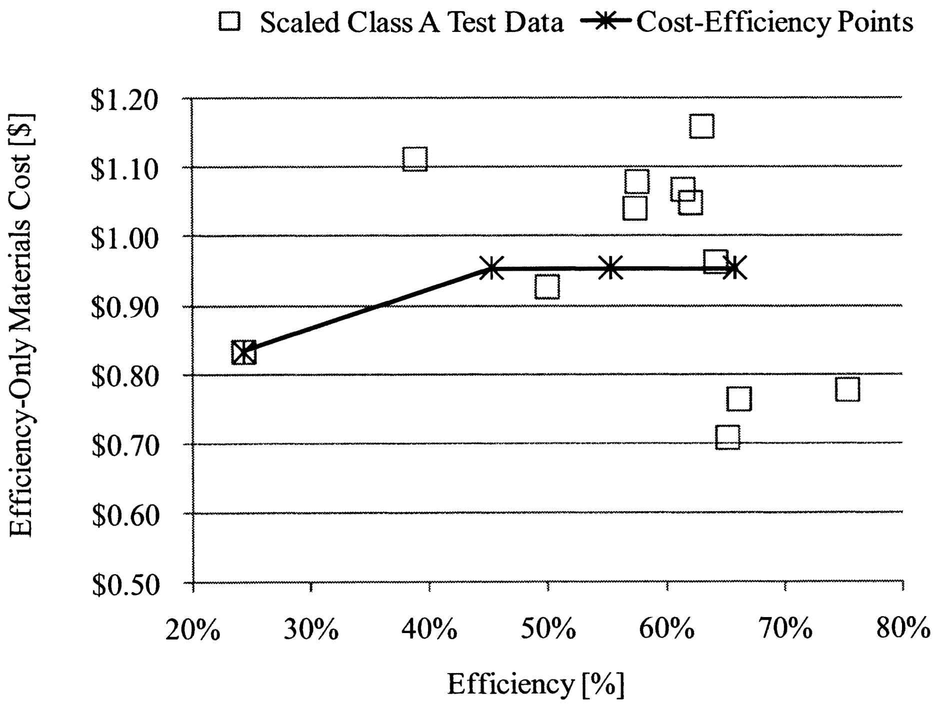


Figure II.9 Cost-Efficiency Curve for a 1.8-Watt EPS for BC for a Vacuum

For the 4.8-watt EPS used in a BC designed for use in a DIY power tool, DOE developed cost-efficiency points by using the same data it used for the 1.8-watt EPS for the BC analysis. The majority of the torn-down EPSs were produced in nameplate output powers, output voltages, and sales volumes different from those of the representative unit (4.8 watts, 24 volts, and 1 million units per year, respectively). Thus, DOE scaled the ERMCs and active-mode efficiencies of the torn-down EPSs using the models described in section II.C.3. Table II.33 shows the original characteristics of the torn-down EPSs. Table II.36 shows the scaled characteristics of the torn-down EPSs with the scaled characteristics highlighted in gray.

Table II.36 Characteristics of Torn-Down and Additional Five-Watt Class A EPSs Analyzed for a BC for a DIY Power Tool, After Scaling (Scaled Characteristics Highlighted in Gray)

ID	Topology	Maximum Output Power W	Output Voltage V	Average Active-Mode Efficiency %	Maximum No-Load Power Consumption W	ERMC 2008$	Sales Volume units/year
103	Switched Mode	4.8	24	90	0.12	0.97	1,000,000
105	Switched Mode	4.8	24	79	0.13	0.89	1,000,000
106	Switched Mode	4.8	24	76	0.13	1.33	1,000,000
17	Line-Frequency Linear Regulated	4.8	24	38	1.85	1.04	1,000,000
27	Line-Frequency Switching Regulated	4.8	24	52	1.42	1.39	1,000,000
22	Switched Mode	4.8	24	64	0.42	1.16	1,000,000
25	Switched Mode	4.8	24	71	0.64	1.30	1,000,000
37	Switched Mode	4.8	24	71	0.66	1.35	1,000,000
18	Switched Mode	4.8	24	76	0.54	1.31	1,000,000
21	Switched Mode	4.8	24	77	0.10	1.45	1,000,000
24	Switched Mode	4.8	24	78	0.11	1.21	1,000,000
8	Switched Mode	4.8	24	81	0.11	0.96	1,000,000

As it did for the 1.8-watt EPS, DOE used the scaled ERMC of the line-frequency EPS #17 as the ERMC at CSL 0. For CSLs 1 through 3, DOE chose to use the average of the scaled ERMCs of all switched-mode units shown in Table II.36 because no clear correlation could be observed between the efficiencies of the switched-mode units and their ERMCs. See section II.C.4 for information on how DOE chose the active-mode efficiency and no-load power consumption requirements for these CSLs.

Table II.37 lists the cost-efficiency points for the 4.8-watt EPS used in a DIY power tool BC, which range from $1.04 for a 38-percent-efficient EPS to $1.19 for a 72-percent-efficient EPS. Figure II.10 shows the cost-efficiency curve for the EPS along with data for the Class A EPSs that DOE analyzed.

TABLE II.37—COST-EFFICIENCY POINTS FOR A 4.8-WATT EPS FOR BC FOR A DIY POWER TOOL

Level	Reference point for level	Minimum active-mode efficiency %	Maximum no-load power consumption W	Efficiency-related materials cost	Basis
		%	W	*2008$*	
0	Less than the II Mark	38	1.85	1.04	Scaled EPS #17 ERMC.
1	Meets the II Mark	56	0.75	1.19	Average of switched-mode test data.
2	Meets the IV Mark	64	0.50	1.19	Average of switched-mode test data.
3	Meets the V Mark	72	0.30	1.19	Average of switched-mode test data.

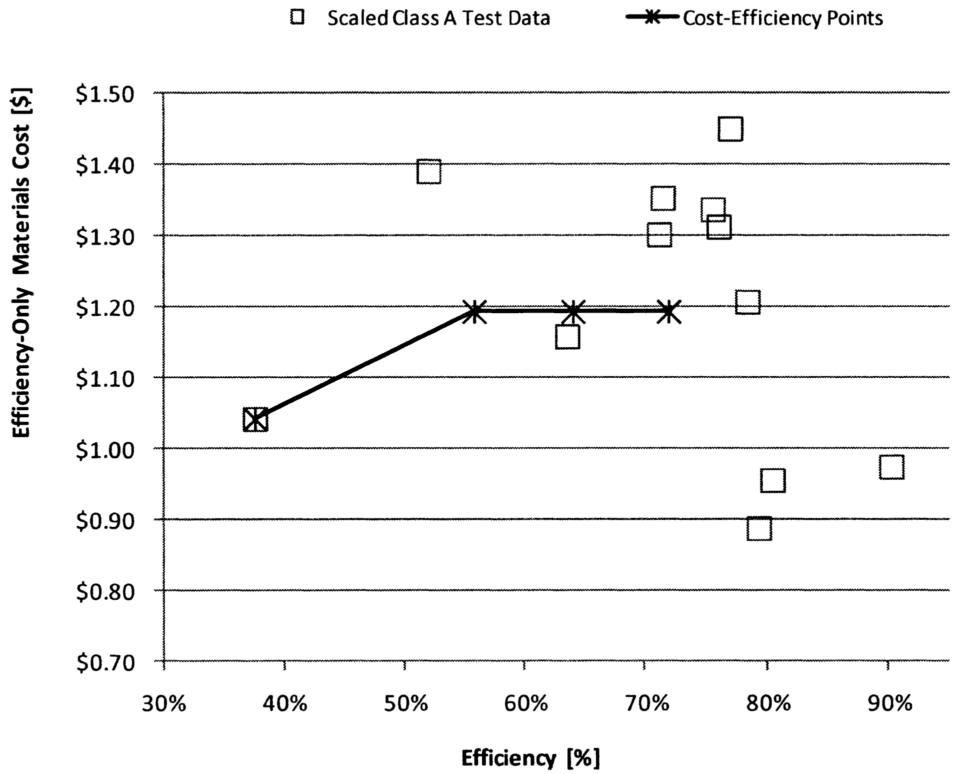


Figure II.10 Cost-Efficiency Curve for a 4.8-Watt EPS for BC for a DIY Power Tool

D. Energy Use and End-Use Load Characterization

1. Introduction

The purpose of the energy-use and end-use load characterization is to identify how consumers use products and equipment, and thereby determine the change in EPS energy consumption related to different energy efficiency improvements. For EPSs, DOE's analysis focused on the consumer products they power and on how end-users operate these consumer products.

The energy-use and end-use load characterization describes the unit energy consumption (UEC), which is an input to the LCC and national impact analyses. UEC represents the typical annual energy consumption of an EPS in the field. UEC for EPSs is calculated by combining (1) usage profiles, which describe the time a device spends in each mode in one year; (2) load, which measures the power provided by the EPS to the consumer product in each mode; and (3) efficiency, which measures the power an EPS must draw from mains to power a given load. Because of the nature of EPSs, the usage profile of the device will be related to the usage profile of the associated application. DOE assumes that usage profiles will not change over the analysis period.

