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Alignment of Standby Power Approaches

Moving Towards 1 Watt and Beyond

19 to 21 October 2010

Shinagawa Prince Hotel, Tokyo, Japan

TECHNOLOGY REPORT

ASIA-PACIFIC PARTNERSHIP ON CLEAN DEVELOPMENT & CLIMATE

4E Efficient Electrical End-Use Equipment
International Energy Agency

APEC International Conference Technology Report - Alignment of Standby Power Approaches

TECHNOLOGY REPORT FOR APEC INTERNATIONAL CONFERENCE

Alignment of Standby Power Approaches
Moving Towards 1 Watt and Beyond

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Introduction

The APEC Standby Power Conference - *Moving Towards 1 Watt and Beyond,* was held from 19-21 October 2010 at the Shinagawa Prince Hotel, Tokyo, Japan. The conference brought together approximately 50 experts on standby power, representing 12 APEC economies, and 10 different manufacturers and suppliers. The purpose of the conference was to bring together both industry and government policy makers to gain an understanding of the possibilities for reducing standby power. The conference covered a wide range of standby related topics, ranging from technologies and components to high level policy and implementation issues.

The conference concluded with an intensive half day workshop that reviewed all of the issues covered by the previous 2 days' presentations. The workshop was split into a technology stream and a policy stream. This report covers all of the technology related elements within the conference.

Three documents are available from the conference website:

1. Summary Report – contains a conference overview, program, list of speakers, list of presentations and participants.
2. Technology Report (this report) – contains an overview of technology related issues raised at the conference, copies of technology related papers (these provide more detail than the presentations themselves), technology workshop summary and conference outcomes.
3. Policy Report – contains an overview of policy related issues raised at the conference, copies of policy related papers (these provide more detail than the presentations themselves), policy workshop summary and outcomes.

A total of 22 presentations were made over the first two days and each of these presentations is available for download at http://www.energyrating.gov.au/standby2010-apec-presentations.html.

Overview of Technology Issues in Conference Papers

Standby power has been an issue of concern for many years. The technology included in products is becoming increasingly complex and many products have now dramatically increased functionality, both in active modes (primary function) and low power modes (where only secondary functions are active). Despite this increase in complexity, it is still possible to implement very low standby power solutions for most products. A wide range of technology related issues were discussed at the conference. The key elements of these presentations and the associated discussion are included in this report.

The conference participants learnt that the key elements with respect to technologies for a low energy future fall into the following broad categories:

- Efficient power supplies for electronic equipment to improve efficiency in all modes;
- Intelligent product design and configuration to minimise standby power;
- Optimisation of energy service delivery (active mode performance);

- Power management systems, to move products into low power modes when their main functions are not required;
- Power scaling to reduce active mode and some low power mode power consumption during periods of low utilisation, especially for information based equipment;
- Development of a number of these technologies and approaches for application in networks, which are rapidly becoming more widespread in their scope and coverage.

Inevitably, some of these technologies and approaches cut across both standby (low power modes) and active modes. This is occurring because products themselves are becoming more complex with a wider range of functions and the distinction between what was once a simple off mode or standby mode and a product's main function are becoming less clear. It also happens that many of the same technological solutions that work for low power modes also work for active modes. In these cases, it makes no sense to ignore the energy savings potential that can be obtained from implementation of these advanced approaches in active mode and concentrate only on low power modes.

Another area where there has been development is the use of external devices to reduce standby power in legacy equipment with poor standby attributes. These appear to work most effectively in clusters of peripheries around a central device such as a computer or television. These types of devices can be effectively used with existing equipment and offer an effective medium term solution to reduce standby on existing equipment.

Each of these main areas, which were explored during the conference, are set out in the following sections.

Efficient power supplies for electronic equipment

Power supplies in electronic equipment are a critical element that affects the overall product efficiency as well as the low power mode characteristics. One of the most critical areas for low power mode energy is the power supply efficiency for small loads as well as the no load power loss. Many of the functions present in low power modes have very small fundamental power requirements to operate (such as infra red remote controls or displays), which means power supplies have to operate at these low output levels for extensive periods. The power supply efficiency at low power output is therefore critical with respect to the standby power characteristics of the products. The conference heard a number of presentations that showed that some of the more advanced power supplies are very efficient at low output and these are now readily available at relatively low cost, meaning that there are no practical barriers to their widespread use in commercial products.

Intelligent product design and configuration to minimise standby power

Power supply attributes, together with product internal configuration, can have a significant impact on the power levels in various low power modes. In more complex products, there are an increasing number of functions present, especially in low power modes. Many of these functions make the product more usable by increasing convenience or by providing additional user oriented features. Many of the most common secondary functions such as remote controls, timers, program/memory functions and sensing functions fundamentally have fairly low DC input power requirements as these are usually very simple electronic circuits. The same applies to network functions that may be present in any mode.

If a power supply is configured to supply a range of different low power functions as well as the main function, it can mean it is required to operate over a wide range of power outputs. The problem facing power supply designers is that the low load efficiency of a power supply tends to decrease substantially as the rated output of the power supply increases (similarly, the no load power loss increases with the rated output of the power supply). For example, if a load of 100mW load for an infrared remote control receiver is being supplied by a 500W power supply (which itself may be required for the main function), the standby or low power characteristics are likely to be very poor.

This problem can be overcome by the use of separate power supplies, which are switched into service as required. Small very efficient power supplies can be used to power low power mode functions separately. This means that when the main function is not operating, the main power supply can be disconnected from the mains, dramatically reducing the products overall standby power. This is particularly important when the product itself has advanced power management features and puts itself into low power modes automatically. Examples where shown at the conference of a 3W power supply with a 10mW no load loss and a 15W power supply with a 20mW no load loss.

Sometimes other elements of product configuration can affect their standby attributes. It could be that power supplies are not disconnected when the product is off (even where there are no standby functions that have to be powered). This can appear as high standby power in some cases.

Some components such as Electromagnetic Compatibility (EMC) filters are sometimes left connected to the mains when the product is in a low power mode or off (so called X capacitors). These capacitors are mandatory when the product is on but are not usually required when the product is off. These filters can consume from 0.2W to 0.5W. This power loss can be overcome through improved product configuration or via the addition of specialised circuits that fully disconnect these filters when in off mode. Other specialised modules can be used to disconnect high-voltage sense resistors or resistor dividers connected to the DC rail in Power Factor Correction (PFC) and/or power conversion stages of a power supply during no-load or standby conditions to reduce power consumption.

Optimisation of energy service delivery

While not strictly within the scope of standby power, the conference heard of a number of products that aim to reduce energy consumption during use (active mode) by optimisation of the energy service delivered to the user. Some examples were soil sensors for clothes washers and dishwashers (to optimise energy), backlight adjustments in televisions to take into account ambient light levels and sensing technology to optimise heating and cooling delivery to the point in the room where the occupant is located (rather than attempt to condition the whole room). These types of sensors and controls can certainly optimise energy consumption.

Power management systems

There is significant energy wasted by products where they are in active mode and they are not used. There is no doubt that one of the key areas where there is a large energy savings potential is the implementation of effective power management in products. Power management moves a product out of active mode into a low power mode when it is not being used. This has to be done intelligently to ensure that user needs are always met. It is also important to make sure that the low power mode that the product enters is also as low as possible.

Some products already have power management systems in place, but this is certainly an area where further research and implementation is required.

Power scaling

The power consumed by electronic equipment, particularly those where the main function is processing information, is influenced by the circuit design and power supply configuration. In many cases, the power consumed by such products is more or less fixed and the information load or throughput (the amount of information being processed) often has little or no effect on the power consumption of the product. Effectively, the power consumed is fairly constant with little or no impact from the volume of data processed. This effect is a characteristic of many types of electronic equipment, and it means the normal concept of “efficiency” for electronic equipment is a difficult one to define, especially in cases of low utilisation. This contrasts markedly with “traditional” appliances and equipment where the energy consumed is usually in proportion (at least to some extent) to the “size” of the energy services delivered.

At face value, there appear to be few technical options to reduce power consumption during periods of lower throughput or demand for information based electronic equipment. This is of some concern, as we know that a lot of electronic equipment remains in active mode for long periods but that the actual processing load is light or even negligible.

However, observations and power measurements on a range of computers and other electronic equipment shows that there is a large potential to internally manage power requirements during periods were there are lower levels of functionality required. Laboratory measurements illustrated that some product types were able to reduce power by 70% or more in active mode where only lower level tasks were required by the user or in idle mode (on but no task being performed).

The conference heard that practical and effective power scaling has been in place for many years in mobile products. The big motivation for mobile product designers is long battery life and small size. Power scaling is achieved using techniques as multi-core processors (where non-required cores can be shut down during periods of low utilisation), scaling of voltage and frequency scaling for processors and power islands.

This approach can be used for many information based electronic products such as computers. It is also very useful in network equipment, as many of these types of devices are effectively required to remain in active mode virtually all of the time, but their level of utilisation is often very low. While power scaling is well understood and well advanced in a number of products, it is not yet widely used in mains powered products, which means there is a large energy saving potential available using this type of technology.

Development of approaches for application in networks

Network connectivity is not well-addressed in most existing policies that deal with low power modes of products. This policy gap appears to have occurred for a variety of reasons: the technology of networks is unfamiliar to many energy policy analysts and experts; there are significant complexities in network technologies and their associated protocols; networks are evolving rapidly on many parallel fronts and the number and type of products with network capabilities is expanding rapidly. However, there are a few examples where products with network capability have been successfully regulated or included in voluntary programs in recent years.

This issue is further complicated by the issue that network connectivity inherently involves multiple devices and therefore some interdependency of devices (which can induce higher energy consumption in other devices on the network), complicating effective energy policy development and implementation. This is especially the case for legacy devices, which may remain connected to the system for many years after new hardware or network protocols are introduced.

The conference heard about a range of technical options to reduce power consumption of products in networks through power management and other approaches. The main areas outlined were:

- Reducing power required for network links (and network related functions)
- Energy management - changing power state of the product (mode) without cooperation of the network
- Energy management - changing power state of the product (mode) in coordination with the network
- Energy management - scaling internal power in proportion task requirements or throughput

- Reducing services delivered by the product (optimising output to more accurately meet user requirements)

Reducing power in network links is an obvious area to examine. Some good progress has been made with the recent ratification of Energy Efficient Ethernet (IEEE 802.3az). This technological development can reduce the power in high speed network links during periods of low utilisation (most of the time). Other protocols to reduce the power required for wireless links are also under investigation.

Technologies to implement internal energy management without the cooperation of the network have been around for many years and these can sometimes be successful. A good example is a network proxy, which tells the network that a device is present and functioning when it is really asleep.

Technologies to implement internal energy management with the cooperation of the network have been around in a limited way for some time, but this is an area where great progress could be made. There appears to be a great energy saving potential for networked devices to share their energy state and information about the tasks they are performing and to be able to shut down when they are not required. In this way all devices can shut themselves down automatically when not required.

Power scaling has been used for many years in mobile systems. Power scaling is where parts of information based electronic equipment are shut down during periods of low utilisation or processing requirement (as previously discussed). This can be done through multi-core processors (when excess cores can be shut down when not required), voltage and frequency scaling (to lower power requirements for processors) and power islands (where unnecessary components are disconnected internally). This is perhaps one of the most exciting areas of power management which is yet to be widely implemented in mains powered systems. It is particular relevant to network equipment and servers and computers, which are often left on continuously but with low levels of utilisation for much of the time.

