Standby energy: building a coherent international policy framework – moving to the next level

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Abstract

Ownership levels of consumer electronics continues to grow and changes in the design and features of appliances and equipment have resulted in the prevalence of energy consumption when the product is not in use. These products are now ubiquitous and, while individually their energy consumption is modest, collectively they consume significant electricity.

Standby is a difficult policy area as the range of possible equipment types and associated modes is enormous. The problem has been tackled in various ways in the international arena. The IEA has coordinated action towards a 1 watt goal. Korea has committed to mandatory 1 watt standby levels for many products by 2010. Australia has a comprehensive national strategy which includes voluntary short term targets and mandatory measures to 1 watt by 2012. Japan has included standby into some of its Top Runner levels. Europe is investigating a possible horizontal standby requirement as part of the Eco-design directive and has a number of voluntary agreements with industry. The US has the Presidential Executive Order for 1 watt for many products. New work is commencing on standby within the Asia Pacific Partnership.

So what is the best policy approach? Which countries have had most success and why? Which policy frameworks appear to be most effective? This paper provides an assessment of all of the relevant policy tools which have been implemented and proposed to date and provides a possible new framework for a coherent international framework for redressing excessive standby energy into the future.

Introduction

The energy consumption of major household appliances is generally well understood. Many of these products are now regulated in many countries for energy efficiency through programs such as energy labelling or Minimum Energy Performance Standards (MEPS). However, there is a significant proportion of residential sector and commercial sector electricity consumption, most commonly called "miscellaneous end uses", that is not well understood or documented. A substantial share of this energy consumption can be classified as standby energy. This is estimated to be growing and could reach nearly 30 % of residential electricity consumption in the USA by 2030 (Ecos, 2006).

Standby energy was really only identified in the mid 1980's. With the advent of consumer electronics and changes in the design and features of appliances, low levels of power consumption have become more prevalent when the product is not in use. There are also many products which are designed to operate on a continuous basis at low power levels and which provide functions such as monitoring (e.g. smoke alarms, security systems, telecommunications and network equipment). These end use products are now ubiquitous and although individually their power consumption is small, collectively they consume a significant amount of electrical energy. While these devices offer increased flexibility, versatility and in many cases improved performance, many also result in power consumption when they are not performing their main function. Such energy consumption is generically described as "standby energy" but it includes a range of modes from "off" through to "on" as well as continuous loads, depending on the product and its function.

Standby energy is now one of the largest individual electrical end uses in the residential sector (more than 10 % in Australia) (EES, 2006a) and is probably equivalent to the energy consumption of refrigerators and freezers in many developed countries. Studies have confirmed that standby energy now represents one of the end uses with the largest potential energy savings in the residential sector.

While the amount of standby energy varies markedly between countries, in part due to the different penetration of appliances but also to some extent due to differences in their standby attributes, the global energy consumption from standby has been estimated by the International Energy Agency (IEA) at between 200 TWh and 400 TWh per year (E3b, 2006).

There is growing international concern about the impacts of all energy consumption on climate change. Even though the level of current information on standby power attributes for many products is poor, there is a need for urgent action to reduce standby energy. Attention focused now on the design and performance of products will ameliorate future standby energy contributions to global warming.

Standby power is a term used widely and loosely in policy circles and generally refers to the power consumption in one or several low power modes. In this paper 'standby energy' is used in the broadest sense to mean the energy consumption during normal use over all relevant low power modes, primarily when the product is not performing its main function. In some cases, however, it also includes a range of small continuous loads (such as clocks, alarms, monitoring systems) which are often excluded as they are considered to be "on" rather than in standby (ie performing their main function). However, such products can easily and appropriately be included within a broad standby policy approach as their design and function resembles low power modes for many other products.

The international test method IEC62301 provides an agreed method to quantify the standby power attributes in a range of low power modes. It currently defines the term "standby power mode" to mean the lowest power when connected to the mains electricity supply. However, this is likely to be modified in the near future to better reflect the normal range of low power modes found in many products.

Ultimately it is the energy consumption in such modes rather than the standby power attributes that are of concern.

The nature of the problem

In the past, electrical products were generally a simple design where the product was either performing its main function (on) or was not (off). Historically, controls tended to be electromechanical in nature and consequently most circuits within the product were mains voltage. Under safety standards, this meant that the product was usually required to have an "off" switch which disconnected the mains supply at the point of entry to the product. Hence, when the product was not in use, the power consumption was zero.

Researchers first noticed that some products appeared to consume power when they were off in the mid 1980's – more than 20 years ago. In fact, the 20th anniversary of the discovery of standby was in 2006. However, the number of products and the power consumption levels at that time were of little concern from a policy perspective.

The television provides an interesting example of the evolution of standby energy levels over time. While the first wireless ultrasonic remote control was released in 1956 by Zenith Radio Corporation[1], the first battery powered remote controls were only available in the 1960's. However, it was not until about 1980 when infra-red remotes were developed that the cost of remote controls for televisions fell dramatically and they became more widely available. Even at this time, the cost of producing remote controls was significant and they were generally only available on premium models. By the early 1990's remote controls had become a standard feature for most televisions and in 2005 in Australia, more than 95 % of models offered for sale now have a remote control as a standard feature (Energy-Consult 2006).

The presence of a remote control in a television meant that the unit consumed power when not performing its main function. This was necessary as a low voltage power supply had to be energised to allow the infra red sensing circuitry to remain active so it could receive a signal from the remote control. Initially, the standby attributes for televisions were fairly poor – typically of the order of 15 Watts or more in the early to mid 1990's. The high power consumption for such a simple device was primarily a lack of a high efficiency low power DC power supply and a lack of understanding and concern by manufacturers. Curiously, televisions which operate on 230 V supply (for example Europe and Australia) also tend to have a "hard" off switch with close to zero power consumption in this mode (although the remote control is inoperable in this state) – this is likely to have an historical original in regional safety standards. Some countries with a 110 V supply (for example USA) tend not to have a hard off switch meaning that the remote control (and the associated standby energy) is active at all times when not in use.

