Examples of Low Energy Product Designs

Author: Ecova (formerly Ecos Consulting) *Date: June 2011*

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Focus of Report	Ecova (formerly Ecos Consulting) produced six brochures outlining examples of low energy product design for electrical appliance components that provide global energy saving opportunities.
Description of Research	The brochures provide a brief discussion on the relevance of each area to standby power consumption and present cutting edge low power product designs for different components of electrical appliances that are either currently available or under development. Combined these could have significant impacts in reducing standby energy consumption. In general the reports are readable, informative and provide valuable overviews for policy makers on each of the six areas. Each reports is summarised individually below.

Standby Power: The Phantom in the Machine

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The Issue

The percentage of household electricity consumption attributed to standby, ranges from 8 -22% and accounts for 1% of the world's CO_2 emissions.[1] Significant efforts to address standby have been occurring since the early 1990's notably the International Energy Agency (IEA) 1-watt initiative setting the target for electronic products of less than 1 watt in standby mode.

Standby power presents the most broadly applicable global energy saving opportunity and manufacturers are continuing to produce more efficient power electronics components. However, there is not a one-size-fits-all solution to standby power. Ecova presents a number of cutting edge design principles to achieve low standby.

Findings - Low Energy Product Designs

Products sleeping longer and deeper

Standby is lowest when products power down as many functions as possible for the longest time (e.g. in efficient televisions standby power is only supplied to the remote control sensor to recognise a wakeup command through a dedicated standby power supply).

Well-designed products can also power down or disconnect the main power supply to further reduce standby power. For example efficient switch mode power supplies (SMPS) send a signal to shut down the main power supply, and integrated circuits (ICs) can effectively switch out certain components when the SMPS is shut down. The combination of these efficient components can reduce power consumption to an almost negligible amount.

[1] According to International Energy Agency estimates.

User friendly standby

A product that does not wake-up quickly will frustrate users who may keep the product in active mode. Presence sensors can recognise when some functions can power down, such as televisions that turn off or dim screens when no one is in the room.

Standby State of the Art in Power Supplies

Three low-power product designs were identified and tested by Ecova:

- 300 W internal power supply (IPS) that shuts down main supply and only operates standby supply where required;
- Power Integrations (PI) TFS762HG offers independent switching for the main and standby supplies (i.e. in standby main supply disengaged); and
- Efficient 2 W external power supply (EPS) for small battery chargers that is able to detect no-load conditions and switch to extremely low standby power of approximately 1% of typical mobile phone adaptors.

If these efficient technologies were adopted in all mobile phones globally energy savings of approximately 7 TWh would be achieved or roughly the annual energy output of 2 coal-fired power stations.

Standby power policy implications

Great progress in standby power has been made since the 1990s; however new features, secondary functions and network capabilities added to products are increasing standby power consumption. Policy focus is required on products such as digital cordless phones and routers that have received little attention to date, while offering savings potential in standby.

Ac-Dc Power Supplies: Building a Better Brick

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The Issue

AC-Dc power supplies (PS) are electronic devices that convert mains-voltage electricity to lower voltage dc electricity used by electronic products. In this process of converting energy these devices consume energy.

Findings - Low Energy Product Designs

Appropriately-sized SMPS

Testing of the 300 W IPS and the 2 W EPS was again used to inform this report. Ecova measured the power factor and efficiency at 20%, 50% and 100% load for the 300 W IPS. Results were very low standby power consumption (0.1W) and the average combined efficiency of 85% and higher. Results showed that the 300 W PS is most efficient at 50% load. SMPS are less efficient at small and maximum loads. The efficiency of the efficient 2 W EPS was greater than 74% throughout the entire load curve. It is evident that power supplies must be chosen carefully such that they operate at their peak efficiency for the connected load.

Reducing rectification losses

Further improvements in SMPS remain possible. Changing from silicon diodes to Schottky diodes cuts power loss by half and is further reduced if diodes are replaced with power field-effect transistors (FETs). Gallium Nitride (GaN) FETs are a new technology that further lower rectification losses – an efficiency improvement of approximately 4%.

Standby power policy implications

Designers must choose appropriately sized SMPS that perform in their high-efficiency range for the loads required by the device. Oversizing results in very poor operational efficiency.

Battery Chargers: Getting Energized About Efficiency

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The Issue

Battery chargers convert mains-voltage electricity into lower voltage dc electricity that is supplied to a rechargeable battery converted into chemical energy and stored for later use. The significant growth in portable devices that rely on rechargeable batteries has economic and environmental advantages. However, every rechargeable battery-powered product wastes some energy when charging the battery.

Findings - Low Energy Product Designs

Charging termination

As 85% of the total energy consumed by battery chargers is consumed when not charging the battery, this report focussed on technologies that save energy during maintenance (once the battery is fully charged) and no-battery mode (battery removed from product).

During maintenance mode some battery chargers can use a variety of methods (voltage or temperature sensors, charge timers) to detect when battery is full and reduce the consumption of power.

There are techniques available to eliminate power consumption in no-power mode as well, such as multiple electrical contacts, micro-switches or other sensors to detect absence of the battery.