Reducing services is another way of reducing energy consumption – this is just another way of better optimising energy consumption to match consumer needs and expectations (i.e. automatically turning off appliances when nobody is in the room if occupants have gone out). This type of power management relies on some information from a network in order to make decisions about when it may be acceptable to reduce services.

Equipment to reduce standby power in legacy equipment

For some years, innovative designers have been building devices that reduce standby in existing appliances by disconnecting power from devices when they are off. These devices vary in their design – some use a common master switch to turn of a nest of devices (manually instigated by the user), others use a signal from a master device (such as a television or computer) to disconnect the power from associated peripherals. Others use infra-red remote control signals to turn off the power.

These devices can reduce standby power consumption in practice now and the conference learned of some field evaluations which assessed the energy savings that can be achieved on real products in real homes. These devices are a great interim measure to reduce standby power in existing products, especially where there are a number of peripherals clustered around a central device, the most effective applications being stereos, audio-visual equipment and computers.

Measurement method for standby power

The test procedure to measure standby power, IEC62301 Edition 1, was published in 2005 and is now widely used around the world to determine accurate power measurements of products in low power modes. It is widely regarded as a state of the art measurement approach for low power modes.

The conference heard of work that has been ongoing in the IEC since 2006 to develop Edition 2 of IEC62301. The main areas where improvements to the test method are being made are:

- Substantial guidance on modes and functions and improved understanding of the operation of many common products;
- Inclusion of data sampling as the preferred measurement methodology;
- Longer initial stabilisation and a longer measurement period in most cases;
- Refinements to the requirements for stability for a valid reading;
- Improved information about the calculation of uncertainty of measurement and the factors that can contribute to this;
- Adjusted uncertainty requirements for difficult loads with low power factor and/or high crest factor;
- Improved guidance on how to measure products with automatic power management (where modes change automatically), especially those with a stable sequence of modes, which are becoming more common.

IEC62301 Edition 2 will deliver an improved test method for measurement of standby power. A Final Draft International Standard (FDIS) was released in October 2010 and voting closes in December 2010. It is hoped that Edition 2 of the standard will be published in early 2011 if there is a positive vote.

Conference Technology Workshop

The technology workshop was held on the third day of the conference. The workshop attempted to review all of the technology developments that had been covered in presentations at the workshop. Each of the topics were classified into three broad categories in terms of actions and outcomes:

- Research required: areas where further research is required in order to identify issues or problems and to set research and development directions and objectives.
- Development required: Areas where the likely technology direction has been identified but where further technical development is required in order to establish or commercialise a technology or approach. This may also include the development of technical standards and protocols.
- Established: technological aspects are well established and commercially available. However, work may still be required to ensure widespread implementation or adoption (often in the policy area).

Low standby technologies

Status: Established

Discussion: The workshop confirmed that technologies to achieve extremely low standby power are available now and that these are both low cost and cost effective. The workshop discussion centred on how to get these established technologies into mainstream products and appliances through improved diffusion and promotion. The workshop agreed that effective policy drivers are desirable, as they can encourage, reward or mandate these types of technologies.

Power scaling in mains powered products

Status: Research required

The workshop acknowledged that power scaling could provide a massive energy saving potential if implemented in main powered products. It was noted that these approaches are already widely used in mobile devices – the main design driver being small devices and long battery life. The main approaches are multi-core processors, power islands, voltage and frequency scaling. These approaches are highly applicable to information based equipment such computers, communications and network equipment, where utilisation levels are often low for extended periods. The discussion focused on how to commence investigations on power scaling in mains power products. Clearly this is technically feasible and some initial investigations clearly show that this is already being implemented in selected mains powered products. It was suggested that the first stage of research would be to document best practice examples of power scaling and then to develop a policy framework that would reward these types of designs.

Power scaling control in mainstream operating systems

Status: Development required

With respect to mainstream operating systems for computers and related equipment (such as Windows, Linux, OS-X), some degree of power management is already available. However it unclear what degree of power scaling is supported across all the available hardware and software platforms, so this may require further development to unlock the full energy saving potential. Some of the more advanced approaches may not be fully utilised in all operating system . To assist in setting this technology development, discussions with major software and hard vendors will be required. It is unclear what level of development may be required in other types of equipment and electronics (such as network equipment, which uses its own internal operating system).

Review of technical standards related to energy and low energy networks

Status: Research required

It was noted that this was an item of work recommended in the APP/4E report titled ***Standby Power and Low Energy Networks – issues and directions*** (referenced as Project A). The workshop strongly supported this proposed project as it is likely to lead to identification of energy saving approaches that can be codified in technical standards and protocols. This is especially important for networks which are becoming more ubiquitous. Once energy saving approaches are defined by standards or protocols, these can readily be included in policies and programs. The outcome of this work is getting efficiency built into networks, especially wireless systems and management of link speed – identifying other technical standards where energy needs should be included. The project would also identify where possible new standards or protocols may be required to cover gaps. A key outcome of the project is putting together a roadmap to help optimise limited research resources.

Standard protocols for reporting energy and status on networks

Status: Development required

The conference heard of an exciting new proposal to include standard protocols for reporting energy, power and status through networks. Initial work is already under way within the existing Internet Protocol (by the Internet Engineering Task Force) to use the existing Simple Network Management Protocol (SNMP) to expose status, power and function to the network to facilitate self management approaches. This work has already started with the formation Energy Management Working Group under IETF. This item of work recommended in the APP/4E report titled ***Standby Power and Low Energy Networks – issues and directions*** (referenced as Project B1). This work was strongly endorsed by the workshop.

Protocols to permit coordination of power management on networks

Status: Development required

This project is closely related to the previous project (Project B1). It is about developing protocols to permit coordination of power management amongst products on a network (with respect to their function and relationship to other devices on the network) once this information becomes available over the network. This will involve development of standard rules and approaches to the implementation of self instigated energy management. There may also be interface requirements with Smart Grid energy management requests from outside the local network. This work (identified as Project B2) has not started but will need to be developed in parallel with Project B1.

Interface between local networks and Smart Grids

Status: Research required

This is a new area where there is a lot of work going on, but at this stage, few standards. What is required are defined protocols for open source building end user networks with full inter-operability and interface definition with smart meters and the wider smart grid (outside of the end use premises). The workshop noted that IEC TC59 is starting some work on this issue. The workshop agreed that IEC (or another body such as IEEE or EPRI) need to take the lead to define the interface between home and business local networks and smart grids. It was noted that IEC standards can take many years to develop, which can create difficulties in such a rapidly moving area. Doug Johnson of CEA offered to provide suggestions of development options in this area after the conference. It was also noted that the CECED Chain standard is being considered within CENELEC. It was also noted that AHAM are also looking at these types of systems.

Assessment of energy service optimisation and load management

Status: Research required

The workshop noted that there are already a range of innovative power management options in appliances and equipment which cover aspects such as user sensing with auto shut down and responses to environmental factors (heat/cool, illumination, occupancy, presence sensors). This could also include sensing appliances that can detect load size and soiling (for example in clothes washers and dishwashers). It was agreed that a robust evaluation system is needed to assess the effectiveness of these types of systems during normal use (context awareness). This is best done within the relevant product performance standards. Future issues could arise from response to load shifting requests (from Smart Grids, such as demand response and operation flexibility) or by options built into these type of systems which could schedule future operation in response to daily changes in tariff schedules.

Rewarding dynamic energy management systems

Status: Research required

The object of energy management systems is to reduce overall energy consumption while continuing to deliver the required energy service to the user. This can be objectively assessed by the evaluation of the total energy consumption under a wide range of different usage conditions. Policy and programs should encourage and reward dynamic and smart power management that can respond to widely varying usage profiles and minimize total energy consumption. It is important that these types of systems save energy during normal use and not just during the test procedure – therefore the assessment procedures need to be designed to assess ranges of activity rather than a single set of specific test requirements.

External smart devices on legacy equipment

Status: Established

The use of external smart devices to reduce standby in clusters of legacy equipment (home entertainment and ICT) was accepted as a viable interim measure to reduce standby power.

It was noted that a number of these types of devices are now commercially available. It was agreed that a robust assessment process is needed to measure the effectiveness of these types of energy saving devices in different contexts and with different types of users and equipment.

Mapping functions into modes

Status: Research required

It was noted that this was an item of work recommended in the APP/4E report titled ***Standby Power and Low Energy Networks – issues and directions*** (referenced as Project E). The workshop supported this proposed project as it will lead to a better understanding of product design and the level of functionality required in low power modes. This increased understanding will enable improved policies approaches to be developed.

Global estimates of global network related energy

Status: Research required

It was noted that this was an item of work recommended in the APP/4E report titled ***Standby Power and Low Energy Networks – issues and directions*** (referenced as Project F). The workshop supported this proposed project as it will lead to a quantification of the scale of network related energy and will help to prioritise the development of policies and programs to redress the most significant areas of energy consumption within networks.

Measurements on commercially available products

Status: Research required

It was noted that this was an item of work recommended in the APP/4E report titled ***Standby Power and Low Energy Networks – issues and directions*** (referenced as Project G). The workshop supported this proposed project as it will lead to a quantitative assessment of current energy management and power scaling approaches already implemented in commercially available products. This will help to identify the most progressive designers and may provide opportunities for further collaboration and research in terms of technology development and the corresponding policies and programs.

Power budget for functions

Status: Development required

It was noted that this was an item of work recommended in the APP/4E report titled ***Standby Power and Low Energy Networks – issues and directions*** (referenced as Project H). The workshop supported this proposed project as it will lead to a quantitative assessment of power requirements for the most common functions present in low power modes (such as off mode, standby mode and network mode). The main objective of this work is to assess the minimum (or reasonable) power requirements for the most common functions present in low power modes in a range of products and then to assess how these could be powered (using various product configurations). The main focus of this project would be to liaise with so called “function providers” in order to assess the fundamental power requirements for these functions (rather than measurement of their actual implementation in real products, which may be poor). The workshop noted that many small, super-efficient power supplies are already available to product designers in order to achieve low standby. This project would be used to support the development of a policy based on horizontal functionality.

Power factor in low power modes

Status: Research required

A number of workshop participants raised concerns regarding poor power factor in many of the newer products on the market. These new products appear to have low standby power (based on measured active power) and meet all of the policy requirements, but some officials are concerned that their low power factor may be having a detrimental effect on the electricity distribution system. The workshop agreed that a new technical study on power factor for low power modes in particular was worthwhile. This should specifically assess the impact (if any) on electricity utilities. It should also look at options for manufacturers and utilities to improve these power factors (if warranted) and assess the energy costs and the technical costs for improving power factor. It was agreed that it is important to put these issues into a large scale perspective of power losses and impacts on the utility grid and distribution wiring, as there is little point in reducing standby at the product level if this has negative impacts elsewhere in the electricity supply system (and just shifts losses from end use equipment to a different part of the system). Some participants agreed to prepare terms of reference for this project and some offered existing technical reports to support this work. (*Assessment of the Impacts of Power Factor Correction in Computer Power Supplies on Commercial Building Line Losses by* Fortenbery & Koomey for the California Energy Commission March 31, 2006 and *Energy Savings Estimate for Power Factor Correction in Televisions* by Paul Bendt, PhD, Ecos Consulting for Pacific Gas and Electric Company April 13, 2009).