The other influence in the mid 1990's was the more ubiquitous international requirements for electromagnetic compatibility (EMC). Most products are now required to meet specified levels of immunity and interference; this means that products have to be robust enough to be unaffected by certain levels of harmonics on the electricity supply system and conversely are not permitted to inject more than a specified level of noise or harmonics back into the supply system. This is usually achieved by the provision of mains filters within the product. However, many of these consume power if they are left connected when the product is off or in standby (when they are typically not required) – such configurations can usually be considered as poor design. While their power consumption is usually modest, it can be of the order of 0.5 Watts whenever these are connected.

What is technically achievable?

Happily, the passive standby (remote control active) power consumption of televisions has been falling steadily for the past 10 years and the average value for new products is of the order

1. The first wireless remote control was called the "Zenith Space Command". The man credited with its invention, Robert Adler, was a Viennese-born inventor with a PhD in physics who emigrated to the US shortly before World War II and spent 60 years with Zenith Electronics Corporation, retiring officially as research vice-president in 1979 but he continued as a technical consultant until the age of 85 in 1999. He died in February 2007.

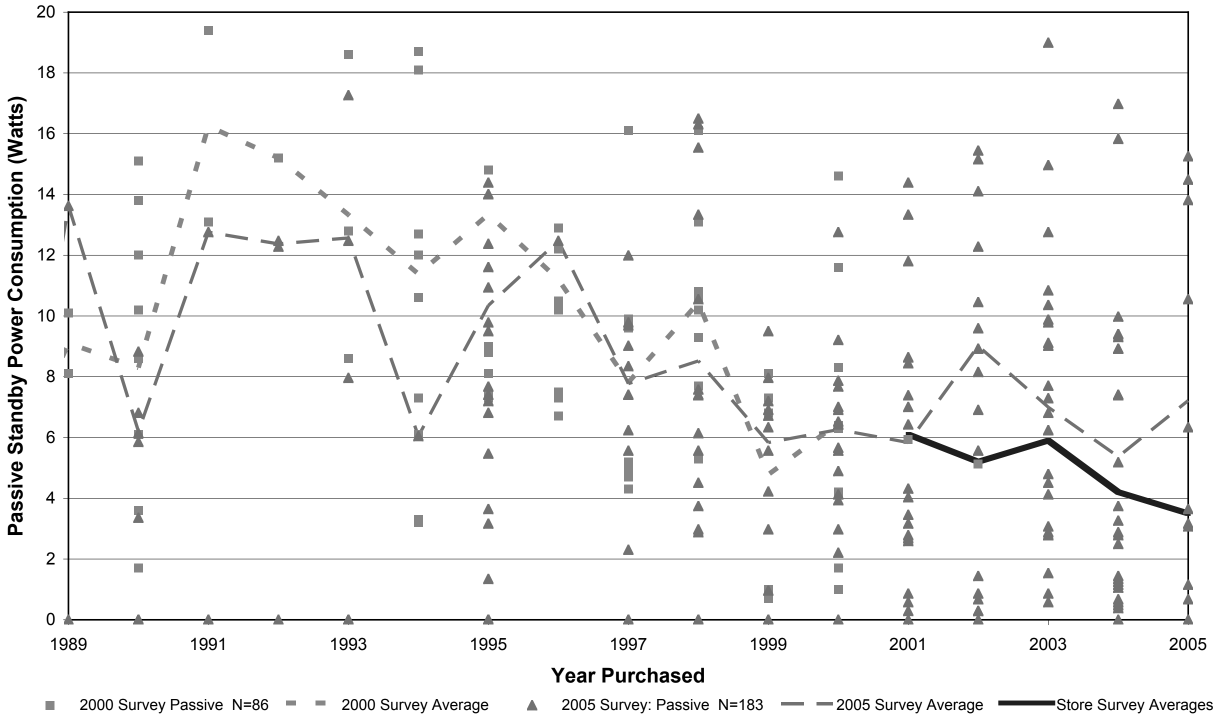

Figure 1. Passive Standby Readings from Australian Televisions

3 Watts in Europe and Australia (see Figure 1 for trends). This is probably a result of improved designs and components as well as pressure from governments to reduce standby energy consumption. However, despite the improvements in this product, there is still a long way to go.

Measurements undertaken in 2004-2006 on 110 televisions offered for sale in Australia showed that while the average passive standby power attribute is 3.5 Watts, there is still a large distribution of power consumption in the market place as illustrated in Figure 2 (includes surveys 2001 to 2006). Some new products were found with a power requirement in this mode as high as 12.7 Watts in this mode while products with the lowest passive standby power attributes are around 0.1 Watts. Most amazingly, the functionality of these devices is exactly the same. Of some concern is that less than 20 % of products have passive standby power attributes of under 1 watt. However, even lower power levels are achievable. Some manufacturers have demonstrated televisions with a passive standby power attribute of less than 0.1 Watts, below the resolution of many field power meters. Low loss DC integrated circuit power supplies have been commercially available for many years from companies such as Power Integrations, with one of their latest products offering a no low power loss of 30 mW, a component cost of less than EURO 0.01 and a consumer payback of a few months (Balakrishnan, 2006).

Another issue that has influenced standby energy levels is the huge advancements in electronics over the past 20 years. Electronic controls are now the norm rather than the exception. Electronic circuits may require one or more low voltage DC supply rails within the product, depending on the function, which run circuits when the product is on as well as any functions that are required in low power modes (remote controls, clocks, memory retention, soft touch switches, monitoring and other controls etc.). These power suppliers may be designed to supply 10 W to 100 W in on mode and are also often used to supply power to standby functions when the product is not operating. Such high output power supplies would typically have significant no load power losses. However, elimination of the majority of such losses is simple through the use of dual power supplies: a small unit with low no load losses for residual standby and low power functions and a larger unit to supply the unit when operating. The latter is disconnected from the mains when it is not required. Of course, to achieve low standby levels will require some design changes in the product to optimise these configurations, but these are relatively straight forward.