Standby power policy implications

With approximately 7 billion rechargeable battery operated products in use worldwide the potential benefits of using the simple and relatively inexpensive design changes suggested here could cut energy consumption by 35% for a wide range of battery charger systems, resulting in savings of 90 TWh/year or the equivalent annual output of 30 coal-fired power stations.

Small Networking Equipment; Making the Connection to Energy Efficiency

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The Issue

Networking equipment is used to connect two or more "edge" devices such as computers, IP phones and printers and remains idle for long periods. These devices consume as much energy whether idle or fully operational. Networked devices are often left in on-mode to maintain connectivity for file sharing purposes or to receive voice over the IP phone calls.

Findings - Low Energy Product Designs

Energy Efficient Ethernet

Completed in 2010 the IEEE 802.3az standard solves the problem of high consumption in idle by powering down Ethernet connections when not required. It is estimated that once fully implemented his standard could save 5TWh per year in the U.S and over 23 TWh worldwide. One company currently sell 802.3az routers while commercial applications are much more prevalent.

Proxying

A network proxy interface can solve the problem of devices remaining in on mode when not in use by allowing the edge device to sleep while maintaining enough network presence to perform the necessary monitoring functions. Several varieties of this technology currently exist such as ECMA – 393 ProxZzzy standard typically located on the Ethernet card inside the computer; and Apple's Wake-on-Demand technology in Apple's wireless router.

Standby power policy implications

More research is required to validate the savings from both Energy Efficient Ethernet and proxying. Both technologies could effectively reduce energy consumption of networked devices without impacting functionality. It is important that policy makers pursue both technologies and increase the rate of adoption for new equipment in the future.

Power Factor Correction: An Energy Efficiency Perspective

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The Issue

Power Factor (PF) is a ratio of real ac power consumed by an electrical load to the amount of "apparent" power that needs to travel on the grid. The ideal PF is 1 i.e. apparent and real power are equal. Power factor becomes relevant to energy efficiency because low power factor can increase resistive losses in wiring, drawing more current than needed to perform the task. While PF for larger devices has been given attention little effort has been made to address PF in small devices.

Findings - Low Energy Product Designs

Resizing components in switch mode power supplies (SMPS) is the simplest way to increase power factor. There are power factor correction (PFC) devices built in to SMPS already available. While technology exists to decrease these PF losses, they are only really cost effective in a commercial setting. This is primarily because of the types of products in use and the increased length of wiring and cables that increase the size of PF losses – commercial savings are 3.5 times residential savings. However, large energy using residential products such as electric wheel chairs may make increasing PF cost effective.

Global savings for improving PF could be 3 TWh per year or closing 1 coal fire power plant.

It is anticipated as technology develops the cost effectiveness of PFC should improve over time.

Standby power policy implications

Policy makers could take action on products in the commercial sphere however for most products in the residential arena, the cost efficiency of this as an energy efficiency measure is still a few years away.

Indicators and Displays: A Judicious Use of Light

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The Issue

Indicators and displays are everywhere. From network router lights to smart phones and multi-coloured graphical displays, light is used to convey messages to users. Reducing energy consumption of these indicators and displays is possible through using the light more efficiently and using reflected ambient light to illuminate displays.

Findings - Low Energy Product Designs

High-efficacy LEDs and LCDs
Individually indicators and simple information displays consume small amounts of energy. However, these displays collectively comprise up to 25% of household energy consumption in developed countries. New technologies such as high efficiency light emitting diode (LED) lamps and reflective crystal display (LCD) indicators could reduce this consumption for both indicators and simple displays (e.g. digital clocks on entertainment equipment) and graphical displays (e.g. monitors and tablets). LED technology continues to improve with new thin film LED increasing the overall efficiency of LED indicators.

Light-recycling Films
In devices with graphical displays such as televisions and monitors, much of the light produced is lost when it is absorbed as heat in the LCD panel. Light-recycling films can be used to reflect and redirect the light, increasing the amount of light that reaches the user without increasing energy consumption. By combining light recycling films with more efficient LED backlights, the consumption of the overall display can be halved.

Harvesting Ambient Light
Light harvesting films in LCDs can harvest both natural and artificial light to save energy usually used by backlights. This technology is typically used in devices exposed to sunlight – e.g. GPS products. This technology can save about 75% of the energy used by a conventional LCD display device.

Presence Sensors
These turn off indicators when not in use via sensors that draw negligible power but can detect when no-one is present.

Organic light-emitting diode (OLED)
Currently expensive and rare, OLED technology offers further energy savings. No backlight is required and they can be lighter and thinner than LCDs, increasing portability while decreasing energy consumption.

Standby power policy implications

LED efficacy is expected to continue to improve with LEDs halving their consumption in the next few years. Standby power policy could be aided by further research on the appropriate brightness for indicators and simple displays and to identify opportunities for dimming indicators. To improve the efficiency of graphic displays, research is needed to assess the performance and energy savings of new display components such as light recycling and light harvesting films.

Ecova' initial research suggests that a universal standard for efficient displays may be difficult. The available technologies mentioned justify efficiency standards for products with active displays – televisions, laptops and desktop monitors – and lower standby targets for products with a significant number of indicators.