For most electric appliances, energy consumption is the energy an application draws from mains while performing its intended function(s). EPSs, however, are power conversion devices, and their intended function is to deliver a portion of the energy drawn from mains to another application. As a result, EPS energy consumption is more appropriately characterized as that portion of the energy that the EPS draws from mains that is not delivered to the load. That is, the energy consumption of an EPS is the difference between the energy drawn by the EPS from mains (E_{IN}) and the energy supplied by the EPS to the attached load (E_{OUT}).

The following sections present the inputs, methodology, and outputs of the annual unit energy consumption calculations. Section II.D.2 explains how DOE calculated EPS energy consumption by examining separately each energy-consuming mode of the device. Section II.D.3 contains the usage profiles and load points DOE used for each type of EPS based on its applications. Section II.D.4 presents the annual energy consumption values DOE calculated for each representative unit at each CSL.

DOE seeks comments on the usage profiles and unit energy consumption calculations used in the determination analysis. DOE also seeks alternative sources, databases, or methodologies for developing its energy use estimates. See chapter 4 of the TSD for additional information on specific calculations.

2. Modes and Application States

When evaluating usage and energy consumption for a device, it is usually sufficient to observe only the energy-consuming modes of that device. Because the function of the EPS is to power consumer product applications, however, evaluating the usage and energy consumption of the EPS also requires evaluating the usage and energy consumption of the application itself.

To avoid confusion when describing usage and energy consumption from the perspective of the application, DOE uses the term ''application state.'' When describing usage and energy consumption from the perspective of the EPS, DOE uses the term ''EPS mode.''

By definition, all energy-consuming application states are part of active mode from the perspective of the EPS. That is, since any energy-consuming application state requires the application to be connected to the EPS, any energy-consuming application state is part of EPS active mode. These states vary by the type of application. In the discussion of usage profile and load characterization, DOE will provide an explanation of the application states it considered when calculating usage and energy consumption.

An EPS can be in active mode, no-load mode, off mode, or unplugged. Table II.38 gives a summary of these modes.

TABLE II.38—SUMMARY OF EPS MODES

EPS mode	Status of EPS connection to mains	Status of EPS connection to application	EPS on/off switch selection (if switch is present)
Active	Connected	Connected	On.
No Load	Connected	Disconnected	On.
Off	Connected	Disconnected	Off.
Unplugged	Disconnected.		

Active Mode: EPCA defines active mode as the condition in which an energy-using product (I) is connected to a main power source; (II) has been activated; and (III) provides one or more main functions (42 U.S.C. 6295(gg)(1)(A)(i)). EPCA defines active mode for EPSs in particular as the mode of operation when an external power supply is connected to the main electricity supply and the output is connected to a load (42 U.S.C. 6291(36)(B)). Thus, in calculating usage profiles and energy consumption, DOE considers active mode to include any condition where the EPS is connected to both mains and the application.

Unless otherwise indicated, DOE assumed that while in active mode, an application places a load of 80 percent of nameplate output power on the EPS when it is operating, and a load of 20 percent when it is idle. DOE further assumed that an application places a load of 5 percent of nameplate output power on the EPS when the application is off. The following section further discusses each application.

No-Load Mode: EPCA defines no-load mode for EPSs as the mode of operation when an external power supply is connected to the main electricity supply and the output is not connected to a load (42 U.S.C. 6291(36)(D)). DOE determined that for EPSs, no-load mode is equivalent to standby, as explained in the ''Final Rule on Test Procedures for Battery Chargers and External Power Supplies (Standby Mode and Off Mode),'' published in the **Federal Register** on March 27, 2009. (74 FR 13318)

Off Mode: Off mode is a mode applicable only to an EPS with an on/off switch in which the EPS is connected to mains, is disconnected from the load, and the on/off switch is set to ''off.'' This definition was promulgated in the final rule. Of the EPSs examined for the determination analysis, only the two high power representative units included on/off switches. In both cases, turning off the switch fully severed the circuit, creating a situation electrically equivalent to the EPS being unplugged from mains. To estimate energy consumption, DOE treated the time when the EPS switch is set to off as equivalent to unplugged time. DOE seeks information on the prevalence and usage of on/off switches on all EPSs.

Unplugged Mode: Unplugged mode is when the EPS is disconnected from mains power. No energy is consumed in this state.

3. Usage Profiles

For many applications, usage depends strongly on the individual user. To account for the variety of users and their associated usage profiles, DOE developed multiple usage profiles where appropriate. DOE then calculated a weighted-average usage profile based on an estimated distribution of user types. For each user type, DOE provided a qualitative description of usage to explain the quantitative usage profile. The following subsections describe the application states, user types, and usage profiles for each representative unit.

a. Multiple-Voltage EPS (40-Watt Multifunction Device)

DOE identified the following application states for multifunction devices:

• Printing, photocopying, faxing (sending and receiving), and scanning: The multifunction device is on and performing one of its primary functions.
• Idle: The multifunction device is on but not performing any printing, photocopying, faxing, or scanning tasks.
• Off: The multifunction device is off, whether by automatic shutdown or by a user-controlled on/off switch.

For multifunction devices, DOE developed one usage profile, which describes usage in an in-home office setting (Table II.39). This profile was derived from a DOE report, ''U.S. Residential Information Technology Energy Consumption in 2005 and 2010,'' prepared by TIAX LLC in 2006. (TIAX LLC, ''U.S. Residential Information Technology Energy Consumption in 2005 and 2010.'' Prepared for U.S. Department of Energy, March 2006.) This usage profile is explained further in section 4.3.1 of the TSD. DOE also derived its estimates of EPS output power from this report, except for the printing, photocopying, faxing, and scanning application state, which DOE assumed to be 80 percent of nameplate output power. DOE invites comments on its usage profile and output power estimates for EPSs for multifunction devices.

TABLE II.39—USAGE AND OUTPUT POWER OF EPS FOR MULTIFUNCTION DEVICE

EPS mode	Application state	Annual usage hours/year	EPS output power W
Active	Printing, Photocopying, Faxing, Scanning	52	*32
	Idle	1,606	9.1
	Off	7,102	6.2
No Load	Disconnected from EPS	0	0
Unplugged	Disconnected from EPS	0	0

* DOE estimated EPS output power for printing, photocopying, faxing, and scanning to be 80 percent of nameplate output power.

b. Multiple-Voltage EPS (203-Watt Xbox 360)

DOE identified the following application states for the Xbox 360:

• Video game playing: The console is on and the user is actively playing a video game.

• Video game idle: The console is on and a video game disc is inserted, but the user is not interacting with the game, *i.e.,* the game is paused, abandoned, or at the menu screen.

• DVD playing: The console is on, a DVD is inserted, and the console is actively playing a movie.

• DVD idle: The console is on, a DVD is inserted, and a movie is paused or at the menu screen.

• No disc: The console is on, but no disc is inserted.

• Off: The console is switched off.

DOE defined two usage profiles for the Xbox 360, one for a light user and one for a heavy user. The usage profiles were based on in-home usage audits of video game consoles conducted by The Nielsen Company in 2006. (The Nielsen Company, ''The State of the Console,'' Q4 2006.) DOE assumed 80 percent of users are light users and 20 percent are heavy users. DVD usage came from a TIAX report, ''Energy Consumption by Consumer Electronics in U.S. Residences.'' (TIAX, ''Energy Consumption by Consumer Electronics in U.S. Residences,'' Final Report to the Consumer Electronics Association, January 2007.) DOE estimated that DVD usage did not vary among user types, and that one-third of video game consoles would be used as a DVD player. DOE estimates of EPS output power for the various application states were derived from estimates of EPS input power in a 2008 report from the Natural Resources Defense Council. (NRDC, ''Lowering the Cost of Play: Improving the Energy Efficiency of Video Game Consoles,'' November 2008.) DOE invites comments on its usage profile and output power estimates for EPSs for the Xbox 360, summarized in Table II.40. Section 4.3.1 of the TSD contains additional detail.

TABLE II.40—USAGE AND OUTPUT POWER OF EPS FOR XBOX 360

EPS mode	Application state	Weighted-average annual usage hours/year	EPS output power* W
Active	Playing Video Game	820	102.62
	Idle Video Game	560	101.50
	Playing DVD	90	95.02
	Idle DVD	150	95.02
	Idle—No Disc	150	86.38
	Off	6,990	2.35
No Load	Disconnected from EPS	0	0
Unplugged.		0	0

*Output power levels for all application states were derived from input power measurements reported in NRDC's "Lowering the Cost of Play: Improving the Energy Efficiency of Video Game Consoles," November 2008, using DOE's measurements of the efficiency and no-load power consumption of the EPS that ships with the Xbox 360.

c. High-Power EPS (345-Watt Amateur Radio Equipment)

DOE identified the following application states for amateur radio equipment.

• Transmitting: The radio equipment is turned on and actively transmitting.

• Receiving: The radio equipment is turned on and actively receiving.

• Idle: The radio equipment is turned on but neither transmitting nor receiving.