Another interesting development is the increasing use of external power supplies to power many electronic products. External power supplies are usually sourced from third party suppliers and provide a convenient and low cost way of powering products for a wide range of markets with different plug configurations, mains power voltages and frequencies. The vast majority of external power supplies are manufactured in China (more than 1 billion per year). Generally, external power supplies are sourced on the basis of their rated or maximum output which is designed to meet the power requirements of the supplied product in its highest operating mode. This of course means that when the product is in a lower power state, the external power supply will be well below its rated output. Many power supplies are also oversized to supply even the maximum power requirements of the product. At low power levels the no load losses of the external power supply (which are generally a function of maximum power output) tend to dominate the power consumption. So even though a product may require only 0.2 W or less in a low power mode, the external power

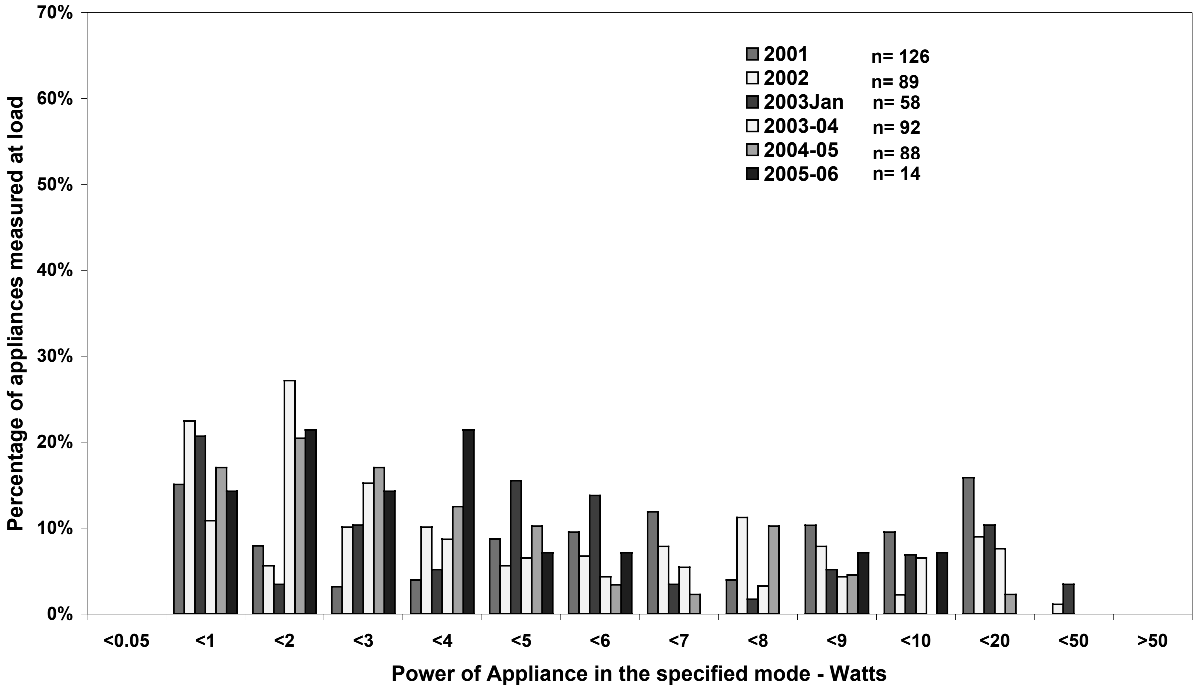

Figure 2. Distribution of Passive Standby Readings for new Televisions in Australia, 2001-2006

supply (which may be rated for 50 W or 100 W output) may have a no load power loss of 2 W to 5 W. While it is technically possible to design external power supplies with dual power outputs for high and low power states, the range of potential different power input requirements in different modes for different products means that such configurations may have to be custom designed in the short term, until some sort of standardised interface and/or design specifications are developed for both external power supplies and end use products. This is an area where some standardisation may be warranted.

Since low or even negligible standby power attributes are already technically achievable for many products, why have these not been implemented on a large scale of it own volition? Even more importantly, why do many product types have deteriorating standby power attributes?

Failure of standby information

In general terms, there is very little information on power consumption in various low power modes for most products. Manufacturers are starting to provide this information on their product brochures, websites and user manuals, but this is still fairly uncommon. So by and large, there is very little information that is readily available to the consumers on standby power attributes for most products. Government and NGO awareness programs have increased awareness of standby power, however some consumers find it frustrating that it is difficult to obtain information for comparison purposes.

Some policy makers advocate the provision of information on standby as a policy tool to reduce standby energy in the market, as is the case for mainstream programs such as energy labelling of major appliances. However, there are some fundamental problems with this approach.

While the power consumption in various low power modes of many products is significant, the level of this power needs to be kept in perspective. Typically the worst standby power attributes are of the order of a few to 10 W or even 20 W, depending on the product. Even if the product is assumed to be constantly in a single mode, at 1 Watt, the total power consumed is 8.76 kWh per year at a cost of around EURO 1 per year in many countries. Even at 10 Watts, the power consumed is worth perhaps EURO 10 to EURO 15 per year. Differences in annual operating cost of a few EURO per year for products that may cost several hundred or several thousand EURO to purchase is not likely to be a big influence on the purchase decision. Other factors such as performance and features are likely to have a much stronger influence.

Therefore, an emphasis on standby energy consumption may distract from more significant aspects of energy consumption. The share of total energy consumption from various low power modes is highly variable at a product level and in some cases is highly dependent on consumer usage profiles. Even for a single simple product like a television, the energy consumption in passive standby mode can be less than 1 % to more than 50 % of the total annual energy consumed, depending on the product attributes and the assumed usage profile (around 5 % to 10 % in secondary modes is fairly typical). Typical consumer usage varies substantially by product type, but even within a product type there is often a huge distribution of usage patterns. Conveying such information in a meaningful way is complex and could be potentially misleading.

At another level, it may be undesirable, for example, if consumers were encouraged to purchase products with low standby energy where the on mode efficiency was poor – this may result in an overall increase in energy consumption. There are selected examples where it may make sense to consider standby energy in conjunction with on mode energy consumption (see vertical policy approach below), but these are generally limited to products that use significant energy (in all modes) and where regulation or other program measures make sense in any case.