Conference Outcomes

Conference participants learned of new technologies that are available now to reduce standby power and advanced and innovative designs for power management and improved user interaction that have already reached the market. Advanced designs that could reduce the energy consumption of many "information based" devices during periods of low utilisation have been used for many years in mobile devices and it was acknowledged that there is a need to encourage their wide spread adoption into mains powered (tethered) products. This could result in large energy reductions in all modes (in addition to standby mode). There has been extensive international cooperation in the area of measurements and test procedures, forming a solid foundation for good policy alignment.

It was acknowledged that networks are an area of growing interest and importance and as such this topic was discussed at length. Increasingly more and more products are connected to networks, so attention needs to be paid to network protocols and product design to ensure that networks are configured to minimise product energy consumption through advanced power management, rather than allowing an increase in overall energy use in all modes. Network products (both products connected to networks and network equipment itself) for the most part are not covered in existing policy frameworks and therefore it is important to develop a path forward to ensure that today's policy is not made redundant with the rapid expansion of network products.

The technology workshop helped to identify areas where progress can be made now and where more research and development is needed to achieve a low standby power future. The conference participants concluded that while there are some technologies available to be implemented immediately, further research, particularly in the area of networked products, was required.

Key conference outcomes are:

- Exchange of experiences and ideas of 50 conference participants over 3 days
- A total of 22 presentations made to conference participants, bringing them up to date with the latest technology and policy developments from around the world
- A technology and a policy workshop at the conclusion of the conference
- A conference website, which hosts all material from the conference including presentations and various conference reports (see http://www.energyrating.gov.au/standby2010-apec-presentations.html
- Preparation of a conference summary and overview document
- Preparation of a technology report (this report)
- Preparation of a conference policy approaches report

From the technology workshop, conference participants made recommendations to proceed with a range of research projects to improve their understanding of technology drivers. These are documented in some detail in the previous section. In summary, the main projects recommended are:

- Power scaling in mains powered products
- Power scaling control in mainstream operating systems
- Review of technical standards related to energy and low energy networks
- Standard protocols for reporting energy and status on networks
- Protocols to permit coordination of power management on networks
- Interface between local networks and Smart Grids
- Assessment of energy service optimisation and load management
- Rewarding dynamic energy management systems
- External smart devices on legacy equipment
- Mapping functions into modes
- Global estimates of global network related energy
- Measurements on commercially available products
- Power budget for functions
- Power factor in low power modes

Annex A - Conference Papers

This Annex contains brief summary papers describing the key issues and major points of each of the technology presentations given on Day 1 of the APEC International Conference - Alignment of National Standby Approaches. The papers were prepared by the presenters for inclusion in this report.

Possibilities in Components Session 1

Asymptote: Zero- Minimizing Standby Mode Energy Waste Presented by Richard Fassler, Power Integrations, USA

(Slide 1) Thank you for the opportunity today to share some recent advancements in reducing standby power consumption in electronic products that we find in our homes and offices.

(Slide 2) During this presentation, I'll cover the following topics: 1) What are the factors affecting the standby power consumption of a product or a system? 2) What are some current cost-effective solutions available for low, medium, and high power applications? 3) Is there a way to get to "zero" standby power consumption without using a mechanical switch?

Before I move into the presentation, I'd like to clarify a few things. First, while the power supply examples presented here were designed, built, and tested by Power Integrations (PI), using the company's power conversion ICs, PI is not a power supply manufacturer, but rather an integrated circuit (IC) semiconductor company that provides ICs to power supply manufacturers. Secondly, everything I describe is representative of today's best available technology. Every part I talk about is available in large quantities, including the last IC I'll discuss which was just introduced last week. Lastly, the solutions shown today are cost-effective solutions.

(Slide 3) Founded in 1988, Power Integrations is the leading supplier of high-voltage analog integrated circuits (ICs) used in power conversion. Our ICs incorporate control and safety circuitry and a high voltage power MOSFET switch on a single silicon chip, forming the core of a switching power supply. Our product families TOPSwitch, TinySwitch, and LinkSwitch are used in power supplies with output power from less than a watt to well over 100 watts. These ICs enable compact, lightweight power supplies that are simple to design and manufacture, highly reliable, and extremely energy-efficient. PI's patented *EcoSmart* energy-efficiency technology, included in all of our ICs introduced since 1998, has saved an estimated total of more than $4 billion of standby energy waste, preventing millions of tons of CO_2 emissions at no added cost to manufacturers and with no change in behavior on the part of consumers. The company sells close to a billion ICs a year, addressing the majority of power supplies built annually, and they're used in a vast range of consumer and industrial electronics - computers, DVD players, TV set-top boxes, cell phone chargers, home appliances, telecom networking equipment, and many others.

(Slide 4) EcoSmart technology automatically improves the efficiency of AC-DC power supplies in both active on mode and low standby modes by automatically reducing power consumption based on power requirements of the load. It enables cost-effective power supplies that meet all current and proposed energy efficiency specifications and regulations. The company has more than 300 U.S. patents including design, high-voltage silicon process technology, system- and circuit-level breakthroughs and IC packaging. The manufacturing process we use produces high quality products, with billions of ICs shipped. We have fully equipped application engineering labs around the world, providing a local presence in major markets. Our website offers complete design support including product specifications, reference designs, design software, and an excellent resource, the Green Room, for information on energy efficiency regulations and programs.

(Slide 5) There are two major components involved in addressing standby losses– the AC-DC power conversion stage (where the AC mains voltage is converted to a lower DC voltage) and the end application's power management circuitry that reduces the load requirements during standby.

Losses in the power conversion stage can be caused by the circuit design (circuit topology and components used) and is an area addressed by the semiconductor industry, with ICs focused on reducing standby power consumption. Additionally, there may be regulations affecting power supply performance that add components/circuits that reduce the overall efficiency of the power supply. Power management related losses are dependent on end application load needs (for example, a set top box that needs to remain active for service provider software updates) or immediate peak power requirements (for example, the in-rush power requirements of a printer's paper feed motor when it receives the input to begin a print job) .

Certainly, both are important, but if the power supply is not efficient at low standby power levels, the total system can't achieve low standby power consumption, regardless of the power management controls in place. In this presentation, the focus will be on reducing the power conversion related losses.

(Slide 6) Switching from a linear-based power supply to a switching power supply was an early and easy way to reduce standby power consumption. However, reducing standby consumption to much lower levels requires improving the efficiency of the switching power supply at very low power levels. Regardless of the semiconductor technology used for the transistor that switches the output current in the power supply (represented in this slide as a simple on-off switch), the two components of power loss are switching losses (determined by $\frac{1}{2} C_{OSS}V^2F$, where C_{oss} is the output capacitance of the transistor, V is the voltage across the transistor, and F is the switching frequency of the transistor) and conduction losses (determined by $I^2R_{DS(ON)}$ where I is the current flowing through the transistor and $R_{DS(ON)}$ is the output resistance of the transistor). In standby mode, reducing switching loss in the switch is key in reducing standby power. There are several ways to accomplish this. One is by using a simple ON-OFF signal to turn the switch on and off, skipping cycles when less power is needed. Another is a more complicated approach of varying the frequency and waveform of the signal that turns the switch on and off, depending on load level requirements. Both can be used to successfully increase a power supply's efficiency at low standby power levels.

(Slide 7) If all power supply designers had to worry about was efficiency at low loads, design would be a lot simpler. But, a few years ago, things became a little more complicated for designers when efficiency programs like ENERGY STAR, the EU Code of conduct and the Ecodesign Directive issued power supply specifications that required supplies to be highly efficient not only at standby levels, but also across a wide range of active mode levels between 25% and 100% of load. An approach called multi-mode switching was developed that keeps the power supply efficiency curve constant over a wide load range and maintains a reasonable efficiency even at very low load requirements such as 1 W and lower.

(Slide 8) This chart shows the general levels of efficiency available from PI product families at low load requirements, all the way down to the no-load requirement, which is when a power supply is connected to the AC mains but not connected to the end application. This could be thought of as the power supply's standby power. As the chart shows, the lower power LinkSwitch product family is capable of no-load consumption at the 10 milliwatt level, in other words, 0.01 watts. The highest power IC family, the TOPSwitch-JX, consumes less than 100 milliwatts in no-load.

(Slide 9) In standby power conditions, for example at the Ecodesign tier 1 limit of 1 watt input, these product families operate at efficiency levels that provide high levels of output power for the end applications standby requirements – over 680 milliwatts for the LinkSwitch-XT to over 770 milliwatts for the TOPSwitch-JX family. At the 2013 Ecodesign tier 2 limit of 0.5 W input, the usable output power levels range from over 330 milliwatts to almost 370 milliwatts.

(Slide 10) Let's take a look at three cost-effective power supply designs with ultra-low no-load power consumption, ranging in power output from 3 W to almost 30 W. Each is built with readily available, non-exotic components and is used with some familiar end products. As shown in the chart, all three provide no-load power consumption well under 100 milliwatts.

(Slide 11) The first is a 3 W adapter/charger that could be used with a mobile phone. At 4.2 milliwatts, the cost for operating this in no-load for 23 hours a day for a year is less than 1 cent per year. This design easily meets any EPS energy efficiency specification in the world today, whether government or industry issued. As the graph shows, even at 230 V input, it consumes less than 10 milliwatts.

(Slide 12) Next is a 15 W power supply that you might find with a cable broadband modem or a wireless router. The converter IC uses an ON/OFF control scheme and yields virtually constant efficiency across the 25% to 100% load range required for compliance with ENERGY STAR and Ecodesign energy efficiency standards for external power supplies (EPS). Even at loads below 10% of the supply's full rated output power, efficiency remains above 75%. This performance is automatic with ON/OFF control and doesn't require the designer to consider specific thresholds within the load range in order to achieve compliance with global energy efficiency standards. Even at a standby consumption level as low as 100 milliwatts, the supply delivers 60 milliwatts to the end application.

(Slide 13) Lastly, here's a higher power (27 W) multi-output power supply that could ship with an LCD monitor. Even at the higher output power capability, no-load consumption at 230 VAC input is a miserly 60 milliwatts as shown on the left chart. The chart on the right shows the power consumed at three different standby load levels. This circuit provides 20 milliwatts of output power while drawing well under 100 milliwatts.

(Slide 14) Sometimes the solution to one problem creates a new problem. Here are two examples found in higher power supplies.

Applications that contain off-line switching power electronics, for example motor drives, domestic appliances, and industrial equipment, have high voltage and high current switching waveforms that generate Electro Magnetic Interference (EMI). EMI can cause problems with other products if allowed back on to the AC mains.

To reduce EMI and meet noise standards (EN 55022B and CISPR22B) a filter stage is inserted at the AC input. As part of this filter, capacitors are commonly placed directly across the AC input terminals to reduce EMI. Due to their location, safety agency recognized X class capacitors are typically selected. Since the capacitor appears across the input terminals, the energy stored in it is present across the input prongs of the power converter and could shock the consumer after unplugging the product.

To prevent this risk once the supply is unplugged, safety agencies mandate that X-caps with values above 100 nF be discharged automatically with a time constant of <1 second (UL1950/IEEC950). Typically this is achieved by placing discharge resistors directly across the capacitor. Unfortunately, the presence of discharge resistors results in a constant power loss while AC is applied. With more stringent no-load and standby input power requirements, this power loss has become a significant portion of the overall power budget. For example, a power supply that uses a capacitance of 1 µF across the incoming AC will require a resistor which dissipates 53 milliwatts at 230 VAC, independent of the output load.