DOE defined three usage profiles for amateur radio equipment based on conversations with the Amateur Radio Relay League. The light usage profile is intended to approximate infrequent use of a radio system. Light users only use their equipment for limited periods on a weekly basis or for an extended period on a monthly basis. The medium usage profile is intended to approximate regular evening or weekend use. The heavy usage profile is intended to reflect the usage of a repeater system, which is a radio setup configured to relay transmissions automatically, or a similar continuous use system. Such systems are typically never switched off. The light, medium, and heavy usage profiles were assumed to represent 50 percent, 25 percent, and 25 percent of users, respectively. Section 4.3.2 of the TSD discusses these three usage profiles.

DOE assumed EPS power consumption to be 80 percent of nameplate in the transmitting application state and 20 percent of nameplate in the receiving and idle application states. DOE also assumed that while in use, a radio system will be transmitting, receiving, and idle for 10 percent, 10 percent, and 80 percent of the time, respectively. DOE seeks comments on its assumptions about the usage of high-power EPSs, summarized in Table II.41.

TABLE II.41—USAGE AND OUTPUT POWER OF EPS FOR AMATEUR RADIO EQUIPMENT

EPS mode	Application state	Weighted-average annual usage hours/year	EPS output power W*
Active	Transmitting	140	276
	Receiving	140	69
	Idle	2,411	69
No Load	Disconnected from EPS	0	0
Off or Unplugged.		6,070	0

*DOE estimated output power levels at 80 percent of nameplate for transmitting and at 20 percent of nameplate for receiving or idle.

d. Medical EPS (18-Watt Nebulizers and 35-Watt Sleep Therapy Devices)

DOE identified the following application states for EPSs for sleep therapy devices and nebulizers:

• On: The on/off switch is set to on and the device is in use.

• Off: The on/off switch is set to off and the device is not in use.

DOE estimated usage for three types of nebulizer users—light, medium, and heavy—with an even distribution among user types. DOE based these user types around the number of sessions per day a user employs the nebulizer. From an energy consumption perspective, a session involves turning on the nebulizer, inhaling the aerosolized medication, and then turning the nebulizer off. Each session is assumed to take an average of 10 minutes. The number of sessions per day ranges from one in the light usage profile to three in the heavy usage profile, depending on the severity of the illness and the type of medication. DOE also assumed that because most users require daily administration of medication, nebulizer users are unlikely to unplug their nebulizers (and associated EPSs) from mains.

Some nebulizers with an EPS offer a rechargeable battery pack as an optional accessory. These EPSs lack charge control because they can power the product directly without the battery. The usage profiles do not represent usage under battery power. Such a profile would increase EPS energy consumption because of the losses inherent in charging and maintaining a battery. Hence, the nebulizer usage profiles used in the determination are conservative estimates of EPS energy consumption.

DOE estimated that 25 percent of light users would unplug the EPS and nebulizer from mains when not in use. DOE further assumed EPS power consumption to be 80 percent of nameplate in the on application state and 5 percent of nameplate in the off application state. The usage profiles DOE developed are contained in section 4.3.3 of the TSD and are summarized in Table II.42. DOE seeks comments on its assumptions about the usage of medical EPSs with nebulizers.

TABLE II.42—USAGE AND OUTPUT POWER OF EPS FOR NEBULIZER

EPS mode	Application state	Weighted-average annual usage *hours/year*	EPS output power *W**
Active	On	121.7	14.4
	Off	8,638.3	0.9
No Load	Disconnected from EPS	0	0
Unplugged		0	0

* DOE estimated output power levels at 80 percent of nameplate when the application is on and at 20 percent of nameplate when the application is off.

DOE developed one usage profile for sleep therapy devices that assumes the user turns on the device when going to sleep and turns it off after waking 8 hours later. DOE also assumed that because of the required daily use of the device, users would likely leave their sleep therapy devices (and associated EPSs) plugged into mains. DOE assumed EPS power consumption to be 80 percent of nameplate in the on application state and 10 percent of nameplate in the off application state. Table II.43 shows this usage profile; section 4.3.3 of the TSD provides additional detail. DOE seeks comments on its assumptions about the use of medical EPSs with sleep therapy devices.

TABLE II.43—USAGE AND OUTPUT POWER OF EPS FOR SLEEP THERAPY DEVICE

EPS mode	Application state	Annual usage *hours/year*	EPS output power *W*
Active	On	2,920	28
	Off	5,840	3.5
No Load	Disconnected from EPS	0	0
Unplugged		0	0

e. EPS for Battery Charger (1.8-Watt Cordless Handheld Vacuum)

DOE identified the following application states for battery chargers for cordless handheld vacuums:

• Active charging: The battery is connected to the battery charger and the battery is in the process of charging.

• Maintenance: The battery is fully charged and connected to the battery charger, and the battery charger remains connected to mains.

Some cordless handheld vacuums use cradles to charge the battery. The cradles that DOE evaluated in its teardown analysis were found to contain no circuitry. The cradle acted as an extension of the EPS output cord. Therefore, in representing usage, DOE treated the time when the vacuum was detached from the cradle or EPS, and the EPS was plugged into mains, as no-load mode.

DOE seeks comments on these issues and on the prevalence of detachable batteries used in household appliances such as cordless handheld vacuums. DOE also welcomes comments on differentiating between wall adapters and cradles and on the type of circuitry cradles typically contain.

DOE developed one usage profile for cordless handheld vacuums with input from the Association of Home Appliance Manufacturers and the Power Tool Institute. This profile was used to represent the usage of all the rechargeable floor care appliances considered in this determination analysis. DOE assumed EPS power consumption to be 80 percent of nameplate in the active charging application state and 35 percent of nameplate in the maintenance application state. Table II.44 shows this usage profile; see section 4.3.4 of the TSD for additional detail. DOE seeks comments on its assumptions about the usage of EPSs with rechargeable floor care appliances.

TABLE II.44—USAGE AND OUTPUT POWER OF EPS FOR CORDLESS VACUUM

EPS mode	Application state	Annual usage *hours/year*	EPS output power *W*
Active	Active Charging	416	1.44
	Maintenance	8,292	0.63
No Load	Disconnected from EPS/Cradle	52	0
Unplugged		0	0

f. EPS for Battery Charger (4.8-Watt Power Tool)

DOE identified the following application states for battery chargers for power tools:

• Active charging: The battery is connected to the battery charger and the battery is in the process of charging. For power tools, DOE estimated a charge rate of C/3, *i.e.,* the battery would take 3 hours to charge.

• Maintenance: The battery is connected to the battery charger and the battery has been fully charged.

• No battery: The battery is not connected to the battery charger.

DOE developed two usage profiles for power tools: One for light usage and one for heavy usage. Each profile represents 50 percent of users. DOE developed the heavy usage profile with input from the Power Tool Institute. DOE developed the light usage profile based on a scaled-back user. DOE assumed EPS power consumption to be 80 percent of nameplate in the active charging application state, 35 percent of nameplate in the maintenance application state, and 1 watt in the no-battery state. See section 4.3.5 of the TSD for a discussion of these usage profiles, which are summarized in Table II.45. DOE seeks comments on its assumptions about the usage of EPSs with rechargeable DIY power tools.

TABLE II.45—USAGE AND OUTPUT POWER OF EPS FOR POWER TOOL

EPS mode	Application state	Weighted-average annual usage *hours/year*	EPS Output power *W*
Active	Active Charging	105	3.84
	Maintenance	2,093	1.68
	No-Battery	104	1
No Load	Disconnected from EPS	104	0
Unplugged		6,354	0

4. Unit Energy Consumption

EPS power consumption is a function of three factors: the nameplate output power of the EPS, the efficiency of the EPS, and the consumption of the EPS when it is in no-load mode. To calculate the energy consumption of an EPS, DOE combined the time and power consumption values shown in the usage profiles above according to a methodology explained in section 4.4 of the TSD. Table II.46 shows the unit energy consumption values DOE calculated for each type of EPS at each CSL.

TABLE II.46—EPS UNIT ENERGY CONSUMPTION (KWH/YEAR)

Candidate standard level	Type of EPS					
	Multiple-voltage EPS for MFDs	Multiple-voltage EPS for Xbox 360	High-power EPS	EPS for medical devices	EPS for vacuums	EPS for power tools
0	15.8	126.0	103.3	40.2	12.0	6.9
1	11.2	32.4	39.5	25.3	4.6	3.3
2	7.7	31.9	28.5	19.3	3.1	2.3
3	6.6	26.6	24.1	13.6	2.0	1.6

E. Life-Cycle Cost and Payback Period Analyses

This section describes the methodology that DOE used to analyze the economic impacts of possible energy efficiency standards on individual consumers. DOE performed this analysis on the same representative units evaluated in section II.C.3. The effects of standards on individual consumers include a change in operating expenses (usually decreased) and a change in purchase price (usually increased). DOE used two metrics to determine the effect of potential standards on individual consumers:

• *Life-cycle cost* is the total consumer expense over the lifetime of an appliance, including the up-front cost (the total price paid by a consumer before the appliance can be operated) and all operating costs (including energy expenditures). DOE discounts future operating costs to the time of purchase.

• *Payback period* represents the number of years it would take the customer to recover the assumed higher purchase price of more energy efficient equipment through decreased operating expenses.[1] Sometimes more energy efficient equipment can have a lower purchase price than the less energy efficient equipment that it substitutes. In this case, the consumer realizes an immediate financial benefit and thus there is no payback period.

