STANDBY POWER LOSSES IN HOUSEHOLD ELECTRICAL APPLIANCES AND OFFICE EQUIPMENT *

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ABSTRACT

Electrical appliances used in homes and offices consume some energy when they are left on standby mode or even switched off. The typical electricity loss for an appliance can range from as little as 1 W to as high as 30 W. This loss and the associated cost are not high enough to attract the attention of the consumer. But when such power losses of all home and office appliances are aggregated at the level of a country, the amount becomes significant and cannot be ignored. According to an estimate of the International Energy Agency, the total standby power demand of the residential sector in industrialised countries amounts to 15 GW.

This paper reviews estimates of standby power losses in different countries around the world. It then analyses various techno-economic options to reduce standby power consumption. Policy instruments and approaches adopted to tackle the issue of standby power are analysed and some country-level initiatives are highlighted. Finally, the paper looks into future directions and emphasises the need for international collaboration to achieve long-term minimum threshold standby power consumption targets of existing as well as new appliances.

INTRODUCTION

Standby electricity is the energy consumed by appliances when they are not performing their main functions or when they are switched off. The energy wasted in this manner is commonly referred to as "standby loss" or "leaking electricity". Many people are not aware of the fact that modern electrical and electronic appliances, even those having on/off switches, consume power for standby functions that include features such as powering of the built-in clock or memory, displaying information, responding to remote controls or programming, charging of batteries, etc. A study done by the Australian Greenhouse Office concludes that up to 80% of the electricity used in video recorders were in standby mode. In New Zealand, microwave ovens consume 40% of electricity as standby energy, mainly to run digital clocks. Field surveys conducted in office buildings of Thailand in 1996 showed that idle losses were 53% for personal computers, over 90% for copiers, printers and fax machines.[1]

The number of products with standby power consumption is growing very rapidly in terms of quantity and diversity. Several products commercialised in the market today do not have any hard "off" switches. Several appliances do not have standby features but are equipped with external power supplies (commonly known as wall-packs). Even when they are not performing any operation or are switched off, a small amount of energy is lost in low voltage power supplies, mainly due to the cheap transformers with high core losses. Common household appliances and office equipment such as televisions, video recorders, audio players, telephone answering and facsimile machines, computers, printers and copiers contribute to this standby loss which is relatively low, with typical loss per appliance ranging from less than 1 W to as much as 25 W.[2]

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As more and more such appliances are being used in households and offices, their energy consumption during standby periods represents a significant share of the total energy use. Recent field studies show that standby power accounts for 9.4% of household energy use in Japan[3], whereas the figure rises to 11.6% in Australia. The standby losses amount to about 20.5 billion kWh for Germany, of which 14 billion kWh are from household appliances and 6.5 billion kWh from office and communication equipment.[4] Surveys conducted in Belgium and Switzerland show that standby energy consumed during off-working hours represents 24 and 36 per cent, respectively, of the total energy use.[5] Pilot projects carried out by the Swiss Federal Office of Energy have shown that most small and medium sized businesses have computer networks that operate mainly during office hours. It is possible to switch off the networked computer servers automatically at night and save about 50% of energy by installing energy optimised devices in computer networks.[6] With the wider use of electronic devices and the future development of home and office networks, one can expect substantial increase in standby power if adequate efforts are not made at the national and international levels.[1] According to IEA figures, standby power in the residential and commercial sectors in OECD may account for 188 TWh/year, or 2.2% of the total OECD electricity consumption.[7] Much of this consumption is unnecessary and can be avoided, as proven by the introduction of power-saving standby modes in several appliances that are permanently plugged in.