Additionally, Power Factor Correction (PFC) circuitry is often required in switching power supplies to improve the ratio of the power factor (the ratio of the real power flowing to the load and the apparent power. The purpose of making the power factor as close to unity (1) as possible is to make the load circuitry appear purely resistive (apparent power equal to real power). That way, the voltage and current are in phase, enabling the most efficient delivery of electrical power from the power company to the consumer. In the case of a switching power supply, an active PFC circuit (consisting of additional semiconductor switches and control electronics) is inserted after the input rectifier bridge. Most PFC controllers monitor DC Bus voltage and current to control supply operation, using a resistor chain between the high voltage rail and a low voltage monitoring pin. These sense resistors burn constant power whenever high voltage is present, even when the controller they're connected to has been disabled during standby. The good news is that adding an active PFC circuit can improve the power factor of a switching power supply from 0.55 to over 0.95. The bad news is that the power loss can be 100 milliwatts or more per resistor chain, significantly increasing standby input power.

(Slide 15) First, we'll look at a solution for EMI discharge resistor loss.

CAPZero is a self-contained, two terminal IC that can be added to any power supply with x-cap discharge resistors to completely eliminate power lost in the discharge resistors. It's a simple product that easily meets safety requirements and helps in achieving the lowest possible no-load input power.

CAPZero acts as a smart switch when placed in series with the discharge resistors. The switch is open while the AC is connected, eliminating the constant power loss through the discharge resistors which can be 100 milliwatts or higher. When the AC is disconnected, the switch is automatically closed and the X-CAP is safely discharged through the resistors. The only change necessary to add a CAPZero IC in this design is a small change to the PCB layout, allowing a very fast time-to-market for updated green power supplies.

(Slide 16) To reduce standby power consumption in a PFC circuit's high voltage bus sense resistors, SENZero was developed.

SENZero eliminates this wasted power by placing a smart switch in series with these sense resistors to effectively disconnect them when main switching is deactivated, cutting off the sense current when it's not required. To give an idea of the type of power savings, we looked at a 385 W PC power supply with active power factor correction. Without SENZero, the supply drew 516 milliwatts of input power. After adding SENZero, the standby power was reduced to 378 milliwatts of input power. That's 138 milliwatts of power saved by SENZero. It also meant this design now met EuP Lot 6 specifications. SENZero's integrated MOSFETS have ultra low leakage, allows the three channel device to consume just 790 microwatts of total standby power.

(Slide 17) How do we get to zero? Solutions to reduce standby and no load consumption have emerged rapidly in recent years. But, the availability of a simple and cost effective “non-mechanical” means to achieve zero consumption has remained elusive. To date, zero standby solutions have required bulky and or costly configurations using relays, manual switches and in some cases even batteries within phone chargers to give the illusion of zero no-load consumption.

The definition of ‘zero’ is a topic of debate depending on the equipment involved. Some manufacturers look at standby consumption in a domestic appliance of below 50 milliwatts as 0.0 W consumption, whereas the most stringent targets in mobile phone chargers are already for < 5 milliwatts (0.00W) no load consumption.

The drive for ever lower power consumption only makes sense if it doesn’t cost more than the energy savings it provides. It’s to this end that a new IC has been developed to meet the most stringent IEC62301 ‘zero’ consumption definition of < 5 milliwatts when connected to a 230 VAC supply.

(Slide 18) LinkZero-AX, a new IC for ultra-low standby supplies, includes a remote-off power down that's easy to use, and provides 0.00 W of total standby consumption, even with the input voltage still connected. When one of the IC’s pins is pulled high or the load is reduced below 0.6%, the IC goes into a very low consumption power down mode, consuming just 3 milliwatts or less, while still able to supply 500 micro amps of local auxiliary power. Another pin is used to wake the IC up, which immediately begins switching, bringing the output into regulation in less than 5 ms.

(Slide 19) Here’s how a block diagram could look for a higher power product that utilizes all three “Zero” family ICs. Together, these products work to achieve the lowest possible standby input power.

(Slide 20) So, maybe this opens up an opportunity for a new power symbol. Most of us are familiar with the IEC power symbols shown in black, denoting power on, power off, power on-off, and the standby power symbol at the top right indicating sleep mode or lower power mode. There’s also a crescent moon symbol indicating sleep mode added by IEEE 1621 as a standby symbol. Could the time be right for a new GREEN-OFF power symbol for a product identifying that it consumes less than 5 milliwatts while in standby. It would be easily recognizable by consumers and let them know that the product they’re enjoying also saves them money when they’re not using it.

(Slide 21) The take-away from this presentation is:

- Power conversion ICs that enable Ultra-low standby levels are available, they are extremely cost-effective, they automatically operate with good efficiency at low loads intelligently and are simple to use.
- With advancements in power management, reducing the power required for a product to achieve a minimum level of alertness as required by the application and end user expectations, future efficiency programs should explore the possibility of reducing standby levels below 0.5 W.
- Additional information about ultra-low standby power circuits and more about Power integrations can be found at: http://www.powerint.com/en/applications/ultra-low-standby

Thank you for your attention.

Where Product Development is at? Session 2

ECO NAVI (eco-navigation) Technology by Makoto Shimizu Panasonic Corporation

I have divided my presentation into three parts. In the first part, I will talk about Panasonic's overview; in the second part, overview of standby power consumption in Japan; and the final part, I will introduce you "ECO NAVI technology", our company's approach to reduce power consumption.

First of all, I will introduce you our company's overview. Panasonic was founded in 1918, and its net sales reached ¥7,418.0 billion for FY2009. Currently Panasonic has 400,000 employees globally.

(GT12) Panasonic aims to become No. 1 "Green Innovation Company" in the electronics industry as looking into its 100th anniversary in 2018. Especially Energy system is promoted and positioned as a "flagship business" of the company. Panasonic offers from energy-creation, -storage, and –saving devices/equipments to optimal energy management systems combining a wide range of energy-related devices and equipments; it is the value only Panasonic can offer.

Now I would like to get to the main point "overview of standby power consumption in Japan" and our company's "ECO NAVI technology". First, I will briefly talk about "overview of standby power consumption in Japan".

According to research of Energy Conservation Center, annual residential power consumption in Japan has increased to 4734kWh per household in 2008. However, annual standby power consumption amounted to 285kWh per household, decreased by approximately 6% of annual power consumption.

If we look at standby power consumption by product, it is largely decreased in audio visual devices. The reason for the decrease is that big standby energy consuming products such as CRT television and VCR are decreased in use. On the other hand, standby power consumption of telecommunication devices and air conditioning increased in amount. Standby power consumption of each device has decreased; however, the number of devices/equipments and amount of time in standby power mode increased.

Next, I will talk about our products status.

As you can see in the chart, air conditioner, TV, and electrical rice cooker are products in sale which have been realized below zero-watt standby power consumption. Also, microwave and washer has zero-watt standby power consumption. These were made possible in 2004 by relative industry groups and manufacturers' efforts.

As I just mentioned, efforts to reduce standby power consumption produced fruitful results. In addition to the decrease in standby power consumption, there is a need to decrease in residential power consumption as a whole.

Lastly, I will introduce you "ECO NAVI technology".

ECO NAVI realizes further energy conservation. Panasonic products equipped with ECO NAVI function can self-control operation depend on the usage environment by sensor and program technologies.

ECO NAVI function is applied to 11 Panasonic products. Today I will talk about air conditioner, TV, refrigerator, and washing machine equipped with ECO NAVI function.

First, I will talk about air-conditioner. Air conditioner equipped with ECO NAVI has three sensors; “people sensor, “insolation sensor”, and “room layout sensor”. Up to approx. 50% energy can be saved, including time in use by sensors and program control. For instance, up until now, wind from air conditioner could not reach people in the room when there was any kind of furniture blocking the wind. Air conditioner with ECO NAVI will utilize room layout sensor to automatically measure positions and heights of walls and furniture, and optimally avoid obstacles to send wind to people in the room.

Also, air conditioner in the past used to cool entire room even there was only one person in the room. This air conditioner equipped with ECO NAVI uses “people sensor” to spot people and cool off where people are. By these functions, we can smartly cut down on electricity an Furthermore, when we sit and read with no activity, air conditioner automatically adjust to lower the air flow. It works likewise when sunlight is weak. It automatically adjusts to weaker air conditioning to conserve energy and to keep comfort. We can monitor electricity costs as results of energy saving activities on main unit display. By this, we hope to make customers more aware of energy conservation.

Secondly I will talk about TV. TV has “brightness sensor”. The sensor detects brightness in the room, self- control brightness of the screen, and realize up to 15 % of energy saving.

At night or when it is dark in the room, the sensor automatically saves brightness of screen for better picture quality and simultaneously saves energy. The level of energy saving can be checked on bar displayed in the screen. TV also automatically turns off the power when no use over 10 minutes to reduce power consumption. On top of that, TV finds linked devices such as Blu-ray Disc Player that is not in use and automatically turns off and realizes up to 16% energy conservation. Another example of it is that when switching from watching Blu-ray Disc Player to TV program, it automatically shuts off Blu-ray Disc Player. We do not have to turn off each device and can easily save energy.

Third and the last, I will talk about refrigerator equipped with ECO NAVI.

Refrigerator equipped with ECO NAVI has “light intensity sensor”, “door opening & closing sensor”, and “temperature sensor”. With three sensors and program control, up to 15% energy saving is possible. d electricity bill.

I will explain 2 eco functions by giving you examples.

The first one is “Rest-at-night ECO”. “Light intensity sensor” detects brightness around refrigerator. At night time, when lights are off, refrigerator decides its own it is not going to be used anymore and automatically switches to ECO NAVI mode. Refrigerator memorizes, analyzes, and even estimates breakfast time of user and switches back to normal operating mode.

The second is “Smart ECO”. “Door opening & closing sensor” detects user’s daily opening and closing door of refrigerator. Refrigerator memorizes, analyzes and estimates door opening and closing of user and controls inner temperature according to the user’s life patterns. When there is no one in the house and no one opens refrigerator, the refrigerator automatically switches to ECO NAVI mode to conserve energy.

The fourth and the last ECO NAVI product is about washer/drier.

Washer/drier is equipped with ”load sensor”, “beam sensor”, and “electrode sensor”.

With those sensors and program control, up to 10% of energy saving and up to 7% of water saving can be realized. Specifically speaking, “load sensor” detects the amount of laundry in the drum and other two sensors detect the level of dirtiness and sweat on the laundry. When the level of dirtiness is low, it automatically controls and sets amount of time and water for less.

That is all for 4 ECO NAVI products. Including other ECO NAVI products which I could not introduce you, Panasonic will continuously make efforts to reduce standby power consumption and entire residential power consumption even more so by “ECO NAVI technology”. Panasonic aims to produce more products equipped with “ECO NAVI” function and expand them domestically and globally.

That is all for my presentation. I hope this presentation helps you.

Thank you very much for your attention.

Recent Nationwide R & D Activity for Reducing Standby Power in Korea by Nam Kyun Kim Korea Electro-technology Research Institute (KERI)

Korean government already introduced "Energy Boy" label as a voluntary standby power labeling system for home electronics in 1999. However, the public attention to standby power was not so big until the first nationwide survey of standby power in Korea which was done by KERI, a public research institute, was published in 2003. The 82 households survey demonstrated that the standby power of major home appliances was apparently high such as 4.3W for TV, 5.5W for VTR(now almost disappeared), 9.1W for audio etc.