EPSs are unique appliances because they are always used in conjunction with other products of interest. Most EPSs are packaged with particular products, so consumers usually do not buy EPSs directly. For example, consumers obtain EPSs for video game systems when buying the video game systems themselves. Thus, although the LCC and PBP analyses use the consumer purchase prices of EPSs, in reality, those prices are a hidden portion of the prices that consumers pay for the product.

The energy consumption and technologies of the non-Class A EPSs DOE analyzed is assessed in further detail in section II.B. Chapter 5 of the TSD contains a description of how DOE used technology options, energy consumption, and other input data to determine life-cycle cost and payback period.

F. National Impact Analysis

In its determination analysis, DOE estimated the potential for national energy savings from energy conservation standards for non-Class A EPSs, as well as the net present value of such standards. Figure II.11 depicts these analyses, referred to collectively as the national impact analysis. A brief description of the national impact analysis follows.

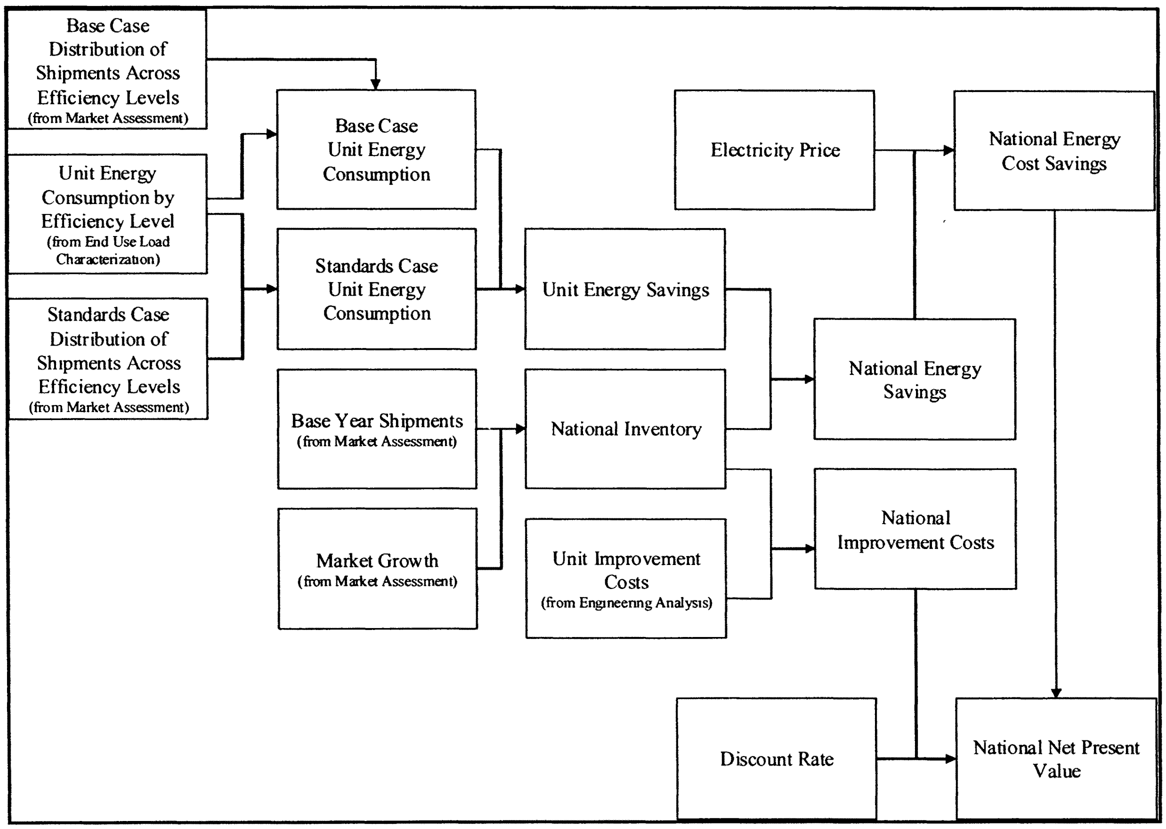


Figure II.11 Calculation of National Energy Savings and Net Present Value

Unit energy savings (UES) is the difference between the unit energy consumption (UEC) in the standard case and the UEC in the base case. Thus, the UES represents the reduced energy consumption of a single unit due to the higher efficiency generated by a standard. Once calculated, the UES is then multiplied by the national inventory of units to calculate national energy savings. For each type of EPS, DOE calculated the shipment-weighted average UEC of products in that class sold in a given year. DOE performed these calculations for each year in the evaluation period in both the standards case and the base case. DOE then calculated UES by taking the difference between the two cases. Using the calculated national inventory and UES for each year of the analysis, DOE calculated national energy savings by multiplying the two inputs together.

The national net present value of energy conservation standards is the difference between electricity cost savings and equipment cost increases. DOE calculated electricity cost savings for each year by multiplying energy savings by forecasted electricity prices. DOE assumed that all of the energy cost savings would accrue to consumers paying residential electricity rates. DOE calculated equipment cost increases for each year by taking the incremental price increase per unit between a base-case and a standards-case scenario and multiplying the difference by the national inventory. For each year, DOE took the difference between the savings and cost to calculate the net savings (if positive) or net cost (if negative). After calculating the net savings and costs, DOE discounted these annual values to the present time using discount rates of

[1] DOE computes a ''simple PBP,'' which uses only the first year of operating costs. Thus, operating costs are not discounted. See section II.E for further information.

3 percent and 7 percent and summed them to obtain the national net present value. See chapter 6 of the TSD for additional details.

III. Results

A. Life-Cycle Cost and Payback Period Analyses

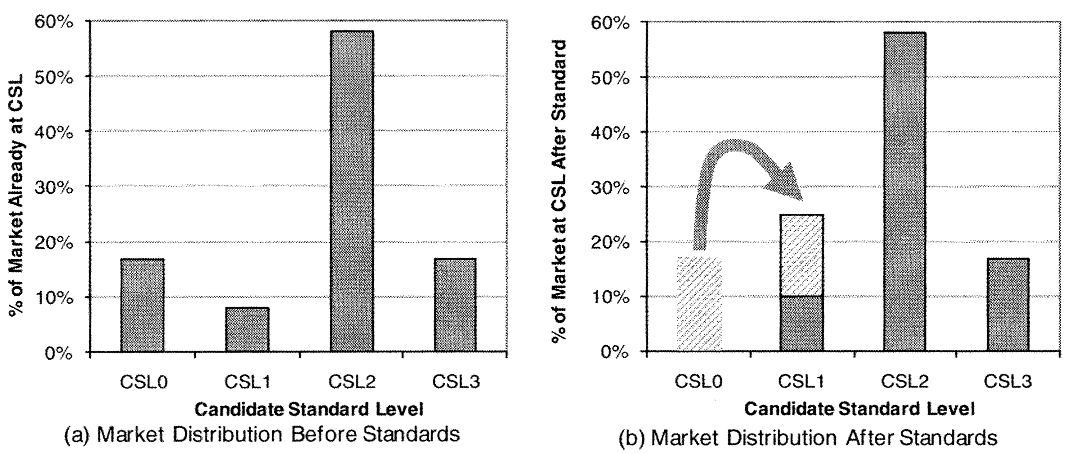
The tables and figures below present key results of the LCC and PBP analyses for all six of the EPS representative units in the residential sector. All LCC and PBP results were generated using the *AEO2009* residential sector reference case electricity price trend, a start year of 2013, and a nominal EPS usage pattern. LCC and PBP inputs are discussed in section II.E. To assess the impact of a standard on consumers, it is helpful to compute the LCC savings that a consumer will experience when replacing an EPS at a particular CSL with an EPS at a different CSL. Eq. III.1 shows how DOE calculated LCC savings:

$$LLCSavings_{k \rightarrow L} = LLC_k - LCC_L \qquad \text{Eq. III.1}$$

where $LCCSavings_{k \rightarrow L}$ is the LCC savings that a consumer would experience when replacing an EPS at CSL k with an EPS at CSL L,
LCC_k is the life-cycle cost of an EPS at CSL k,
LCC_L is the life-cycle cost of an EPS at CSL L,
k is the CSL of the EPS being replaced, and
L is the CSL of the EPS being purchased.

DOE assumes that at any given time, EPSs of a variety of efficiencies can be found on the market for a particular product. (For example, there are EPSs of different efficiencies for radios and video game systems.) Different percentages of consumers in the country own these different EPSs. For example, DOE believes that 17 percent of the market may own an EPS at CSL 0 for a particular vacuum cleaner battery charger, while 8 percent of the market may own an EPS at CSL 1 for that same product. (Because DOE expects that there is a wide variety of efficiencies in the marketplace, it condensed the efficiencies into the four CSLs for purposes of analysis.) See Figure III.1 for an example, where (a) shows the market distribution of efficiencies for the EPS before standards, and (b) shows consumers with CSL 0 EPSs replacing those EPSs with units at CSL 1 due to the imposition of a standard at CSL 1.