In developing countries, there is lower penetration of electronic products at homes and in offices and one would normally expect much lower standby power consumption of households as compared with their counterparts in the industrialised world. However, the appliances that are available in the market are very often not necessarily those state-of-art products sold in the developed countries. No detailed field surveys are so far available for developing countries in the Asia-Pacific region. A survey of 51 households in Japan showed that if the appliances in use were replaced by the latest models sold in the market, the standby energy use per household would reduce from 398 to 228 kWh/year, representing almost 43% savings. This shows the great potential for reducing standby power consumption with technological improvements. Industry has proven that savings as high as 90% can be achieved in many appliances without any reduction in services, and that too at low or no cost.[8]

Another aspect that merits attention is the awareness and the attitude of consumer towards standby power use. This loss is not high enough to attract attention at the level of the consumer. Surveys conducted on households in the UK conclude that raising the awareness of end-users can help in as much as 25% reduction in standby power.[9] Here too, technical solutions play an important role by assuring that the settings are maintained in the appliance or the “wake-up” time of the appliance is reduced considerably.

Reasons for emphasising the need to minimise standby power losses include the commercial availability of technical options, the relatively short replacement period of appliances concerned, and the considerably high and unnecessary energy consumption due to inefficient technology.

ESTIMATION OF STANDBY POWER LOSSES

Various national studies have been conducted by researchers to estimate the standby power losses at homes and offices. Some of these studies are based on field measurements and others are “bottom-up” estimates. Field measurements are conducted in sample representative houses in terms of ownership of specific types of equipment and having average electricity consumption. On the other hand, for “bottom-up” estimates, standby losses of a wide range of individual appliances are measured separately in homes, offices and stores; the average standby energy consumption is then multiplied by the number of those appliances sold in the country. In the absence of actual measurements, calculations are based on standby power measurements of appliances reported in consumer magazines.

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[1] A networked product is put into standby mode not only by the user, but also by external sources such as other products or a service provider. Moreover, this product can also communicate with external sources. Such types of products are typically connected to a network either by cable or wireless.

The types of appliances taken into consideration for evaluating the total standby power loss are mostly the common ones found in almost all countries. These different categories of appliances include: audio and video equipment (television, VCR, Cassette/CD/DVD players, video players/recorders, speakers and sound systems…); telephony (cordless telephone, answering machine, interphone…); kitchen appliances (microwave, kitchen oven, rice cooker, bread maker…); set-tops (analog and digital cable box, television decoder, internet terminal, satellite system…); office appliances (personal computers and monitors, modems, ink jet/laser printers, scanners, photocopy machines, typewriters…); battery operated devices (cell phones, battery chargers, notebooks/laptops, hand-held power tools and vacuum cleaners, shavers…); and miscellaneous home appliances (security system, water treatment unit, door openers, timers, low-voltage halogen lamps, motion sensors…). But there are some appliances which are unique to a specific country, such as the "shower-toilet" in Japan, electric fences in Australia, and the Minitel communication system in France.

Findings of some of the recent studies carried out to assess the standby power losses in selected countries around the world are summarised below.

AUSTRALIA[10]

The Australian Greenhouse Office (AGO) and the National Appliance and Equipment Energy Efficiency Committee have recently concluded a study to quantify the residential standby energy consumption in Australia. The study employed several research techniques, such as intrusive survey of 64 households, appliance ownership surveys through telephone interviews with 801 respondents all over the country, measurement of 533 appliances in major retail stores, and analysis of historical measured data.

The average standby and miscellaneous consumption, including small continuous loads, was found to be 86.8 W or 760 kWh per annum per household. This amounts to 11.6% of Australian residential electricity use in 2000. This is equivalent to around US$ 200 million worth of electricity each year, generating 4 million tonnes of carbon dioxide. The results imply that the miscellaneous and standby electricity consumption has grown by 8% per annum from 1994 to 2000 (i.e. doubling every 9 years).

Only about 15% of the appliances were found "unplugged" during the survey. A large proportion of appliances consumed power in both standby and off modes. Many products were found to have no hard "off" switches. These include video cassette recorders, computer peripherals (speakers, modems, fax machines, scanners and printers), audio-visual equipment (integrated stereos, DVDs), and an increasing number of white goods that incorporated "soft touch" electronic controls.[2] Computer peripherals such as scanners, modems and speakers were found to consume energy in off mode. An emerging concern is the audio visual equipment (not including TV and VCR) whose standby consumption is high, an average of 9.5 W, and is expected to grow faster due to large numbers present in households.