The survey estimated the annual standby power consumption; 306 kWh per household per year which shares 11% of household electricity and 4600 GWh nationwide per year which occupies around 1.7% of total electricity. The message was simple and apparent that something has to be done against standby power.

Since 2004, Korean government and Korea Energy Management Corporation (KEMCO) started the effort to align the Korean standby standard with IEA's 1 Watt initiative. Korean 1 Watt Standby Committee which participated with government, NGOs and major domestic home electronics companies was launched in 2005 in order to establish a master plan for achieving 1W standby.

The "Standby Korea 2010" was a grand roadmap to 1 Watt standby on the basis of the committee's activity and declared by the name of the Ministry of Commerce, Industry and Energy(MOCIE, currently MKE-Ministry of Knowledge Economy). The Korean standby roadmap describes 1 Watt approach into three stages. Stage 1 was considered as maintaining period of the on-going voluntary policy in the years 2005-2006. Stage 2 was designed for a transition period from voluntary to mandatory 1 Watt in the years 2007-2008. Stage 3 was ambitiously designed to implement a mandatory 1 Watt policy to all products by 2010.

The declaration of 1W roadmap raised two issues to Korea. One issue was the necessity of new standby policy development, and the other was the pressure of technology development to meet 1 watt standby or below in each product category.

In terms of policy development, standby warning label as a mandatory standard was studied for years. Korean government finally decided to implement the "Conventional" Energy Boy label in parallel with the "New" standby warning label. Energy Boy label may be attached in case a product meets the standby standard whereas the standby warning label should be attached in case it fails to meet the standard. Any product can be distributed and be sold in Korean market even though not meet the standby standard as long as it attaches the yellow warning label.

The world-first standby warning label was implemented in year 2008 in Korea. Currently 19 product categories are filed for the warning label items.

In terms of technology development, the R & D planning committee was launched in 2005, which set up a technology roadmap and built a nationwide R & D consortium to achieve 1 watt or below in an extensive category of home electronics.

The R & D planning committee reported technology development roadmap to achieve 1 Watt standby by 2010. According to the plan, power supply technology program will be executed till 2011 by developing power management device, low-loss power device and energy-efficient switch-mode power supply(SMPS) technologies. Power saving technology in networked products and test protocol development were also included in the technology roadmap.

It looks that an appliance has a supply chain starting from the electronic component level, via power supply level to appliance itself for the purpose of achieving a lowest standby power. Each level must be optimized not only technically but also cost-effectively.

The first nationwide standby R & D consortium was launched in 2005. The consortium had 3 technology groups and 8 individual projects(some of the projects started in 2007). Most of the project teams had industry, university, and research institute participants. Project period are 3-5 years. In case a project accomplishes the planned goal or the technical targets, it terminates. Currently two of the projects are on-going under the standby technology development program.

In terms of the energy-efficient components development, our consortium has been developing PWM control ICs, half-bridge converter ICs etc. We are also developing hybrid power ICs which is the combination of control IC, gate driver IC and discrete power device like MOSFETs.

Our consortium also has been developing various energy-efficient power supplies such as flyback converters, half-bridge converters, auxiliary power supplies and inverters etc. The photos are the developed power supplies in the consortium.

We have also developed various appliances with low standby technology such as TVs, set-top boxes, electric toilet wares, rice cookers, integrated stereos etc.

Flat-panel televisions like LCD, PDP are the representative home electronics with minimum standby power. The normal power consumption of FPTV is at the range of several hundred Watt, but the standby power is below half a watt which definitely surpasses almost all other home appliance categories. The biggest standby power consumption of a digital TV is originated from the switching loss of the power device. Therefore switching loss should be cut down and also other loss factors of TV power supply should be minimized in order to achieve standby power below 0.4W.

Rice cooker is operated daily in every household in Korea. Currently rice cooker market is moving to hot plate type to induction heating. The standby power loss analysis of induction heating cooker shows that most of the loss comes from 20V power unit rather than others like induction inverter. Our consortium succeeded in developing energy-efficient 1.3kW induction heating inverters as well as auxiliary power supply to yield 0.22 watt minimum standby power.

We also succeeded in developing integrated stereos with 0.4 watt standby power in total. We designed the audio system that the auxiliary power supply works during main power is off. The power loss was cut down by dropping operation voltage of the relay power(12V → 6V), the sub-micom power(5V → 3.3V) etc.

In summary, we have been developing energy efficient components, power supplies, and various home appliances to align with Korea's 1Watt program. Recent survey in the electronics retail stores indicates that most of the products are below 1 Watt at standby mode, which is definitely contributed by the nationwide R & D activity for minimizing standby power.(end)

Energy Saving Devices and the Challenges Ahead by Domenico Gelonese Embertec Australia - APEC Presentation October 2010

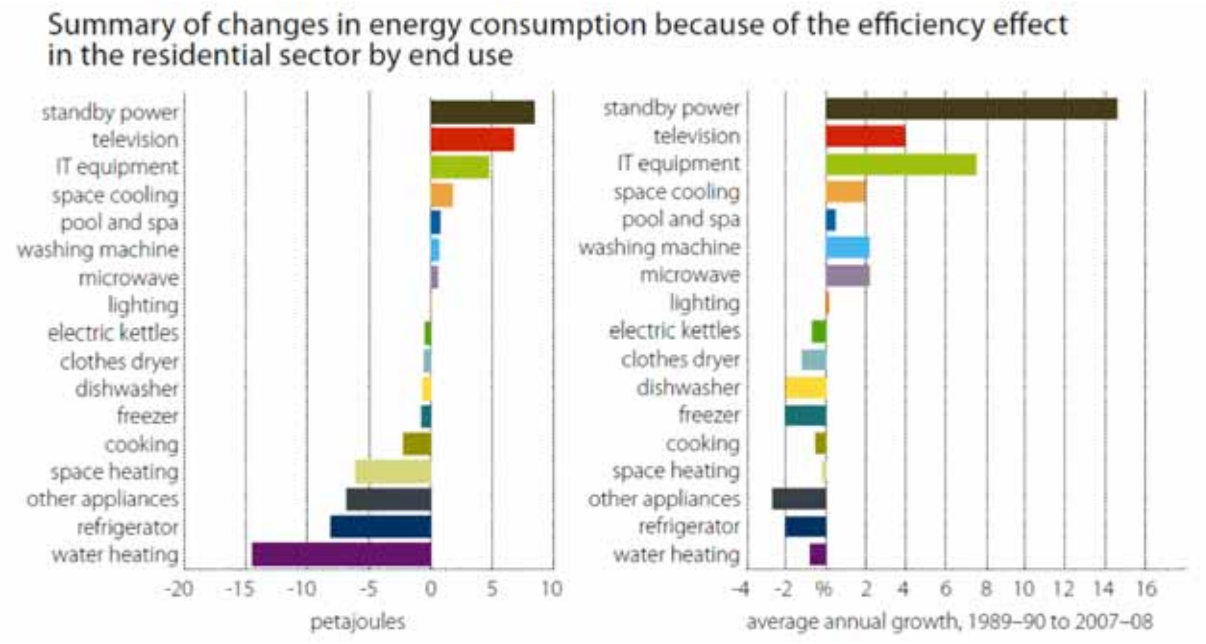
Contents

1. Who Are Embertec?

- Embertec is a technology developer and licensor of energy efficiency solutions
- To date Embertec has undertaken over 6 years of research & development in technologies that drive automated energy efficiency
- International advisor and supplier to State/Federal Governments, Regulators and Energy Utilities in the area of Standby Power mitigation
- November 2008 - Awarded $1.6M R&D Grant from the Australian Federal Government to further research into Standby Power reduction technologies.
- Have a comprehensive understanding of the energy efficiency space and the efficiency opportunities that exist in the areas of standby power reduction.

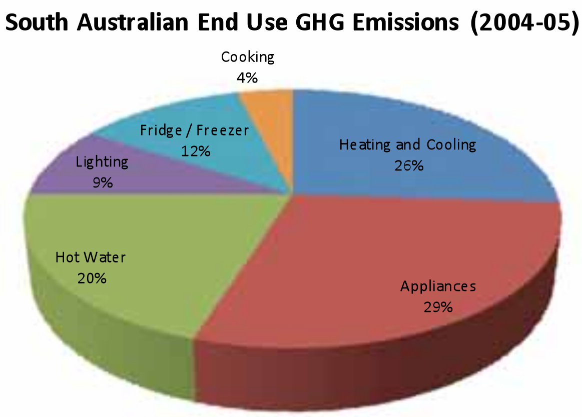
2. Residential Energy Consumption Trends

A report released in September 2010 largely confirms what many energy efficiency analysts have stated previously. The table below published by the Australian Bureau of Agricultural and Resource Economics (ABARE) highlights some worrying but expected trends in residential end use energy consumption.



The key findings show that in the years from 1989-90 to 2007-08; the largest annual growth in energy consumption in the home is due to standby power, televisions and IT equipment.

Although some 5 years old, the assessment of end use GHG emissions in South Australian homes highlights appliance usage as the largest contributor to end use GHG emissions. Since this period there has been a sharp increase in the penetration rate of household appliances.



3. Targeting the "Low Hanging Fruit"

For a number of years, APEC economies globally have seen the GHG reduction opportunity through running Incandescent Light Bulb replacement with CFL programs. These products have long been the "Low Hanging Fruit" for energy efficiency programs globally.

These programs presented many valuable lessons around the structure of these programs to deliver mass levels of energy efficiency. Most important amongst these lessons was the need to create robust assessment methodologies for energy efficiency devices to ensure performance.

As energy usage continues to rise in other areas of the home with the greater proliferation of electronic devices in the home (IT / AV devices) contributing to much of this increase, a concerted approach similar to the CFL programs undertaken globally is required.

Energy Star, MEP's, and other initiatives all aim to reduce the power consumption of these devices but these efforts alone are unlikely to counter the increased penetration and total energy use of these devices in the home.

4. The Opportunity

The Opportunity exists to address the wasteful energy consumption of residential appliances quickly, efficiently and with minimal interference to the householder.

What is required is to move up "one branch" to the next level of energy efficiency products aimed to assist households reduce end use GHG emissions.

The immediate opportunity is to address environments in the home where there exists a "nest" of electronic devices. These environments are typically the following;

- PC / IT Environment (Personal Computer / Information Technology)
- AV Environment (Audio Visual)

5. The Solution

A strategic approach through regulatory frameworks limiting the permissible energy consumption of these devices, (Energy Star and equivalents) in addition to the adoptions of energy saving devices targeted at these environments will offer a unique market opportunity to address this wasteful energy consumption instantly.

6. The Efficiency Challenge

A regulatory efficiency approach with CE OEM's is a lengthy process which often leads to lagged energy efficiency gains as old equipment is "replaced" over time. In addition in many instances, old equipment is not discarded but simply moved to another area of the home.

Thus combining a regulatory approach with the strategic diffusion of energy saving devices can deliver an instantaneous and prolonged energy efficiency in residential environments with little to no adverse effects on the householder.

Energy Saving Devices are a new product space with many varying product and technology adaptations. Numerous energy saving devices are on the market which deliver varying levels of device automation and environment adaptability.

Device automation and adaptability to the targeted AV / PC environments are the key drivers of the energy efficiency achieved through the energy saving device and these functions need to be properly assessed to value the energy efficiency derived from each type of technology.

Valuing a product based on its individual energy efficiency performance will drive industry investment to develop smarter technologies and having these products independently valued will deliver consumer confidence in these technologies and promote widespread uptake and energy efficiency.