Figure III.1 Example of a Standard at CSL 1 Affecting the Market Distribution of EPSs



(a) Market Distribution Before Standards (b) Market Distribution After Standards

Accordingly, DOE calculated a weighted-average LCC savings based on how much a potential standard would affect the market. In calculating the weighted average, DOE assumed that consumers below a standard level would move up to the standard level and not beyond it when purchasing new products, while consumers already at the standard level or above it would continue purchasing at the same levels. Thus, the weighted-average LCC savings represents the LCC savings of the average consumer affected by standards. Eq. III.2 shows how DOE calculated the weighted-average LCC savings:

$$WeightedLCCSavings_L = \frac{\sum_{k=0}^{L-1} \left(LLCSavings_{k \rightarrow L} \times MARKET_k \right)}{\sum_{k=0}^{L-1} MARKET_k} \qquad \text{Eq. III.2}$$

where $WeightedLCCSavings_L$ is the LCC savings that the average consumer affected by a standard set at CSL L would experience, $LCCSavings_{k \rightarrow L}$ is the LCC savings that a consumer would experience when replacing an EPS at CSL k with an EPS at CSL L, and $MARKET_k$ is the percentage of the market already owning EPSs at CSL k.

The same analogy can be drawn for the weighted-average payback period calculations; that is, DOE calculated a weighted-average payback period based on how much of the market would be affected by a potential standard. DOE also assumed that consumers below a standard level would move up to the standard level and not beyond it when purchasing new products, while consumers already at the standard level or above it would continue purchasing at the same levels. Thus, the weighted-average PBP represents the PBP of the average consumer affected by standards. Eq. III.3 shows the equation DOE used to calculate the weighted-average PBP.

$$WeightedPBP_L = \frac{\sum_{k=0}^{L-1} \left(PBP_{k \rightarrow L} \times MARKET_k \right)}{\sum_{k=0}^{L-1} MARKET_k} \qquad \text{Eq. III.3}$$

where $WeightedPBP_L$ is the PBP that the average consumer affected by a standard set at CSL L would experience, $PBP_{k \rightarrow L}$ is the PBP that a consumer would experience when replacing an EPS at CSL k with an EPS at CSL L, and $MARKET_k$ is the percentage of the market already owning EPSs at CSL k.

a. Multiple-Voltage EPS (40-Watt Multiple-Function Device)

DOE analyzed two multiple-voltage EPSs. The first was designed for a multiple-function device and had an output power of 40 watts. Table III.1 and Figure III.2 present the results for this EPS. Four sets of results are plotted in the figure:

- ''Weighted Average'' represents the average LCC savings weighted by the percentage of the market already at each CSL to indicate savings for an ''average'' affected consumer (Table III.1).
- ''Movement from CSL 0'' represents the LCC savings that consumers owning the baseline EPS would achieve by purchasing EPSs at CSLs 1, 2, and 3.
- ''Movement from CSL 1'' represents the LCC savings that consumers owning the CSL 1 EPS would achieve by purchasing EPSs at CSLs 2 and 3.
- ''Movement from CSL 2'' represents the LCC savings that consumers owning the CSL 2 EPS would achieve by purchasing the EPS at CSL 3.

TABLE III.1—LCC AND PAYBACK PERIOD RESULTS FOR MULTIPLE-VOLTAGE FORTY-WATT EPS

Situation before standards							Standard at CSL	
Standard at CSL	Conversion efficiency	No-load power	Percent of market already at CSL	Consumer purchase price	Operating cost	LCC	Weighted-average life-cycle cost savings	Weighted-average payback period
CSL	*%*	*W*	*%*	*2008$*	*2008$/year*	*2008$*	*2008$*	*year*
0	81	0.5	25	8.45	1.86	16.44	....	....
1	86	0.5	50	9.49	1.32	15.15	1.29	1.9
2	90	0.3	25	11.26	0.91	15.15	0.43	3.8
3	91	0.2	0	11.67	0.78	15.01	0.47	3.5

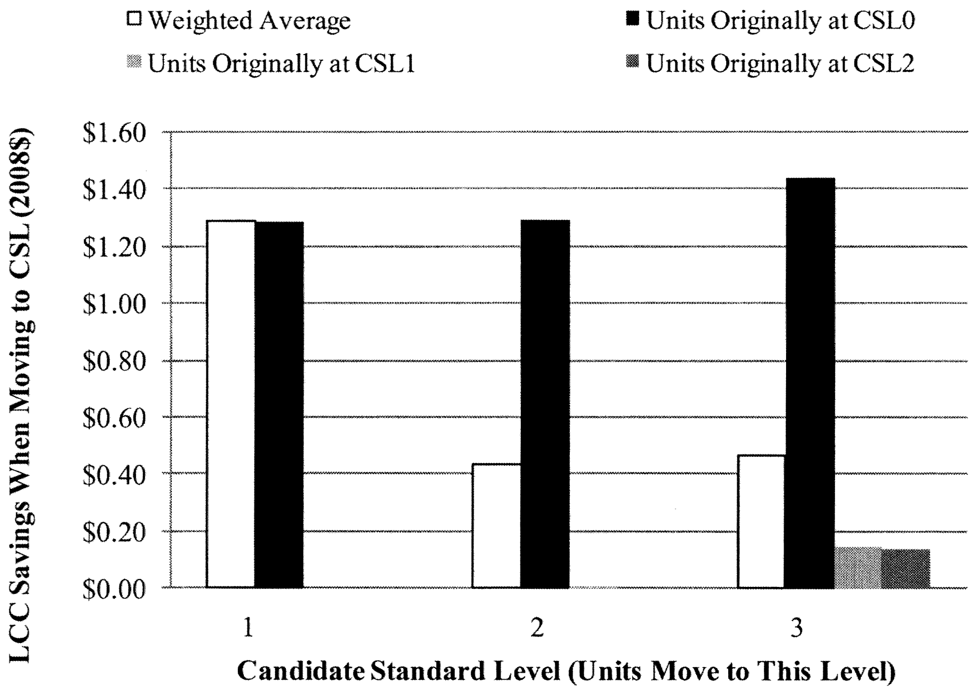


Figure III.2 Life-Cycle Cost Savings for Multiple-Voltage 40-Watt EPS

For the multiple-voltage 40-watt EPS, all consumers would experience positive LCC savings if a standard were set at CSL 1, CSL 2, or CSL 3. The weighted-average LCC savings for a standard at CSL 2 is approximately one-third of the weighted-average LCC savings for a standard at CSL 1 because 50 percent of the market is at a CSL 1 baseline EPS and consumers replacing CSL 1 EPSs with CSL 2 EPSs would experience LCC savings of about $0.01.

b. Multiple-Voltage EPS (203-Watt Video Game)

DOE also analyzed a multiple-voltage EPS with an output power of 203 watts, designed for use with a video game console. Table III.2 and Figure III.3 present the results for this EPS.

TABLE III.2—LCC AND PAYBACK PERIOD RESULTS FOR MULTIPLE-VOLTAGE 203-WATT EPS

Situation before standards							Standard at CSL	
Standard at CSL	Conversion efficiency	No-load power	Percent of market already at CSL	Consumer purchase price	Operating cost	LCC	Weighted-average life-cycle cost savings	Weighted-average payback period
CSL	*%*	*W*	*%*	*2008$*	*2008$/year*	*2008$*	*2008$*	*year*
0	82	12.3	5	19.08	14.87	82.78		
1	86	0.4	95	28.12	3.82	44.49	38.28	0.8
2	86	0.3	0	28.49	3.76	44.62	1.79	6.1
3	89	0.3	0	38.29	3.14	51.73	−5.32	14.2