There has been a noticeable decrease in standby power, with the average value for televisions dropping from 16 W in 1991 to just over 5 W in 2001. The same is true for VCRs whose average standby consumption has come down from 10 W in 1990 to 4 W in 2001.

CHINA[11]

China has emerged as a major player in terms of production and use of appliances. Over the last 20 years, the average annual growth rate in appliance production has been 32.1% per annum. The demand for these appliances continues to increase in the domestic market; 30 million colour TV were sold in 2000.

Based on a preliminary survey undertaken in a very limited number of households in China, the mean standby power consumption is estimated as 29 W. The main contributors to this standby power are

[2] White goods refer to household appliances such as refrigerator, washing machine, microwave oven and cook-top. Entertainment equipment and office equipment are referred to as brown and grey goods, respectively.

identified as the TV , VCD and audio systems. Depending on the model of television, the standby power varies from 2.4 to 21.1 W, with an average of 9.6 W. For VCDs, the standby losses range from 3.4 to 21.8 W, and the average is 12.9 W.

The time period during which the appliances remain in standby mode is uncertain. Many people tend to unplug their television. Without further detailed measurements and surveys, it is difficult to assess and extrapolate the standby-related electricity losses in the country. Assuming the equipment to be in standby mode during 10 hours per day, the total standby losses for the country are estimated to be 13 billion kWh per year. The China Certification Center for Energy Conservation Products plans to introduce voluntary labelling for television and printer in 2001.

FRANCE[12]

A study was commissioned in 1998-99 by the French Agency for the Environment and Energy Management (ADEME) to carry out field measurements of standby energy use of more than 70 categories of equipment in 178 households representing the entire housing stock in terms of average penetration of specific types of electrical equipment and average electricity consumption. This is considered to be one of the largest end-use studies in the world. The electric space and water heating systems were not included in the study.

Standby power use in individual homes were measured to be as little as 1 W to as high as 106 W. Some of the equipment found having high standby power use are summarised in Table 1.

Depending on the assumptions made regarding the time period during which some appliances are assumed to be in standby mode, the average household standby power use was estimated to range from 29 to 38 W. The average annual household standby electricity consumption was calculated as 235 kWh per annum, which represented 7% of the total residential electricity consumption in 1999.

Table 1. Appliances with high average standby power use in France (1998-99)

Appliances	**Standby power (W)**			**Number of models monitored**
	Maximum	**Minimum**	**Average**	
Television	22	1	7.3	205
VCR	30	1	9.9	169
Hertz TV decoders	16	9	11.0	34
Satellite dish decoders	17	5	8.7	26
Cable TV decoders	23	3	9.5	4
Hi-fi Stereo	24	1	7.2	108
Miscellaneous hi-fi TV/video	34	4	14.4	8
Voltage stabiliser	18	14	15.7	3
Induction cook-top	18	4	13.2	10
Kitchen oven	18	6	14.5	4

JAPAN[13]

A study conducted by the Energy Conservation Center of Japan (ECCJ) to assess the standby energy loss in Japanese households included surveys of 51 households located in metropolitan areas and covered a total of 955 appliances. In parallel, a nation-wide questionnaire was distributed and feedback received from 933 households regarding the number of appliances owned, the pattern of their use, and power consumption. The measurement results provided the average standby power consumption according to the type of appliances, as detailed in Table 2.

The standby power consumption of a typical household is estimated as 398 kWh per annum; considering that a household consumes 4,227 kWh per annum on an average, the standby power accounts for 9.4% of household electricity use. The main culprit for this high share is identified as the VCR which alone accounts for almost a quarter of the total standby power use. The gas water heaters and audio combinations account for another quarter of standby energy.

The study looked at the standby power consumption of the recently commercialised appliances and concluded that it was possible to reduce the standby power by almost 43% if the households replaced their existing appliances with the latest ones available in the market.

THAILAND[14]

Field surveys were carried out in sample office buildings of Thailand in 1996 to assess the energy-saving potential of office equipment, including personal computers, printers, copiers and fax machines. Based on the survey, it was concluded that office equipment accounts for only 2.2 to 5.6% of total energy consumption in buildings audited.