Studies in Australia have shown that standby energy (in the broad sense) is responsible for as much as 11 % of electricity consumption in residential households (EESa, 2006) based on detailed measurements in 120 homes in 2005. A typical house in Australia in 2005 was found to have 67 different individual products that ran on mains power (this ranged from a low of 16 items to a high of 136 items for the houses surveyed). On average, 48 of these were plugged in to the mains at any one time and of these some 27 consumed some power in the mode in which they were found or in their lowest mode (if they were found in the on mode). The average power consumed by these products was a total of 90 Watts (an average of over 3 Watts each). There were a few products which had a number of possible modes where consumer behaviour could influence the overall energy consumption of the product. For example, about 50 % of televisions in Australia were found in passive standby mode (remote control active) and about 50 % were off[2] (despite some local campaigns to switch televisions to off mode when not in use). However, this was one of the few products where a lower mode was available on the product. In most cases the only way to reduce standby energy further from the state found was to disconnect it from the mains. While this can be organised by more enthusiastic consumers (e.g. power strips for computers and peripherals), in many cases disconnection from the mains is awkward (difficult access) or not practical (having to reset functions such as memory and clocks). Experience in Australia from household surveys in 2000 and 2005 is that consumers are concerned about the magnitude of standby energy but become rather distressed when they discover the limited potential to reduce the levels in their own home.

In Denmark there has been some limited success in the modification of behaviour to reduce standby energy (Gram-Hanssen & Gudbjerg, 2006) but this requires careful documentation and metering of equipment, as well as motivation from the householders. It is not clear how persistent such behavioural changes would be in the long term. The Europeans have also had success in the use of technical devices to reduce standby energy of existing products (power strips with USB connections to computers, devices that detect non operating power and turn the product off), but these are only worthwhile when targeting clusters of products which collectively have high standby power attributes such as computer peripherals and home entertainment equipment. Again these technical devices have limited potential to reduce standby energy across the board and are likely to be much less cost effective than steps to improve the standby energy consumption attributes of individual products themselves, which should only cost a few Euro cents per product.

The crux of the issue is that at an individual product level, standby energy appears small or even trivial. However, when considered collectively, standby energy is now one of the largest single end uses in the household. In Australia, standby energy now accounts nearly as much energy consumption as the total stock of refrigerators and freezers. Ironically, these products have been regulated for energy labelling for more than 20 years and MEPS for more than 8 years, yet we are only in the early stages of addressing standby energy.

Split Incentives

So, if the technological tools to reduce standby energy (in most cases to negligible levels) are readily available, why aren't these being used by manufacturers? Probably the single largest factor is the age old policy failure of split incentives. Manufacturers and suppliers operate in a highly competitive (and often global) market place and there is intense pressure to deliver the maximum performance at the least cost. This generally means that any cost increase of the product, even if this is much less than EURO 1, is generally strongly resisted, unless there are clear marketable benefits. There is no benefit for the manufacturer to make the product more expensive to reduce power consumption - if the product has poor standby power attributes, it is the consumer that bears the cost of ongoing energy purchases of this, not the manufacturer. Energy consumption is largely invisible to the consumer except through programs like energy labelling.

Even if good information on standby power attributes was available to consumers in the market place, the impact of this is likely to be too small to be of significance in the decision making process in most cases. The negligible energy and small annual cost of standby power for an individual product provides no incentive for manufacturers to use low standby power attributes in their marketing material or as a point of difference (hence there is little market pull potential to encourage low standby power designs). The transaction cost of taking this information into the purchasing decisions for the 20 or 30 products that may use standby energy in a typical home over a purchasing cycle of 10 years is likely to be far too high. In short, standby energy is typically too trivial at an individual product level for the consumer to build it into their decision making process. But collectively, consumers pay the cost of high standby energy that arises from poor product design.

It appears that some form of policy approach to reduce standby energy is warranted, but the relatively low energy consumption per product, the large number of product types and product numbers (sales volumes both now and in the future) mean that we need to rethink our policy approaches to deal with this issue. However, before exploring this concept further, an appraisal of what we actually know and current policies on standby power attributes around the world will provide insights into what is effective and what is not.

Policy versus reality: what are the trends in standby power attributes?

Curiously, while some standby information on some products is available, there is little coherent information available around the world that provides a clear picture of overall trends in standby energy. Some countries have good information on the current status of some products, but there is a paucity of solid information on product trends over the past 5 years or more. Good data on trends is necessary to make reasonable estimates

2. Note that off mode is only applicable where there is a hard off switch. Most US televisions do no have an off switch.

of standby energy consumption of the stock of products in use. Even in Australia, which has been assiduously collecting data every year on new products since 2000 (together with two detailed household surveys of the stock of products installed), the trends at a product levels are not always clear (EES, 2006b).

There are several complications in determining the trends in standby energy. The first is that many products have a number of possible modes and generally speaking there is poor data on the usage patterns of products which dictate the frequency and duration of these modes. For a simple product like a television, for example, there is reasonable data on the average hours of use through the collection of data on viewing habits of consumers (which is driven by strong commercial interests such as advertisers). But even this simple data is not applicable to multiple televisions in the one house – it is recognised that viewing patterns of second and third televisions in the home are quite different to the primary television. Most developed countries now have a television ownership of 2 per household and this continues to increase (Harrington et al, 2006). Even if we know with great certainty the hours of television watched per week, little data on the frequency and duration of the relevant low power modes (when not in use) is readily available. (Outside of North America, many televisions have both an off mode and a passive standby (remote control active) mode). Determining the share of the relevant low power modes is fraught with difficulty.

Undertaking a face to face or phone survey of how consumers leave their products when not in use results in potential bias as many consumers are aware of the standby issue and may feel guilty about leaving their televisions in passive standby mode, for example. Intrusive surveys that record the mode of the product "as found" are more reliable, but this approach really only provides a random snapshot of the most common modes. The only reliable method to determine total energy consumption is end use metering at a product level over a substantial period (such as a year or more). Even where this data has been available historically, it is generally of little use as almost all end use metering devices used for such studies have a minimum power resolution of the order of 5 watts, well above the typical low power levels of relevant modes for many products. An extensive metering campaign in Sweden at the moment is one of the first to use meters with good low power resolution that will provide detailed information on the time and energy consumption in various low power modes in due course (Bennich, 2006). However, since some of the attributes influencing consumption are local, this will provide the most authoritative understanding of the situation only for Sweden. In the USA some limited monitoring of 50 houses for a period of 2 weeks has been used to obtain preliminary data on usage patterns for a wide range of household products (Ecos, 2006).