Below are some images of but a few energy saving devices on the market;





Given the wide range of energy saving devices on the market today, a testing methodology to validate their energy efficiency and performance is the key to their consumer acceptance and will also create greater market awareness of their existence.

A robust testing methodology will ensure reliable and effective energy saving devices are adopted by households. As stated earlier, valuing energy saving devices which deliver maximum levels of automation will drive further investment in this space to create smarter technologies/products which deliver greater levels of energy efficiency

It is imperative that lessons learnt from CFL programs are carried over to this new product category to ensure maximum energy efficiency is delivered which is predominantly driven by consumer acceptance.

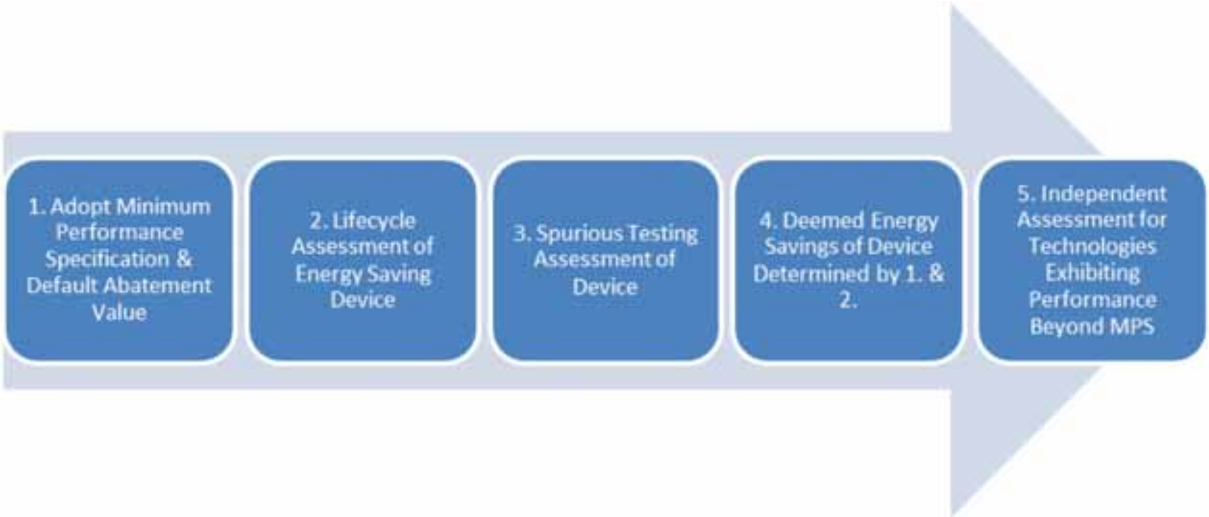
Greater levels of consumer satisfaction from the performance of energy saving devices will drive industry acceptance and adoption of this new product category.

7. Assessment Methodology

Numerous State/Federal Governments and Regional Regulators are currently in the process of developing assessment methodologies for energy saving devices.

Depicted below is one such approach to testing existing energy saving devices and ensuring the ability to assess new technologies as they emerge.

An assessment methodology which supports the ongoing development of technologies and products in this space will drive future efficiencies.



8. Minimum Performance Specification (MPS)

The aim of a Minimum Performance Specification is to deliver a detailed assessment process for energy saving devices to ensure the following key criteria are achieved;

i) A Robust qualitative and quantitative performance assessment of energy saving devices to ensure the household acceptance and energy efficiency through their adoption.

ii) To provide energy saving device product proponents a clear, cost effective assessment framework that can be easily executed by certified electronic testing laboratories

iii) A stage gated process will be more cost effective for the applicants as costs can be spread across each of the stages with devices failing at any stage not having to incur additional assessment costs for later stages.

The first three (3) phases are to ensure the quality of the energy saving devices seeking category accreditation under the proposed activity. An eligible energy saving device will pass each of the first three (3) stage gates which will ensure the devices ease of use and ongoing greenhouse abatement potential.

The carbon abatement potential of the device is a product of its lifecycle assessment and the adopted default abatement factor for energy saving devices. All devices must pass the Minimum Performance Specification and Spurious Testing process to ensure reliability.

The final phase allows for newer technologies which exhibit greater levels of functionality with independently validated energy saving capabilities to be valued also. This is important in order to promote industry investment in more efficient technologies.

9. Overall Aim & Final Comments

The overall aim of the energy saving device assessment process is to ensure the following key elements are delivered;

- A robust performance assessment of energy saving devices ensuring the integrity of energy efficiency programs
- Cost effective assessment process of energy saving devices lowering the barriers for market participation
- Rewarding energy saving devices based on their actual abatement potential
- Promote further industry investment in abatement generating technologies
- Provide information to the public on the performance of energy saving devices available in the market

Embertec has a comprehensive understanding of this testing methodology and is available upon request to discuss this MPS, testing methodologies and the value to participating Regions, States and APEC economies in adopting a robust assessment framework for energy saving devices.

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Inefficient energy consumption through residential appliance usage is an area which needs to be approached with careful thought, consideration and robust execution to deliver the maximum energy efficiency and GHG abatement opportunity possible.

Thank You

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From Standby Power to Total Energy Session 3

Scaling Power Use to Functionality: Design Strategies and Opportunities for Energy Savings

(Prepared for the APEC Standby Power Conference in Tokyo)

Chris Calwell Ecos

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Introduction

Most of the efforts to improve the energy efficiency of consumer products in recent years have employed one of two distinct strategies. The first has been to reduce power consumption in standby mode (when a product is delivering minimal functionality and should be consuming as little power as possible). The second has been to reduce power consumption in active mode (when a product is performing its intended function).

As energy-using products have become increasingly sophisticated and complex, the distinctions between these two modes of operation have blurred. Products are increasingly doing *something* when their users believe them to be "off," even if that functionality is as minimal as displaying the time, watching for a remote control signal, or maintaining a connection to a network. Likewise, products are increasingly doing very little (idling) much of the time their users believe them to be "on." As a result, it has begun to matter less whether users remember to *manually* switch their products off, and it has begun to matter more whether products are smart enough to *automatically* scale their power use to the amount of functionality needed in real time.

The technologies that have been traditionally used to accomplish power scaling in energy-using devices are familiar and widespread:

- dimmer switches for lighting products
- speed controls for motor, fans, and pumps
- thermostats for heaters and air conditioners

However, each of these devices is typically manual, meaning that the user needs to select a particular setting to achieve a preferred outcome, and to change that setting when his or her preference changes. Automatic power scaling shifts more of that decision-making capability to the device itself, giving it sufficient awareness of its surroundings or *context* to make intelligent decisions within the broad boundaries established by user preferences. For example, a lighting system could monitor room occupancy and daylight lighting levels, using that information to determine how much artificial light to provide in each room of the house at various times of the day (including no light at all to unoccupied rooms). Likewise, programmable thermostats can bring a degree of additional intelligence to the process of making rooms comfortable if they are aware of the time of day, the day of the week, the season (heating, cooling, or neither), and whether the home is currently occupied.

The Promise of Automatic Power Scaling

Still, in each of these two examples, the intelligence, sensing, and control capability are external to the device itself. What are the prospects for embedding automatic power-scaling into consumer products directly, and how would it change their energy use? Conceptually, most products are capable of at least a degree of automatic power scaling, because integrated circuits have made the power and space requirements and cost premium manageable for the circuitry needed to sense context and make decisions on the basis of environmental inputs.

Perhaps the most important products in which to have this capability are consumer electronics and office equipment, because their sales and share of total energy use are growing rapidly, they are very likely to be networked to other devices, and their duty cycles tend to be highly variable and unpredictable from day to day and from user to user. Finally, and most importantly, these devices have the technological capability to consume only a few percent or less of their peak power consumption during periods of inactivity, provided they can correctly determine when those periods occur and respond accordingly. Bringing automatic power scaling to such products tends to achieve the largest relative power savings (Figure 1) at minimal work loads or levels of functionality (consistent with the *idle* state).

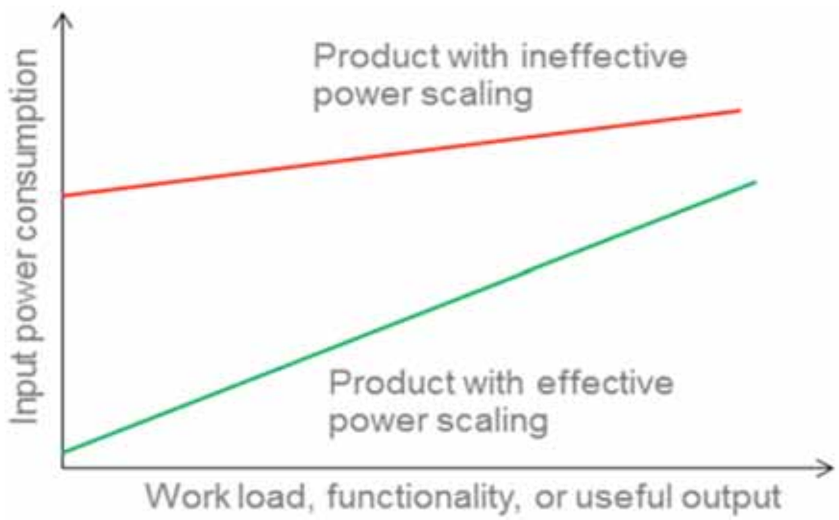


Figure 1 - Conceptual Impacts of Power Scaling

As the work load gets closer to maximum, naturally, the remaining power savings opportunity from automatic power scaling shrinks, though other efficiency design strategies can have an impact in that situation.

Consumer Electronics Applications for Power Scaling

Multimedia computers, complex set top boxes, and game consoles represent particularly compelling near-term opportunities for energy savings from automatic power scaling. All three types of devices are designed to handle very complex and rapidly changing combinations of audio and video data, which may need to be processed, amplified, modified, or stored as required by the user. Similarly, all three device types have considerable networking capability, but utilize only a fraction of that available bandwidth most of the time. Yet all three types of products have thus far demonstrated a relative inability to switch off or slow down unneeded circuitry during periods of less intensive computation or minimal network traffic.

Power scaling *is* typically found in desktop and laptop computer microprocessors, which can automatically adjust processor voltage and frequency in response to workload. But that same capability is not regularly found (or enabled via software) in the powerful graphics cards installed in such computers, and the graphics cards can draw as much power as the rest of the computer combined, even when the image on the screen is not changing. The newest designs have begun to achieve power scaling through the use of simpler motherboard-based graphics that can handle most of the graphics workload, only activating powerful card-based graphics processors as needed to handle more complex workloads, but few multimedia PCs have adopted these strategies to date.

Similarly, high definition set top boxes have demonstrated modest declines in their peak power consumption in recent years, but most continue to draw nearly the same amount of power when switched off as they do when recording high definition content or playing it back. Most current product designs record video content continuously and check in with the service providers' network frequently for security and content update purposes. Such devices should increasingly be able to retrieve programming or program guide content as needed from "the cloud" via broadband connection when requested by the user, instead of keeping all of that information locally. This would allow the set top boxes to idle at very low power levels most of the time, or allow their capability to be embedded in the TV itself, saving a tremendous amount of electricity.