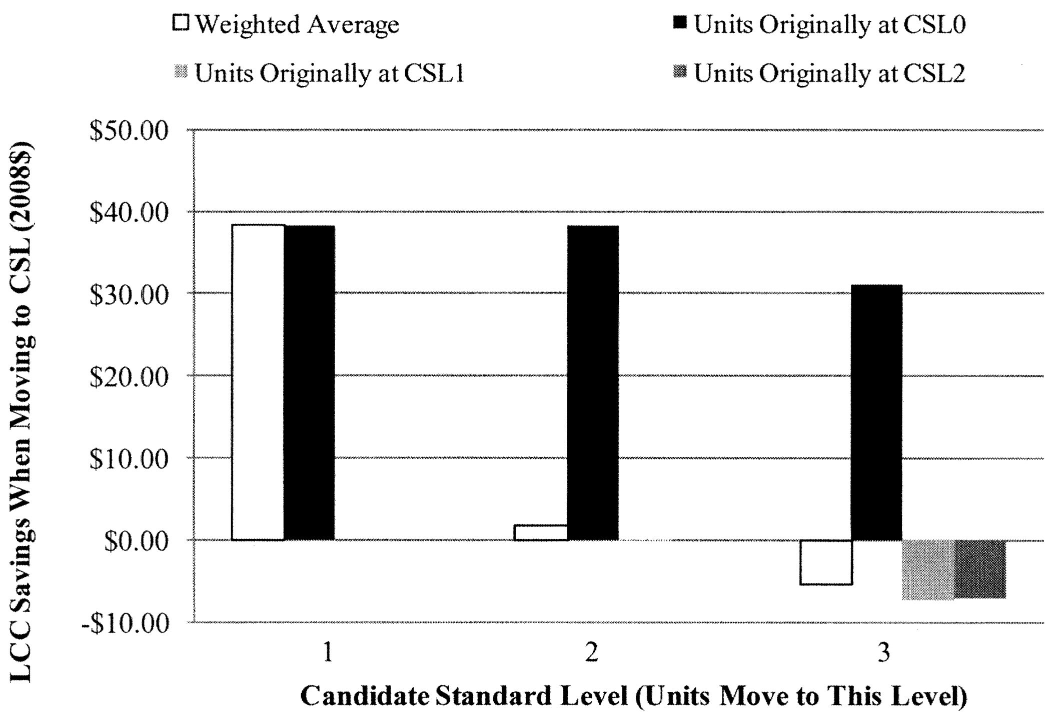


Figure III.3 Life-Cycle Cost Savings for Multiple-Voltage 203-Watt EPS

All consumers would experience positive LCC savings if a standard were set at CSL 1. Consumers replacing CSL 0 EPSs with CSL 2 EPSs realize LCC savings over 20 times greater than the weighted-average LCC savings. DOE believes that 95 percent of the market currently consists of multiple-voltage 203-watt EPSs at CSL 1, such that consumers replacing a CSL 1 EPSs with an EPS at CSL 2 would realize LCC savings of −$0.13. If a standard were set at CSL 3, only consumers replacing CSL 0 EPSs with CSL 3 EPSs would experience positive LCC savings. Because 95 percent of the market would experience negative LCC savings (−$7.24) under a CSL 3 standard, however, the majority of consumers would not recover the increased efficiency-related consumer purchase price in reduced energy costs over the expected lifetime of the product.

Note that the weighted-average PBP of a standard at CSL 2 is greater than the EPS lifetime of 5 years, even though the weighted-average LCC savings are positive. This is because 95 percent of the market (those replacing EPSs at CSL 1 with EPSs at CSL 2) would experience a PBP of 6.4 years if a standard were imposed at CSL 2, while 5 percent of the market (those replacing EPSs at CSL 0 with EPSs at CSL 2) would experience a PBP of 0.8 years.

c. High-Power EPS (345-Watt Ham Radio)

DOE analyzed a high-power EPS that is used in amateur radio applications and has an output power of 345 watts. Table III.3 and Figure III.4 presents the results for this EPS.

TABLE III.3—LCC AND PAYBACK PERIOD RESULTS FOR HIGH POWER 345-WATT EPS

Situation before standards							Standard at CSL	
Standard at CSL	Conversion efficiency	No-load power	Percent of market already at CSL	Consumer purchase price	Operating cost	LCC	Weighted-average life-cycle cost savings	Weighted-average payback period
CSL	*%*	*W*	*%*	*2008$*	*2008$/year*	*2008$*	*2008$*	*year*
0	62	15.4	60	208.10	16.20	331.75		
1	81	6.0	40	60.71	6.17	107.81	223.95	N/A
2	84	1.5	0	66.12	5.09	104.93	137.24	N/A
3	85	0.5	0	76.37	4.50	110.68	131.49	N/A

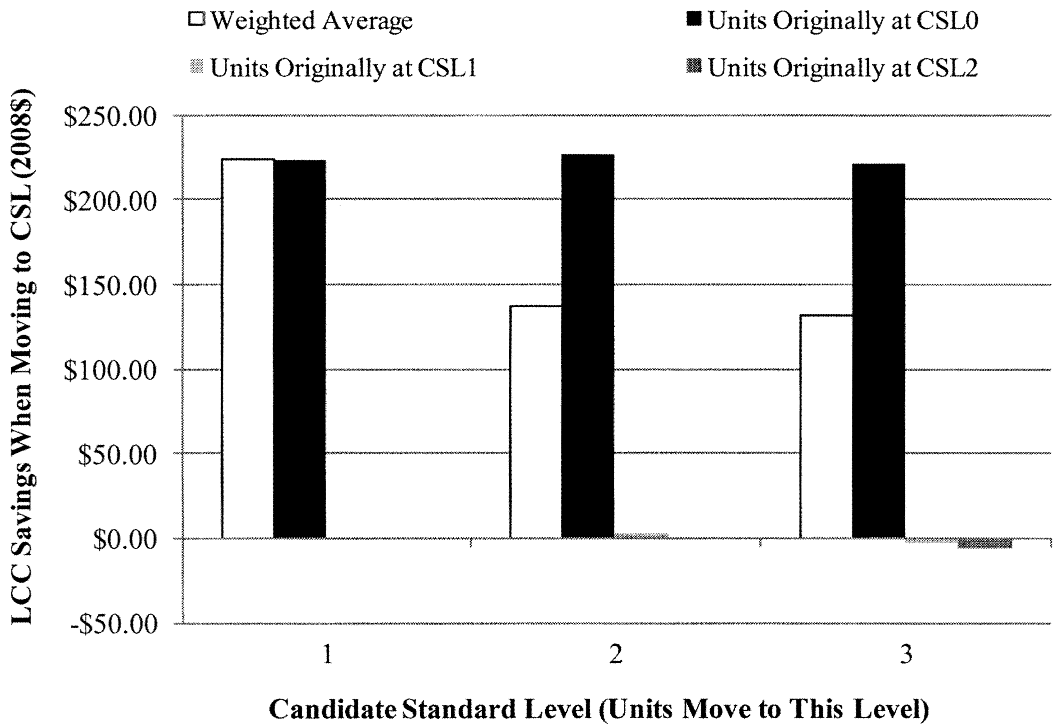


Figure III.4 Life-Cycle Cost Savings for Multiple-Voltage 203-Watt EPS

Based on market research, DOE estimated that no consumers own high-power EPSs at CSL 2 or CSL 3. Note also that there is no weighted-average PBP at any CSL because consumers replacing EPSs at CSL 0 would immediately realize savings due to the lower efficiency-related consumer purchase prices of the EPSs at higher CSLs. DOE assumed that consumers owning EPSs at CSL 0 are 60 percent of the market.

d. Medical EPS (18-Watt Nebulizer)

DOE analyzed a medical EPS that is used with a nebulizer and has an output voltage of 18 watts. Table III.4 and Figure III.5 present the results for this EPS.

TABLE III.4—LCC AND PAYBACK PERIOD RESULTS FOR MEDICAL 18-WATT EPS

	Situation before standards						Standard at CSL	
Standard at CSL	Conversion efficiency	No-load power	Percent of market already at CSL	Consumer purchase price	Operating cost	LCC	Weighted-average life-cycle cost savings	Weighted-average payback period
CSL	*%*	*W*	*%*	*2008$*	*2008$/year*	*2008$*	*2008$*	*year*
0	66	0.6	25	10.62	4.74	40.95		
1	76	0.5	25	13.04	2.99	32.13	8.82	1.4
2	80	0.3	50	13.04	2.28	27.60	8.94	0.5
3	85	0.2	0	20.53	1.60	30.79	1.28	7.7

	Situation before standards						Standard at CSL	
Standard at CSL	Conversion efficiency	No-load power	Percent of market already at CSL	Consumer purchase price	Operating cost	LCC	Weighted-average life-cycle cost savings	Weighted-average payback period
CSL	*%*	*W*	*%*	*2008$*	*2008$/year*	*2008$*	*2008$*	*year*
0	66	0.6	25	10.62	4.74	40.95		
1	76	0.5	25	13.04	2.99	32.13	8.82	1.4
2	80	0.3	50	13.04	2.28	27.60	8.94	0.5
3	85	0.2	0	20.53	1.60	30.79	1.28	7.7

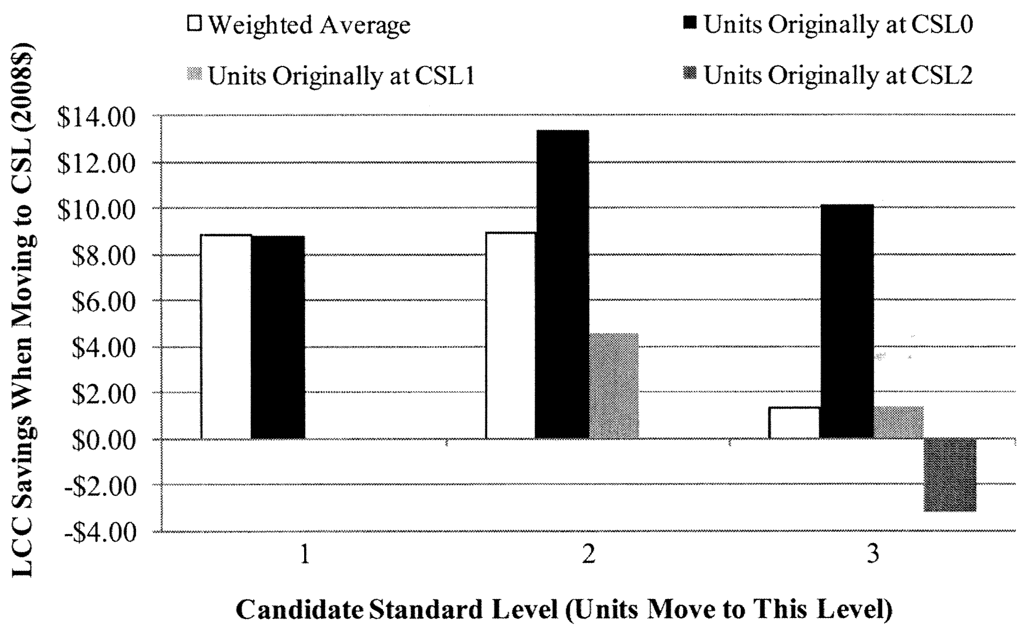


Figure III.5 Life-Cycle Cost Savings for Medical 18-Watt EPS

All consumers purchasing medical 18-watt EPSs would experience positive LCC savings if a standard were set at CSL 1 or CSL 2. The least weighted-average LCC savings would be experienced under a standard at CSL 3. This is because if a standard were set at CSL 3, consumers replacing CSL 2 EPSs with EPSs at CSL 3 would experience negative LCC savings of −$3.19, lowering the weighted average.

e. EPSs for BCs (1.8-Watt Vacuum)

DOE analyzed two EPSs for BCs; one of them is designed for a rechargeable hand-vacuum and has an output power of 1.8 watts. Table III.5 and Figure III.6 present the results for this EPS.