The issue of usage patterns is less complex for products that have few relevant modes or even one dominant mode. However, more complex products like home entertainment equipment can be very difficult in terms of determining frequency and duration of all relevant modes. Some products have power management as well, which needs to be understood when developing such estimates. Products like European style washing machines and dishwashers have two relevant modes – off and "left on" (where the user does not manually turn the product off when not in use). These modes are well understood and there is now reasonable data available on the typical power levels of each. However, getting information on the frequency and duration of each mode in the field is very difficult. Even low power end use metering equipment can be difficult to interpret unless power levels of all the relevant low power modes are known prior to long term monitoring for each individual product monitored.

The other difficult aspect of determining "trends" (long term changes in a product attribute) is that there is a large and ongoing change on the mix and types of products on the market. Increasingly the boundaries between certain products types are starting blur as well. Consider the DVD player. This started as a simple stand alone product to play DVD discs. Then a DVD recorder version appeared, and now there are devices with hard drives and a tuner to record programs from television broadcasts. These devices have started to replace VCR recorders, which are now almost obsolete. The conversion to digital television broadcasts has meant that there are a range of devices with hard drives and digital tuners to assume the role of a VCR and set top box combined. The advent of new high density formats such as Blue Ray mean that more variations are available. Many of these high end products can edit video, burn discs in a large variety of formats, can act as a music players, have USB, firewire and LAN connections and can stream music and video over a wired or wireless network. Consider also the new media centres which are a PC and display device which is used as television, set top box, DVD player and hard disc recorder. Many PCs now come standard with a television tuner. Even the range of televisions is now confusing with analogue tuners, digital tuners, some with both, and some have none (technically monitors, but they are used as televisions). So called IPTV (television delivered through a broadband connection) adds another dimension to this once simple product. We now have refrigerators with LCD screens and internet connections, appliances with home network connections, and air conditioners with remote communications capability. All of these variations make defining products and therefore tracking trends in standby difficult – do we treat each variation as a variation of an existing product type or as a new product type? How do we deal with such different levels of functionality? Some products many only remain on the market for as little as 5 years before becoming obsolete. Care is required to make sure we are comparing apples with apples.

Given the rapid changes in technology and product variations, it is little wonder that the overall trend on standby energy is somewhat unclear internationally.

Consider the humble microwave. There are currently two main versions available on the market: one with a mechanical timer (less common) and one with electronic controls and clock display. Most mechanical timers have low power consumption in off mode (most are close to 0.1 watts or less) but some are as high as 2 watts. On the other hand, electronic control models on average have a passive standby power attributes of around 2.5 Watts (low 1.2 Watts, high 5 Watts). Electronic control models have been improving over time and some are now available with an off mode (no display, some internal time functions and soft touch switches only). It is important during data collection that the characteristics of the product and mode being monitored be understood. A measured value of 1 watt would be poor for a mechanical timer but very good for an electronic unit with a display active, given the current state of technology. Mixing the modes (or comparing the lowest mode) across product types into a single average value for microwaves would be misleading, particularly if the product share of the two types varied a lot among countries or over time.

In an attempt to improve the level of information available around the world, Australia has launched an international project to track the low power mode attributes of a standard "basket of products", in much the same way as the cost price index (changes in the average prices) is determined by tracking the market prices of a range of standard consumer goods. It is hoped that the core data collected in Australia to date (some 6,000 new products offered for sale in stores and some 12,000 products installed in homes) can be augmented through a coordinated series of data collection efforts around the globe. A set of representative 12 core products has been developed and a data collection instrument and standardised data collection procedure has been developed (Standby Data, 2007) together with an additional 30 secondary products where data can also be pooled. Initial interest has been expressed by USA, Canada, China, Japan and Europe and other countries are encouraged to join the project.

The purpose of these standby measurements for a common basket of products is to allow national and international comparisons of like products across different countries and regions. Such measurements will highlight the magnitude of standby power and enable comparisons across different regions. They will track the effectiveness of the policy mix used in individual countries and highlight the best products in a number of categories.

Because information will be collected at an individual product level, differences among brands and models can also be examined. The information can be used to encourage manufacturers which supply products with good standby attributes and to pressurise manufacturers which supply products with poor standby attributes to make rapid improvements.

Eventually, the data collected will also provide trends in standby power attributes by product type over time so that the rate of improvement or deterioration can be quantified within and between markets as well as by product type and even brand.

Such improved information at a product level will assist national governments to formulate specific responses to the issue of standby energy. It will eventually allow specific manufacturers to be identified if they continue to supply products with poor standby attributes in selected markets. Such information is important for monitoring the market and for measuring program effectiveness, but it also underpins growing international cooperation on the standby issue.

Good data takes time to collect but it is clear that urgent action is required now on this issue. In an ideal world perfect policies would be developed on the basis of comprehensive information. Given the pressures of climate change and the rapidly changing market, we don't have this luxury. What is needed are sensible policies that are robust enough to give good outcomes while minimising the risks of failure or adverse outcomes. Policies can be adjusted and refined as data improves over time. This is widely understood and many countries have dealt with the issue in an expedient and pragmatic manner.

Policy matrix – different approaches by country

Since the launch of the IEA's aspiration 1-Watt target in 1999, the issue of standby power has gained an international profile. In countries most which have an energy efficiency policy, standby power is now an important component. Almost all recent national policy statements mention standby power explicitly, which was not the case 2-3 years ago. Follow-up processes to the G8, Asia Pacific Partnership, APEC and the Commission on Sustainable Development Marrakech accord have all called on Governments to make a greater commitment to the IEA 1–Watt standby target and other programs to tackle standby power.

However, while there has been a steady growth in the implementation of national programs, the geographic and product coverage is still sporadic. This is despite regular international conferences designed to share up-to-date information and provide co-ordination of activities. Most recently these have been held Copenhagen (2005), Seoul (2005) and Canberra (2006), At the last meeting it was proposed that future conferences should be held in China, India and Brazil in order to stimulate policy development in major developing countries.