Game consoles, likewise, have seen declines in their peak power consumption as manufacturers have refined power supplies, integrated functionality onto fewer microchips, and found ways to cool circuitry more cleverly. But even with those design advances, idle power levels can still be 80% or more of maximum power levels in current products. Similarly, when game consoles are asked to perform relatively simple tasks like playing music or a movie (Figure 2), they have not been able to do so at power levels much below their peak consumption or close to that used by dedicated music and movie players. The evolving ENERGY STAR specifications for these products are poised to steadily push such design changes in future product revisions.

The primary message of the data shown in Figure 2 is that automatic power scaling could save a tremendous amount of energy in many different types of consumer electronic products, primarily by ensuring that highly functional devices like multimedia computers, complex set top boxes, and game consoles do not consume significantly more power to perform basic tasks or to idle than the inexpensive special-purpose devices like DVD players and CD players do. Apple's latest Mac Mini desktop computer is an impressive demonstration of what is possible in this regard, seamlessly scaling its power use from about 35 watts (game play) down to about 7 watts (idle) as it is given progressively less complex tasks to perform.

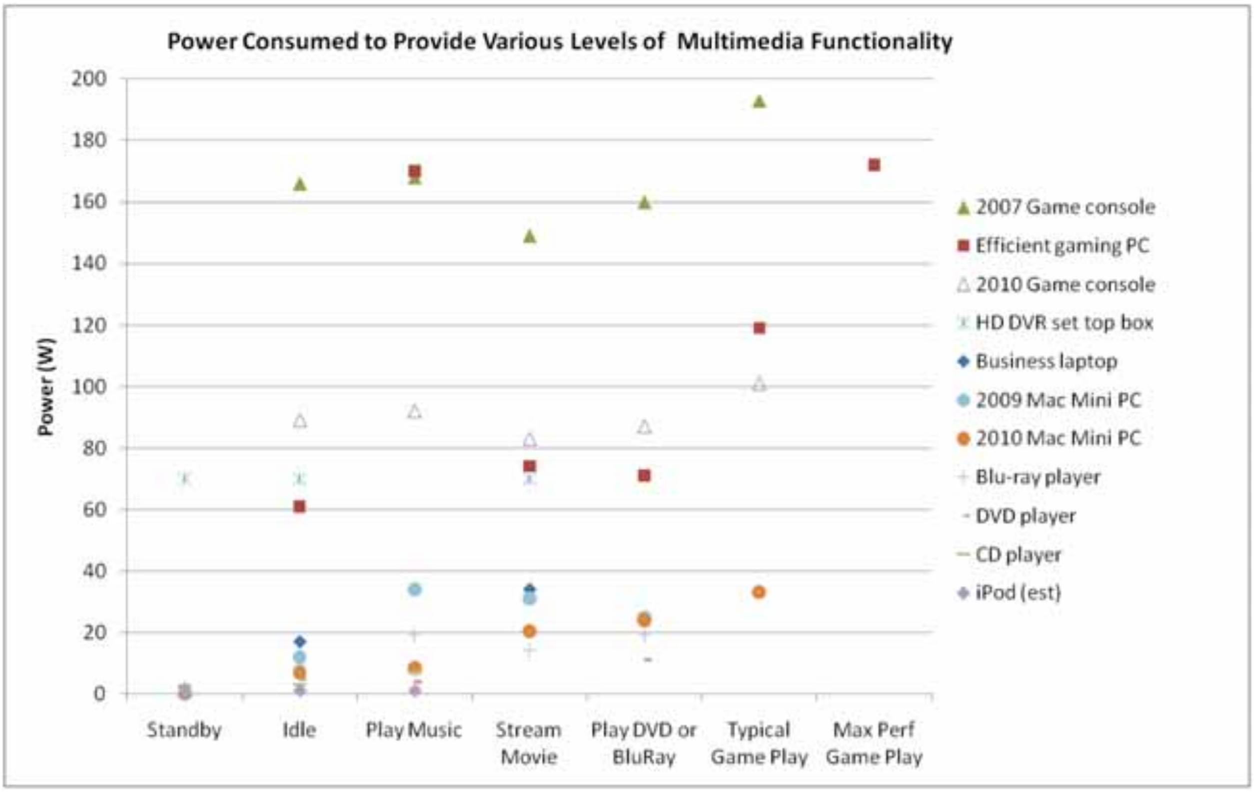


Figure 2 - Ecos Measurements of Power Use in Various Multimedia Products

Conclusions

Some have held out hope that the elusive "smart grid" will eventually bring a degree of centralized intelligence and device control to homes and offices that will allow their energy-using products to operate more efficiently. This may indeed happen, but the lead time and expense associated with rolling out the needed infrastructure to support such a change will be considerable. In the interim, there is much that can be done to save energy cost effectively by embedding a degree of intelligence and context awareness in the individual devices themselves.

Such technologies will allow these products to remain on networks to the degree necessary to keep the network functioning during periods of minimal data flow, while shutting off circuitry that is simply not needed during the majority of the time the devices are not working very hard. Simply stated, it is increasingly rare to manually switch an electronic product fully on or off with a press of a button. However, it *should* become increasingly common for such products to automatically switch elements or portions of their circuitry on and off in a way that is seamless and largely invisible to the user, saving tremendous amounts of energy in the process.

Introduction

Anecdotal evidence suggests that a great deal of the energy consumption of residential consumer electronic devices occurs when these devices are actually left on but not in use. Technologies are being developed to control the devices so as to reduce their power consumption. One such technology is being developed by Embertec, a device that can monitor and control the energy use of devices such as televisions and personal computers, and their peripheries. Embertec had sponsored a small field trial of their technology which produced significant findings regarding energy usage by residential audio visual and computer equipment. The methodology of this field trial and its results are presented below.

Methodology

The approach adopted by EnergyConsult in undertaking this field trial was to develop a process which required no change in householder's interaction with their devices whist providing a detailed understanding of equipment usage patterns in the home. This approach would achieve significant clarity on household device usage trends in AV and PC domestic environments.

The field trial was undertaken over a 3 month period and covered some 38 installations. 20 households were involved with 19 AV and 19 PC environments monitored for a period of between 1 and 2 weeks each. Over 4GB of energy usage data was acquired during the trial allowing for detailed analysis of household power usage in AV and PC environments.

The trial involved two stages:

1. The first stage involved the validation of the functionality of the energy saving device within the first 5 households, over a two week period, and conducting a pre/post test of the impact of the Embertec device. The Embertec device was installed and set to log mode (where the device was not enabled, but could record infrared (IR) signals, power, cumulative energy and time at one second intervals). This enabled the functionality of Embertec device to be established and the pre-installation energy usage of the measured devices to be measured.

   At the beginning of the second week, the Embertec device was switched to controlled mode. In this week, the connected equipment was controlled according to the functionality of the Embertec device. This enabled pre-installation and post installation measurement data to be collected and compared to the monitoring only measurement methodology used in the second stage.

2. The second stage applied to the next 15 households where the Embertec device was set to log mode, and equipment connected to the energy saving device was again monitored. In this situation, the Embertec device was monitored to record when the energy saving mode was enacted (i.e., the power to the connected equipment was switched "off"), however the Embertec device was intentionally configured to not turn off the equipment but to monitor when it would have isolated power to the connected devices. This enabled the real time monitoring of power consumption and energy savings while the energy saving device simulated actual operation. Operation was monitored for periods of 1 to 2 weeks, with an average of 8 days.

This logging approach allowed the monitoring of the actual power consumption trends in fifteen houses, and the potential impact of the device, without distorting the equipment usage characteristics of the household by the energy saving device itself. This significantly reduced the potential measurement error that could occur with alternative methodologies and may be a useful approach to use in future studies of the energy impact of energy savings devices.

Robustness of Data

The data collected for this study was extensive. The data collected included the following:

1. Measurements of the power use, voltage and power factor for each item of equipment connected to the AV and PC environment were made using a power meter (SparoMeter from Denmark). The power use in each relevant mode (in-use, active standby, passive standby and off) were measured and recorded for each household at the start of the field trial.

2. Detailed one minute logs of average power use (watts) and time (date/hour/minutes) were recorded and downloaded from the data logger (OmégaWatt from France). This data provided very accurate average power of the equipment connected to the energy saving device.

3. Very detailed one second logs of the power (watts), energy use (Wh), energy savings (Wh), infrared signals and time (date/hour/minutes/seconds) were recorded on laptops connected via the serial port to the Embertec device.

4. Households were surveyed about their use of each PC and AV equipment in terms how long (hours/day, days/week), time equipment is usually switched off, and how the equipment is turned off (button, remote, software, never, etc). In addition, socio demographic data was collected on each household.

Measurements of the power consumption recorded by the Embertec device were correlated with the measurements of the data loggers and found to be within 2%, which confirmed the accuracy of the Embertec device for recording data. The data loggers were also calibrated with a Yokogawa Power Analyser before the field trial was undertaken and their accuracy was confirmed to be within 2%.

Applicability of Household Sample

The aim of this study was to sample a range of typical Australian households but the analysis revealed that the sample was slightly biased towards the higher income groups. Analysis also revealed the sample was biased towards a slightly higher representation of appliance ownership than is the case for the average Australian home, due to an over representation of high income households. However, the main types of appliances measured in the sample for the most part fits the norm excepted to be found in Australian homes, with notable exceptions being an over representation of televisions, laptops and laser printers. The existence of multiple AV and PC systems in the sampled households should not have affect the results of this study though as measurements were only made of the power use of the central AV or PC systems in each household.

Analysis

The analysis approach required the detailed assessment of power use over time combined with the information on the power use of the individual equipment. The actual measured time of use of the equipment was compared and correlated with the stated use of the equipment, as derived from the householder surveys. This enabled an intricate analysis of the typical power use for each electronic AV or PC device for each minute, for the duration of the field trial.

The analysis used standard definitions of power modes and in addition, the active standby mode was further defined as present when:

For AV Equipment, after no user (IR) activity was detected for a period of 1.5 hours

For PC equipment, after the power use of the PC box was stable for a period of 30 mins.

So power usage in the active standby mode typically occurs when the user has moved away from the device or accidently left the device on. This is evident in both the PC and AV environments as shown in the following figures, where passive standby mode and active standby mode is shown by the arrows (with the width of the arrow indicating the time in the mode).