TABLE III.5—LCC AND PAYBACK PERIOD RESULTS FOR 1.8-WATT EPS FOR BCS

Situation before standards							Standard at CSL	
Standard at CSL	Conversion efficiency	No-load power	Percent of market already at CSL	Consumer purchase price	Operating cost	LCC	Weighted-average life-cycle cost savings	Weighted-average payback period
CSL	*%*	*W*	*%*	*2008$*	*2008$/year*	*2008$*	*2008$*	*year*
0	24	1.9	30	3.07	2.15	12.27		
1	45	0.8	50	3.52	0.84	7.11	5.17	0.3
2	55	0.5	20	3.52	0.55	5.89	3.15	0.1
3	66	0.3	0	3.52	0.35	5.03	3.38	0.1

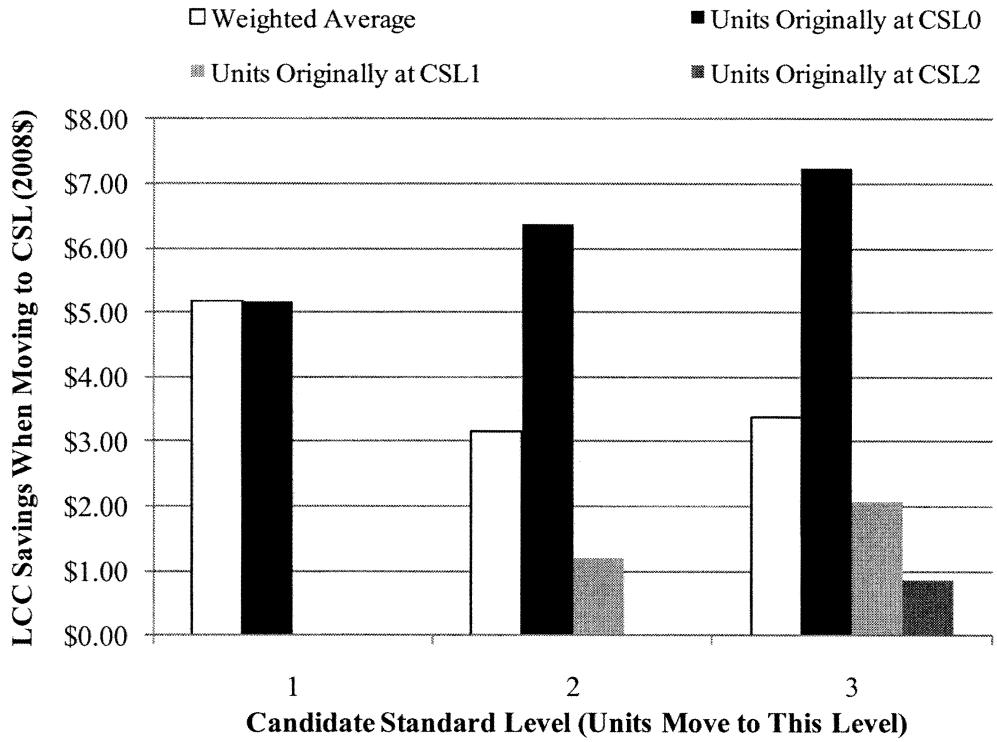


Figure III.6 Life-Cycle Cost Savings for 1.8-Watt EPS for BCs

Consumers would experience positive LCC savings for a 1.8-watt EPS for BCs if a standard were set at any CSL. Consumers replacing CSL 0 EPSs would consistently experience the greatest LCC savings. For a standard at CSL 2, the weighted-average LCC savings would be approximately half as great as the savings experienced by consumers replacing CSL 0 EPSs with EPSs at CSL 2. This is because the majority of the market owns CSL 1 baseline EPSs, and consumers replacing CSL 1 EPSs with CSL 2 EPSs would experience LCC savings that are several times lower ($1.21) than consumers replacing CSL 0 EPSs with CSL 2 EPSs ($6.38). The situation would be similar for a standard set at CSL 3.

f. EPSs for BCs (4.8-Watt DIY Power Tool)

The second EPS for BCs that DOE analyzed was designed for a rechargeable power tool and had an output power of 4.8 watts. Table III.6 and Figure III.7 present the results for this EPS.

TABLE III.6—LCC AND PAYBACK PERIOD RESULTS FOR A 4.8-WATT EPS FOR BCs

Situation before standards							Standard at CSL	
Standard at CSL	Conversion efficiency	No-load power	Percent of market already at CSL	Consumer purchase price	Operating cost	LCC	Weighted-average life-cycle cost savings	Weighted-average payback period
CSL	*%*	*W*	*%*	*2008$*	*2008$/year*	*2008$*	*2008$*	*year*
0	38	1.9	25	4.32	0.81	7.81		
1	56	0.8	50	4.94	0.39	6.61	1.19	1.5
2	64	0.5	25	4.94	0.27	6.11	0.90	0.4
3	72	0.3	0	4.94	0.19	5.75	1.03	0.3

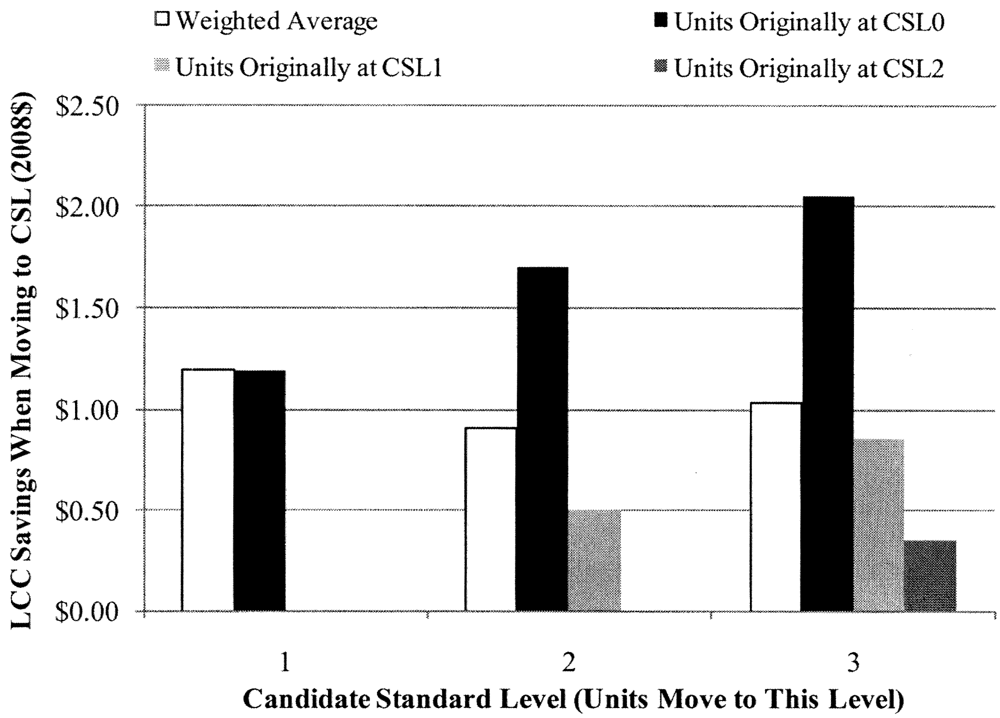


Figure III.7 Life-Cycle Cost Savings for 4.8-Watt EPS for BCs

All consumers would realize positive LCC savings if a standard were set at any CSL. Consumers of 4.8-watt EPS for BCs replacing CSL 0 EPSs would experience the greatest LCC savings. For a standard at CSL 2, the weighted-average LCC savings would be approximately half as great ($0.90) as the savings that would be experienced by consumers replacing CSL 0 EPSs with CSL 2 EPSs ($1.70). This is because the majority of the market owns a baseline EPS at CSL 1, and consumers replacing CSL 1 EPSs with EPSs at CSL 2 would experience LCC savings that are several times lower ($0.51) than consumers replacing CSL 0 EPSs with CSL 2 EPSs. The situation would be similar for a standard set at CSL 3.

B. National Impact Analysis

Table III.7 gives a range of values for energy savings potential for each type of EPS at each CSL. These ranges show the sensitivity of the simulation model to varying assumptions about the future. The lower energy savings estimates assume that the energy efficiency of non-Class A EPSs would improve over time due to factors other than a Federal standard. Conversely, the higher estimates assume energy efficiency would not improve over time. DOE also estimated the net present value of energy savings and incremental consumer costs, assuming discount rates of 3 percent and 7 percent. These estimates of NPV are shown in chapter 6 of the TSD.