A summary of current programmes is shown in Table 1, illustrating the spread of policy responses to standby. It should be noted that this does not indicate the number of products covered by each type of policy. In all, there are standby policies for 41 different products, although of these about 15 are included in at least four countries.

The voluntary endorsement label, Energy Star is the most wide-spread program which targets standby power consumption. In a significant new development, the upgraded specifications for computers and imaging technologies are largely based on test methodologies which take account of all modes in a duty cycle. Similarly, the mandatory Australian energy label for dishwashers and clothes washers now specifically includes standby power as well as on-mode in the determination of the annual energy and star rating.

A number of countries have adopted regulations, and several are actively considering regulatory approaches to standby. Australia, Korea and Taiwan have indicated that they will implement regulations for standby power consumption for many products over the next few years. Australia has announced its intention to introduce a uniform 1 Watt requirement for all electronic appliances and equipment by 2012, starting with home entertainment equipment. A number of products are effectively 'regulated' in Japan through the Top Runner program. The US DoE is working on new national regulations for some electronic appliances which will include standby power, although there is no implementation date.

In Europe, the voluntary Code of Conduct has been expanded to cover standby power in external power supplies, set-top boxes and broadband modems. The EU Eco-Design Directive provides the opportunity to introduce standby regulations in Europe, although this is unlikely to come into force before 2008.

There are a number of databases of energy efficient products, some including standby levels, which aim to provide information to procurers/consumers. The US, Korea and, most recently, China have mandatory government procurement policies for energy efficient appliances (including standby requirements). It is not known how many other governments use this information, but there is anecdotal evidence that several governments use energy performance is a tendering criterion.

The international conferences and linkages made between policy-makers has helped to encouraged increased harmonisation of performance criteria for some products, notably external power supplies. In order to provide a mechanism for continual dialogue on harmonisation the IEA is proposing a new Implementing Agreement. One Standby Power Annex is intended as a forum to assist in implementation of a horizontal standard.

Current main policy options for standby energy

The policy instruments adopted vary, but the approaches to establishing criteria to date fall into several main categories as follows:

- set maximum permitted targets at a product by product level (voluntary or mandatory)
- integrate standby energy into the total energy consumption for the product – this is the so called vertical approach (voluntary or mandatory).
- set a uniform maximum level for all products across the board (such as the IEA 1 Watt target).

While each of these approaches has merit, they also have problems and limitations. These are discussed briefly below.

Product by product targets: The advantage of this approach is that clear requirements can be defined for each product. The requirements can take into account typical product designs and variations (functionality) and provide a basis for putting pressure on manufacturers to improve their products to meet the specified targets. Different targets can be set for different modes. However, there are several possible problems with this approach. The first is the sheer number of products which have to be considered, classified, analysed, documented and targets set and maintained. In Australia as many as 50 different product types make up 90 % of household standby loads in typical households, while the remaining 10 % is made up of many and varied products (a further 30 or 40 products). The law of diminishing returns applies – how many products (and what

Table 1: Summary of International Standby Policies

Region	Country	Adoption of 1 Watt Policy	Roadmap for appliances	Voluntary Agreement	Label	Database	Government Procurement	Regulation	Other
KEY				I = between individual companies G= industry-wide	V = voluntary M= mandatory	Db = searchable database facility	M = mandatory standby targets for government purchases	SWA = sales weighted average MEPs = minimum energy performance standard u/c = under consideration	WL = warning label u/c = under consideration
IEA: Asia-Pacific	Japan			G	V, M		M	SWA	
	Korea	●	●		V		M	MEPs u/c	WL u/c
	Taiwan	●	●		V				
	Australia/New Zealand	●	●	G	V, M	db		MEPs	
IEA: North America	United States	●			V	db	M	u/c	
	California (and other states)					db		MEPs	
	Canada				V	db			
IEA: Europe	EU			I	V	db		u/c	
	GEEA:				V	db			
	Germany				V	db			
	Nordic Countries				V	db			
	Denmark	●		I					
Plus 5	Brazil								
	China				V		M	MEPs	
	India								
	Mexico								
	South Africa								

share of standby energy) do we target? Already policies covering 41 products have been identified worldwide. Another more serious problem is that uniform targets for a particular product type requires a tight definition of that product and has the potential to stifle product innovation and performance. If a target is set on the basis of current products which may, for example, use only simple controls, a new product with electronic controls may perform better and use less energy overall but may not meet the specified low power targets and could therefore be excluded from or penalised in the market. Even within some product types, some designs result in fundamentally different modes due to different design approaches. A related problem is the continual introduction of new products onto the market (which require further analysis and new targets) and the morphing of existing product types, making historical targets irrelevant - or requires frequent re-definition of that product type. This is particularly problematic in the home entertainment area, but also for computer peripherals. In short, setting and maintaining targets at a product level is administratively burdensome.

Vertical approach: In the vertical approach the standby energy (in all secondary modes) is considered in conjunction with on mode energy consumption, typically for a defined or typical usage profile that is representative of normal use across all relevant modes for the product. Conceptually, this is the total energy consumption over a given duty cycle or usage pattern for a typical user. This allows standby energy to be considered as part of the total energy consumption of the product. This approach keeps standby and low power modes in perspective with total energy consumption for the product (standby may be a large or small share of total energy). Typically, vertical requirements work well where the total energy consumption of a product is significant and where it is already covered by regulation or where regulation is proposed as part of a program measure. For this approach to work adequately, a representative user profile, which covers the frequency and duration of all relevant modes (including "on" or in use), needs to be developed. Products that are already regulated for on mode (such as those covered by energy labelling and Minimum Energy Performance Standard (MEPS)) may lend themselves to this approach. The energy consumption of low power modes has been successfully incorporated into the dishwasher and clothes washer energy label in Australia and New Zealand (Harrington, 2005) and for the dishwasher energy label in the USA (Meier, 2006), but curiously, not for MEPS in the USA. This approach is also used for selected products covered by the Top Runner program in Japan including televisions, VCRs, DVD recorders and is also included in various ways for other products such as toilet seats, microwave ovens and photocopiers (EECJ, 2007). In contrast, the European energy label for wet products (dishwashers, clothes washers and clothes dryers) has not considered the energy consumption of low power modes to date and the current scheme does not lend itself to this approach as the energy label does not define the number of uses per year for these products, primarily because these vary substantially across the EU member states (only per cycle energy is shown on the label). A further issue with this approach is that usage patterns vary substantially for some products from country to country, leading to a different assessment of consumption in different markets. This may be problematic for manufacturers of internationally traded goods and governments who wish to see harmonised test and performance requirements – this why energy consumption in each mode needs to be separately measured and reported under the test procedure, as usage patterns will vary by country and even within a country there will always be a distribution of usage patterns. So there are a limited number of cases where a vertical approach will be functional and workable – typically for those products which warrant regulation in some shape or form on the basis of total energy consumption for a defined usage pattern.