Figure 3: PC Power Use Example from Field Trial

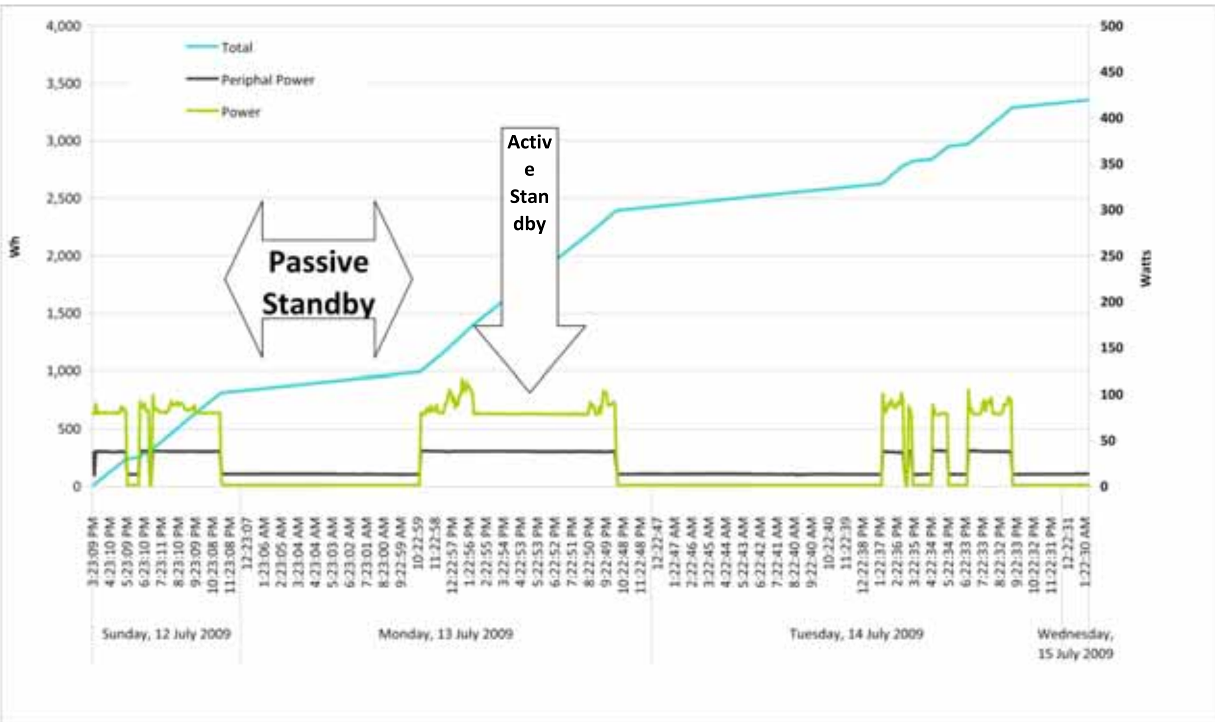
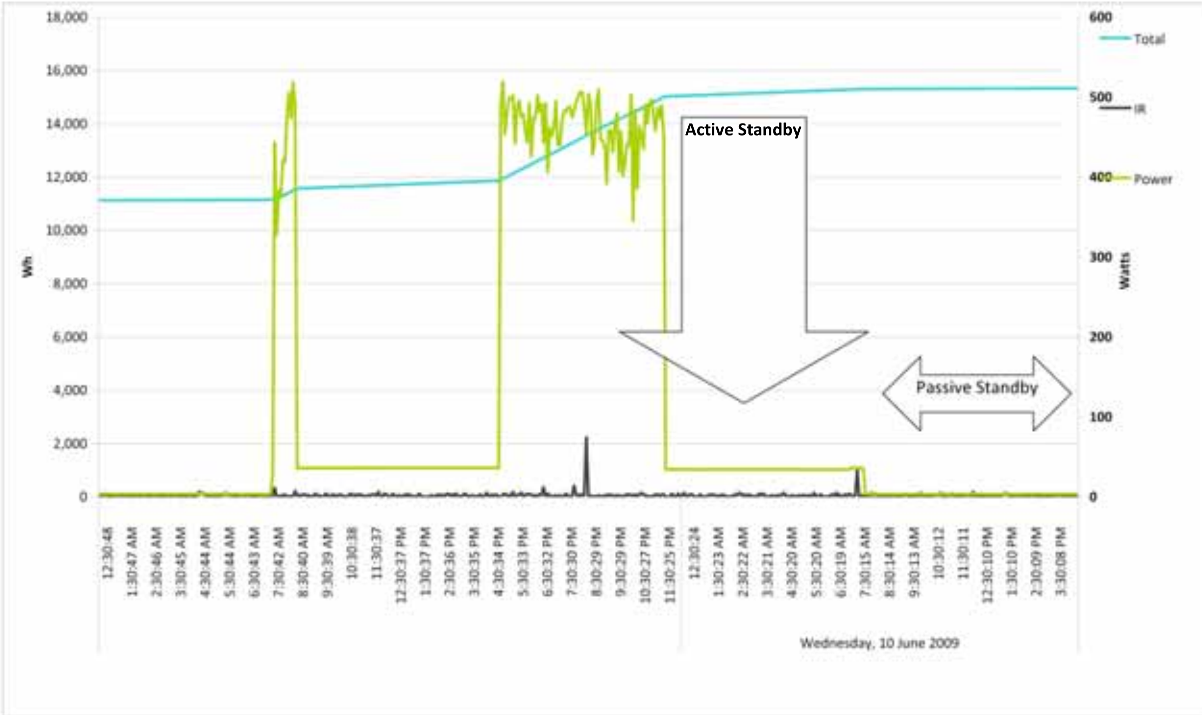


Figure 4: AV Power Use Example from Field Trial



Results

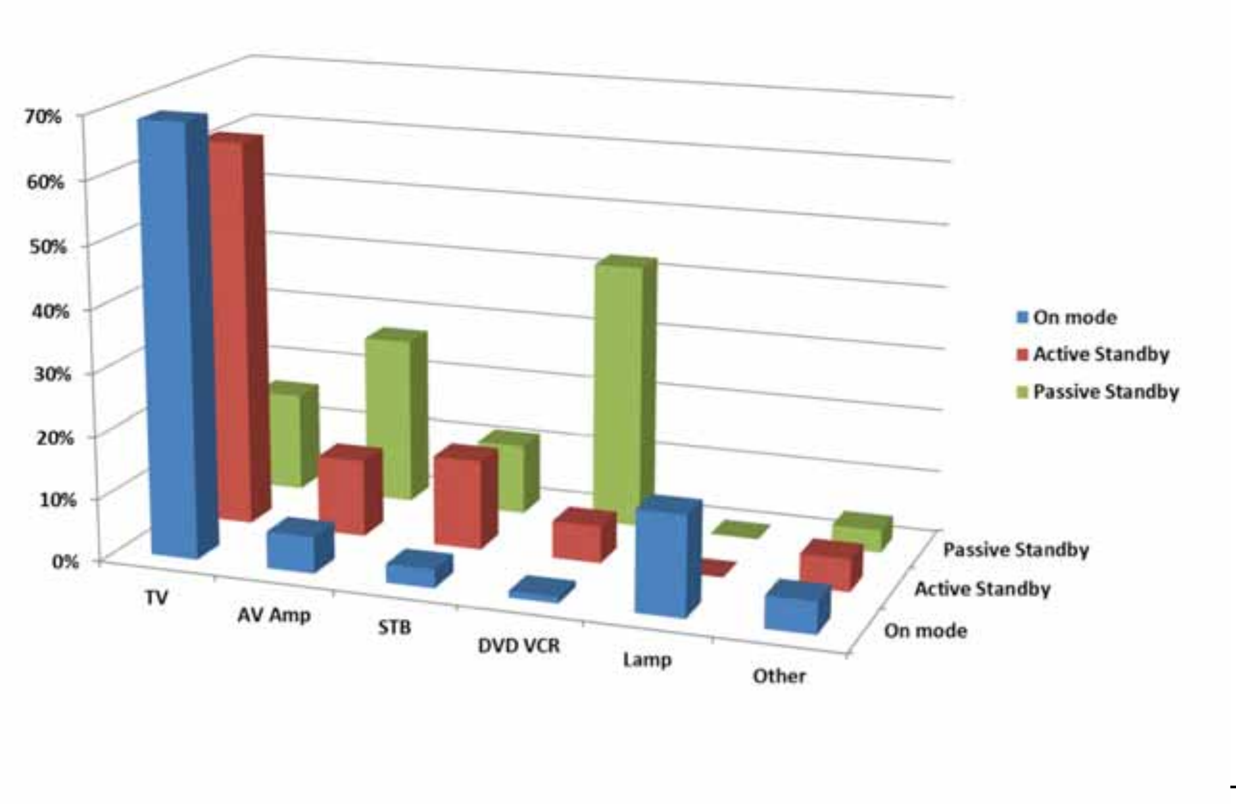
The data was analysed to determine the time spent in the various power modes and the power consumption in those modes. The average time by mode and the average power for all equipment powered in the AV environment is shown in ***Table 1***.

Table 1: Average Power Use and Time in Mode for AV Environment

	In-use	*Active Standby*	*Passive Standby*	*Off*
Time by Mode (hrs/day)	5.5	7	9.5	2
Average Power (W)	382	214	16	0

The average active standby power energy consumption is predominately related to the TV (62%), STB (14%) and AV receiver (12%). The passive standby power energy consumption is mostly related to DVD players/recorders (42%) and AV receivers/stereo/amplifier (27%). For each of the modes, ***Figure 5*** shows the average share of total energy consumption by device type.

Figure 5: Average Share of Mode Energy Consumption by Device Type



The amount of time, average power and energy consumption in various modes for the PC environment was also assessed for the field trial participants. ***Table 2*** presents the average time and power use by mode for all PC equipment located in the PC environment.

Table 2: Average Power Use and Time in Mode for PC Environment

	In-use	*Active Standby*	*Passive Standby*	*Off*
Time by Mode (hrs/day)	2.9	10.0	11.1	0
Average Power (W)	158	159	28	0

The proportion of energy use by PC equipment is separated into the "PC box" and the PC peripherals (monitor, printers, routers etc). The proportion of power use by PC peripherals represents about 53% of the total energy consumption of the PC environment.

The results were then analysed to determine the energy consumption of the devices in the PC and AV environment by mode of use and to estimate the annual energy consumption in each mode. The field trial results of household energy use in both the audio visual (AV) and personal computer (PC) environment are summarised in ***Table 3*** below.

Table 3: Average PC and AV Energy Use by Mode

Environment	**Energy Use by Mode**	*All Modes*	*In-Use*	*Active Standby*	*Passive Standby*
PC kWh	**pa**	857	448	290	77
	Percent Energy Use	13%		68%	19%
AV kWh	**pa**	1,370 767		548	55
	Percent Energy Use	56%		40%	4%

Source: Analysis of 20 households AV and PC environment power consumption

The overall estimated annual energy consumption in ***Table 3*** includes all the energy used by all the devices connected in the PC and AV environment. It is important to note that non-AV or PC equipment, such as desk/table lights, was also powered in this environment and hence recorded as the field trial total results as the objective was to measure all devices that could be controlled by an energy saving device. The average load of these non-PC/AV devices contributed 150 kWh pa to the PC environment and 192 kWh in the AV environment.

The results indicate that active standby power consumption is a major contributor to energy consumption for both PC and AV equipment, and leads to the majority of energy consumption in the PC environment. Passive standby energy consumption is also quite significant in the PC environment.

Conclusions

There are two important conclusions that can be drawn from the field trial, these being that:

- Active standby power consumption is a major contributor to energy consumption for both PC and AV equipment, yet the main focus of standby power savings programs have been on reducing passive standby power consumption; and
- Intrusive household surveys which undertake detailed metering and data-logging of appliance energy usage, can provide unprecedented insight into residential energy usage and potential for standby energy savings.

The field trial did not simply look at total power consumption over a period of time but more importantly monitored second by second the power usage levels of AV and PC devices in the targeted environment in addition to numerous other operational parameters. This approach has provided insight into the importance active standby energy consumption has in residential energy consumption and also has provided probably the most detailed assessment of power usage trends ever recorded in a residential field trial in Australia. The field trial sample has provided highly accurate time of use information that has not been assessed in other studies in Australia and should provide a high level of confidence in the measurement accuracy of the results acquired during the field trial.

The key limitation of the field trial is the relatively small number of households involved in the trial and the potential bias in terms of the number and nature of AV and PC equipment in the homes. This limitation can be overcome by undertaking a field survey using a larger number of households, combined with a telephone survey of a statistically representative number of households. By correlating the survey instrument with the field results, it will then be possible to draw reliable conclusions regarding the Australian populations AV and PC appliance usage and residential energy consumption.

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