TABLE III.7—NATIONAL ENERGY SAVINGS POTENTIAL FROM STANDARDS

Type of EPS	Cumulative primary energy savings potential 2013 to 2042 (trillion BTU*)		
	CSL 1	CSL 2	CSL 3
Multi-Voltage for Multifunction Devices	26.21–28.2	46.3–50.4	52.8–56.9
Multi-Voltage for Xbox 360	1.8–30.8	6.0–34.7	39.9–69.5
High Power (>250 W)	0.25–0.32	0.30–0.38	0.33–0.41
For Medical Devices	5.3–9.7	21.4–28.7	42.6–50.6
For Battery Chargers for Floor Care Appliances	0.39–0.69	0.60–0.90	1.09–1.41
For Battery Chargers for Power Tools	0.24–0.44	0.42–0.61	0.63–0.82

*1 Quad = 1,000 trillion BTU.

If a CSL is selected for each type of EPS to maximize energy savings, subject to the constraint that the NPV be non-negative, total primary energy savings across all types of non-Class A EPS could be as much as 141 trillion Btu or 0.14 quads over 30 years. CSL 3 yields maximum energy savings and has a positive NPV (both at the 3-percent and 7-percent discount rates) for all EPS types except multiple-voltage EPSs for the Xbox 360. For multiple-voltage EPSs for the Xbox 360, CSL 2 has a positive NPV in one base case but a negative NPV in the other. Thus, to estimate energy savings potential across all types of non-Class A EPS, DOE selected CSL 1 for this one type of EPS. Table III.8 shows the contribution of each EPS type to total savings potential and the NPV of a standard set at the selected CSL. Notably, most of the energy savings comes from increasing the efficiency of

EPSs for medical devices and multiple-voltage EPSs for multifunction devices.

TABLE III.8—ENERGY SAVINGS POTENTIAL WHEN CSLS ARE SELECTED TO MAXIMIZE ENERGY SAVINGS

Type of EPS	CSL	Energy savings potential 2013 to 2042 (trillion BTU*)	Net present value 2013 to 2042 ($ million)	
			3% discount rate	7% discount rate
Multi-Voltage for Multifunction Devices	3	52.8–56.9	156–174	76–85
Multi-Voltage for Xbox 360	1	1.8–30.8	13–189	9–101
High Output Power (>250 W)	3	0.33–0.41	2.4–2.9	1.2–1.5
For Medical Devices	3	42.6–50.6	81–130	27–50
For Battery Chargers for Cordless Handheld Vacuums	3	1.09–1.41	8.0–10.1	4.5–5.6
For Battery Chargers for Power Tools	3	0.63–0.82	4.1–5.1	2.3–2.8
Total		99–141	264–512	120–245

*1 Quad = 1,000 trillion BTU.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Information and Regulatory Affairs (OIRA) within the Office of Management and Budget has determined that today's regulatory action is not a ''significant regulatory action'' under section 3(f)(1) of Executive Order 12866. Therefore, this action is not subject to OIRA review under the Executive Order.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of General Counsel's Web site, *http://www.gc.doe.gov.*

DOE reviewed today's proposed rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003.

Today's proposed rule, if promulgated, would set no standards; it would only positively determine that future standards may be warranted and should be explored in an energy conservation standards rulemaking. Economic impacts on small entities would be considered in the context of such a rulemaking. On the basis of the foregoing, DOE certifies that the proposed rule, if promulgated, would have no significant economic impact on a substantial number of small entities. Accordingly, DOE has not prepared a regulatory flexibility analysis for this rulemaking. DOE will transmit this certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act

This rulemaking, which proposes to determine that the development of energy efficiency standards for non-Class A EPS is warranted, will impose no new information or record keeping requirements. Accordingly, OMB clearance is not required under the Paperwork Reduction Act. (44 U.S.C. 3501 *et seq.*)

D. Review Under the National Environmental Policy Act

In this notice, DOE proposes to positively determine that future standards may be warranted and should be explored in an energy conservation standards rulemaking. DOE has determined that review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.;* NEPA) is not required at this time. NEPA review can only be initiated ''as soon as environmental impacts can be meaningfully evaluated'' (10 CFR 1021.213(b)). Because this proposed rule would only determine that future standards may be warranted, but would not itself propose to set any standard, DOE has determined that there are no environmental impacts to be evaluated at this time. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (August 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have Federalism implications. The Executive Order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive Order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined today's proposed rule and has determined that it would not preempt State law or have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of today's proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform'' (61 FR 4729, February 7, 1996) imposes on Federal agencies the general duty to adhere to the following requirements: (1) Eliminate drafting errors and ambiguity; (2) write regulations to minimize litigation; and (3) provide a clear legal standard for affected conduct rather than a general standard and promote simplification and burden reduction. Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (Pub. L. 104–4) (UMRA) requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a),(b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA (62 FR 12820) (also available at *http://www.gc.doe.gov*).

Today's proposed rule, if promulgated, would not result in expenditures of $100 million or more in a given year by the external power supply industries affected by this rulemaking. This is because today's proposed rule sets no standards; it only positively determines that future standards may be warranted and should be explored in an energy conservation standards rulemaking. The proposed rule also does not contain a Federal intergovernmental mandate. Thus, DOE is not required by UMRA to prepare a written statement assessing the costs, benefits, and other effects of the proposed rule on the national economy.

H. Review Under the Treasury and General Government Appropriations Act of 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights,'' 53 FR 8859 (March 18, 1988), that this regulation would not result in any takings which might require compensation under the Fifth Amendment to the United States Constitution.

J. Review Under the Treasury and General Government Appropriations Act of 2001

The Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. The OMB's guidelines were published at 67 FR 8452 (February 22, 2002), and DOE's guidelines were published at 67 FR 62446 (October 7, 2002). DOE has reviewed today's notice under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001) requires Federal agencies to prepare and submit to the OIRA a Statement of Energy Effects for any proposed significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy, or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

Today's regulatory action proposing to determine that development of energy efficiency standards for non-Class A EPS is warranted would not have a significant adverse effect on the supply, distribution, or use of energy. The OIRA Administrator has also not designated this rulemaking as a significant energy action. Therefore, DOE has determined that this proposed rule is not a significant energy action. Accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under the Information Quality Bulletin for Peer Review

On December 16, 2004, OMB, in consultation with the Office of Science and Technology (OSTP), issued its Final Information Quality Bulletin for Peer Review (the Bulletin). 70 FR 2664. (January 14, 2005) The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal government, including influential scientific information related to agency regulatory actions. The purpose of the bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are ''influential scientific information.'' The Bulletin defines ''influential scientific information'' as ''scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions.'' 70 FR 2667 (January 14, 2005).

In response to OMB's Bulletin, DOE conducted formal in-progress peer reviews of the energy conservation standards development process and analyses and has prepared a Peer Review Report pertaining to the energy conservation standards rulemaking analyses. The ''Energy Conservation Standards Rulemaking Peer Review Report,'' dated February 2007, has been disseminated and is available at *http://www.eere.energy.gov/buildings/appliance_standards/peer_review.html.*

V. Public Participation

A. Submission of Comments

DOE will accept comments, data, and information regarding this notice or any aspect of the rulemaking no later than the date provided at the beginning of this notice. After the close of the comment period, DOE will review the comments received and determine, by December 19, 2009, whether energy conservation standards for non-Class A EPSs are warranted.

Comments, data, and information submitted to DOE's e-mail address for this rulemaking should be provided in WordPerfect, Microsoft Word, PDF, or text (ASCII) file format. Submissions should avoid the use of special characters or any form of encryption, and wherever possible comments should include the electronic signature of the author. Comments, data, and information submitted to DOE by mail or hand delivery/courier should include one signed original paper copy. No telefacsimiles (faxes) will be accepted.

According to 10 CFR part 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit two copies: one copy of the document including all the information believed to be confidential, and one copy of the document with the information believed to be confidential deleted. DOE will make its own determination as to the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include (1) a description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known or available from public sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) a date after which such information might no longer be considered confidential; and (7) why disclosure of the information would be contrary to the public interest.

B. Issues on Which DOE Seeks Comments

Comments are welcome on all aspects of this rulemaking. DOE is particularly interested in receiving comment from interested parties on the following issues as they relate to non-Class A EPSs:

- Applications not included in this determination analysis,
- Product lifetimes,
- Present-year shipments estimates,
- Present-year efficiency distributions,
- Market growth forecasts,
- Usage profiles,
- Technology options for increasing efficiency,
- Costs related to increasing efficiency,
- Unit energy consumption calculations and values,
- Prevalence of on/off switches,
- Prevalence of charge control in wall adapters for motor-operated, battery-charged products,
- Circuitry designs used in cradle chargers, and
- Alternative sources, databases, and methodologies for the analyses and inputs used in this determination.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice.

Issued in Washington, DC, on October 23, 2009.

Cathy Zoi,

Assistant Secretary,

Energy Efficiency and Renewable Energy.

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