Uniform targets for all products: Under this approach a flat target is set for all products irrespective of type or function. An example was notionally initially developed by the IEA as part of their 1 watt target for standby power attributes which has been adopted in Korea (KEMCO, 2005), Australia (Campbell & Macfarlane, 2006) and under the US Presidential Executive Order 13221 (Bush, 2001). Under these programs the maximum permitted power in standby mode is generally one watt, although there are sometimes some exceptions. This approach has simplicity as its key benefit. The uniform target is clear and it avoids the problem of product definitions and changes over time. The concept was that a standby power attributes of the order of 1 watt is small enough to be insignificant (although 30 products at 1 watt still equates to 250 kWh/year), so if a product meets the target, then it is deemed satisfactory. However, a uniform target (a one size fits all approach, if you like) does have some drawbacks. Such a target does not take into account how easy or how difficult it may be to achieve for particular product types – in general terms, it is a fairly blunt instrument. For products with only a simple off mode with no intermediate states, a 1 watt target is very easy to meet – a more realistic target would be 0.2 watts or less. On the other hand, products with displays, remote controls and communication or network functions may really struggle to meet both consumer performance requirements and such a power target. Uniform targets tend to apply to only lower power modes and they tend not to deal with higher intermediate or secondary modes nor the requirement for power management to the lowest possible power state – this is where major energy savings occur in the field.

So all of the main policy approaches used to date have advantages but also some limitations. Is it possible to develop a new approach that is somehow more flexible yet deals with the shortcomings of the existing systems? The main issues that we need to address within a new approach seem to be:

- continual changes in product definitions, splitting and merging of traditional product types, new products types appearing;
- changes in product features and functionality;
- a range of relevant modes of interest (rarely a single mode, or the lowest mode only, is of interest);
- setting technically advanced but achievable targets at a product level.

It is fairly clear that, while the vertical approach is of value for selected products, this program option has a fairly limited scope and could only realistically be expected to deal with a small proportion of products of interest. So while it is a useful tool to have in the policy toolbox, it is by no means a panacea for the standby problem.

One of the dangers of setting a maximum power level for low power modes is that there may be a temptation for manufacturers to avoid or circumvent the requirements (in practice, if not on paper) through gaming or adjustment of modes. For example, a manufacturer may provide a product mode that has very low standby power attributes which meets a specified target but in reality this mode is difficult or inconvenient for the consumer to activate (or there are negative consequences such as loss of presets or clock settings etc.). Another variant of this type of circumvention of requirements is to remove low power modes from the product design so that the product remains in "on mode" or in some higher mode which is not covered by a target. This of course results in a highly negative outcome and policy makers need to remain vigilant to ensure that such perverse outcomes are not occurring as a result of new policy measures.

We need a new approach that can overcome these problems and help redress the standby energy issue in the medium term.

Horizontal functionality – foundation of a new standby policy

In many ways, a uniform target across product types has many merits – it is all inclusive and is largely immune from changes in product definitions, modes and functions. But inevitably, products will appear that will not fit comfortably into the uniform requirement and there will be pushes for exemptions or variations in the target for particular product classes. Such exemptions may be few in the short term, but eventually it could create a complex layer of requirements and levels that lie outside the original uniform requirements. An interesting example is the implementation of the US presidential executive order for one watt – in reality the permitted level for a number of product type varies from this stated 1 watt level (FEMP, 2007). The other disadvantage of the exemption consequence is that exemptions can be driven by political processes rather than sound technical reasons – large well funded organisations could put pressure on organisations or government to provide exemptions for specific products types or classes. A notionally uniform target with a large number of exceptions and variations is no better than trying to deal with targets at a product by product level.

An alternative approach is called the horizontal functionality approach. This is where a maximum power level that potentially covers a wide range of product designs and product types is developed on the basis of the level of functionality offered by each individual product, potentially across a range of different low power modes that may be present. The term horizontal comes from the development of a common requirement that cuts across a wide range of product types. Conceptually, it is a system of providing a power budget or allowance for the provision of a specified level or type of functionality (or combination of functions) which are active in the product in the particular mode.

The advantage of this approach is that it can capture any new product or variations on existing products and, in a fair and technically consistent manner, develop an acceptable power level based on the present and/or active functions. The power level could theoretically be unique for an individual product (if the combination of functions was unique), although in reality a single level would apply to broad groups of products with the same combinations of functions. Ultimately, this policy could effectively keep up with changes in the technical design of products over time and with new products as they appear on the market in a way that is more comprehensive and coherent than any other policy platform developed to date.

The way it would work would be to define an acceptable power budget or level for each type of function that is present and/or active on a particular product in a particular mode. For example, a product with a remote control would be given a certain allowance, a product with a remote control and a clock display would get a higher allowance. A different product without some of these features but with other features would sum the relevant feature allowances to set a total power level for that product and mode.

It is critical that the allowances are developed on the basis of well proven available technologies that can provide the level of functionality required in real products. Two notional levels could be developed – one which is based on "acceptable" practice (the basis of a maximum permitted power level) and a more stringent level that represents "current best practice" – this level would be best suited to endorsement type programs which identify exceptional performers in the market place.

Initial investigations have found that under this type of scheme that there are two main product categories: those without the need for communication and those that have a communication capability. Communication here means the need for ongoing two directional dialogue among two or more pieces of equipment. In this context, a remote control would typically not be classified as "communication" as the remote control sends a signal which is not dependent on the response of the product – the signal only goes in one direction. Dealing with communication equipment is potentially complex, but including this type of product has the advantage of allowing a wide range of telephony and computer related equipment (and increasingly consumer electronics) to be included in such a scheme. Many of these products are currently excluded from existing schemes as they are regarding as in being in 'on' or active modes. Energy consumption is strongly affected by the type and frequency of the communication and the connect speed of the communication. Therefore in a networked environment some of the energy consumption of a product will be dependent on the characteristics and usage patterns of other attached products. Work is required on appliance network protocols to allow products to go to sleep for long periods if they are unlikely to be required by the network for some period and to connect at low speeds where possible. It may also be necessary to preclude or shut out "bad actors" with poor network behaviour (eliminate network chatter) to reduce energy consumption of all networked products. The interdependence among products is really new to energy efficiency and this is perhaps a major issue that needs urgent investigation, given that interconnectivity is likely to grow.

How practical is such an approach? It remains to be seen. While some development work on this approach has been done (Nordman, 2006), the details are still some way from being finalised. The proposed sets of horizontal requirements could cover the minimum power mode, other low power modes, power supply specifications (efficiency, no load), battery charging attributes, network capabilities, and user interfaces. Existing examples of functional adder systems for individual (or families of) product types are the EU Code of Conduct on Broadband Equipment (see http://energyefficiency.jrc.cec.eu.int/) and the new Energy Star specifications for imaging equipment (Energy Star, 2007). In Europe, the Ecodesign Framework Directive of 2005 (Official Journal of the European Union, 2005) established procedures that will create minimum efficiency standards for most of the major appliances in the next five years (Siderius & Meier, 2006). In 2006 the Fraunhofer Institute, who have been commissioned under Eco-design Directive to examine the issue of requirements for standby power attributes, released a draft report which provides some initial thinking on a horizontal approach (Fraunhofer, 2006). In January 2007 they released their interim report which provides more detail (Fraunhofer, 2007).

A pragmatic option – uniform targets with horizontal functionality

While a horizontal functionality approach appears to have promise, especially for more complex products, the approach of establishing uniform targets across the board for all products has already gained some momentum in Korea, Australia and to some degree the USA. The favoured target at this stage is 1 watt for all products, but there are certainly some limitations in terms of its application to certain product types and modes. As noted above, this approach has the strength of a simple uniform requirement for all products and it is clear and easily understood. It would seem to make most sense to use this existing approach as a foundation and compliment it with a horizontal functionality approach for the development of requirements for more complex products in the future that may not fit neatly or easily into the uniform target approach. Over time, targets under a horizontal functionality approach could be more widely applied and eventually could replace a uniform 1 watt target.

The obvious policy solution is therefore to maintain and even encourage, at least for the time being, the current requirements of a 1 watt target across the board for all products (as far as possible). Where a supplier or manufacturer feels that this requirement is not practical or too onerous, then they could opt to use a level for their product based on a horizontal functionality approach. This would ensure that there is a clear path to allow the development of more sophisticated products with higher levels of functionality while ensuring that these meet reasonable short term standards for standby power attributes. It could reasonably be expected that allowable power levels for many simple products under a horizontal functionality approach would be well below 1 watt. Policy makers could then prepare for a smooth planned transition from a uniform 1 watt target to levels that are more technologically relevant (and probably are less than 1 watt in many cases) under a horizontal functionality approach. Of course, power allowances under a horizontal functionality approach would need to be reviewed from time to time to ensure they reflect best practice and the available technology.

The whole purpose of policy measures like this is to ensure that there are real energy reductions in the design of future products during normal use. They are intended to focus the attention of manufacturers to improve their products through better design because at this stage there is little incentive to do so in the marketplace, nor is there likely to be. One key aspect is to ensure that products put themselves down into the lowest possible power mode wherever possible. Realistic power management strategies, where products come out of idle active modes whenever possible, are likely to save more energy than any other requirement. This will make sure that consumer behaviour (whether this is poor or good) is much less relevant in terms of energy consumption. This is far more likely to provided persistent savings when compared to programs that rely on human behaviour and the use of specialised equipment to reduce energy consumption.

Ideally, products should be smart enough that they can do the job they are required to do while minimising the energy consumption at every possible level, independent of the user.

Conclusion

The issue of standby energy is growing and the number of products in the home and office that use some power continuously is expanding. We have very little concrete information on what is actually happening in the market place in terms of standby attributes – the trends for existing products are often unclear and there are many complex and rapid changes in the market that are likely to impact on future standby energy consumption.

Given the urgent nature of our efforts to try to redress ongoing climate change impacts, it is critical that governments act in a decisive and responsible manner, even in the face of the limited information currently available. We don't have time to wait for good data to develop perfect policies. Pragmatic action is critical but we need to mindful of possible consequences and ensure that favourable outcomes arise under a range of possible scenarios. It is important to remember that nearly 90 % of the equipment that will use standby power in 2020 is yet to be designed and built, so we have a golden opportunity to make a difference.

Many countries have started to address the standby energy question through a number of considered and carefully constructed policy approaches. However, while all of the approaches adopted to date have some merits, they also have problems in terms of implementation and longevity.

The policy of setting a uniform 1 watt target appears to have the most appeal and could build on the significant efforts already implemented in many parts of the world. The IEA initiative provides a strong focal point for policy actions to address growing standby energy consumption and allows concrete policies to be implemented quickly. This could be complimented with an approach to develop a horizontal functionality requirements that could initially be applied to more complex products and in the long term provide an integrated scheme to deal with all product types and designs in a coherent fashion.

Ultimately, the power consumed in low power modes is largely wasted. Consumers and government would happy if the power levels consumed by most products were negligible. It appears that the technological solutions are already available in many cases, but what is required is policy action to focus the attention of manufacturers to ensure that best practices are adopted in a timely manner, in spite of the lack of direct incentive to do so. Unfortunately it appears that standby energy is likely to be an issue that requires decisive measures now and in the foreseeable future.

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