Although office equipment is normally turned off at night and during weekends, it is left switched on unnecessarily during the day. The idle periods for machines were found to be 53% for the personal computers, 94% for copiers, 96% for dot-matrix and ink-jet printers, 98% for laser printers, and 98% for fax machines. The load patterns were monitored to determine the times spent in active, standby, suspend, and off modes. The results of the field audits are summarised in Table 3.

Table 2. Measured average standby power consumption of appliances in Japan

Category	**Appliance type**	**Year of manufacture**	**Standby power consumption**	
			Average (W)	Sample number
Audio-visual equipment	Tuner for satellite broadcasting	1997	12.25	6
	Audio combinations	1993	6.48	26
	Set-top boxes	1997	6.40	4
	VCRs	1993	6.17	62
	TV sets with VCR	1996	5.56	8
	Portable systems	1993	2.26	65
	TV sets	1993	1.89	83
Information Technology (IT) Equipment	Telephone with fax	1996	5.87	28
	Telephone with answering machine	1996	3.60	18
	Personal computers	1998	2.28	36
	Telephone adapters	1997	1.93	12
	Telephones (cordless handsets)	1996	1.73	32
	Printers	1998	1.64	23
	PC monitors	1998	0.76	19
	Cellular phones	1999	0.60	27
	Word processors	1995	0.35	8
Cooking / housework equipment	Electric ranges and ovens	1992	2.79	45
	Rice cookers	1995	1.89	42
	Washing machines	1994	0.91	44
	Dish washers and dryers	1997	0.35	10
	Clothes dryers	1991	0.00	12
Lighting and other equipment	Table lamps	1995	0.19	36
	Multi-function toilets	1991	3.40	27
	Video game machines	1997	1.15	17
Water heater	Gas water heaters	1995	8.43	25
Air conditioning	Air conditioners	1995	2.61	45
	Coolers	1984	1.74	9

equipment	Fixed heaters Portable heaters	1983 1993	2.04 2.07	7 34

Most users were unaware of the built-in power management features of the equipment. If the power management features were enabled, from 15 to 26% of annual electricity consumption could be reduced without additional costs. The study concluded that if all the commercial buildings in Thailand had similar operating patterns and power management features were enabled, it could lead to lowering of the energy consumption of office equipment by 700 GWh per annum by 2005.

UK[15]

To estimate the standby power consumption of UK households, 282 appliances were measured and 32 sample houses were covered. In addition, the householders were questioned about the usage pattern of appliances to estimate the standby electricity consumption.

Table 3. Measured power demands of office appliances in different operating modes

Equipment	**Active (W)**	**Standby (W)**	**Suspend (W)**	**Off (W)**	**Number of equipment**
Personal computer without monitor	36	27	-	-	111
Monitor	66	15	-	-	111
Copier	0.86 Wh/page	206	162	18	19
Laser printer	0.88 Wh/page	64	21	-	25
Dot matrix/ inkjet printer	26	13	-	-	10
Laser fax machine	1.1 Wh/page	17	-	-	2
Thermal/ink-jet fax machine	24	14	-	-	19

Based on the analysis, the average standby electricity demand was found to be 32 W. This led to an average annual electricity consumption of 277 kWh per annum per household, i.e. 8% of the total electricity use of the residential sector.
An analysis of the product categories showed that the audio-visual products accounted for 68.6% of standby power use; here too, VCR and hi-fi dominated with a high share of 65%.

The feedback from the questionnaire showed that more than half of the users were willing to switch off the appliances if the machine could retain the programme settings when it was switched off. It also concluded that a proper awareness campaign among the users was capable of inducing a reduction of standby power consumption from 32 to 24 W, or from 277 to 209 kWh per annum per household.

USA[16]

In USA, hundreds of individual appliances of different ages were measured in homes, stores and repair shops to derive the average annual energy consumption for each device. Separate surveys conducted by the public agencies provided the appliance ownership of households. The average home’s standby electricity use was estimated by calculating the types and number of appliances with standby in an average home, then adding up the standby power of all the devices.

A typical home in the USA required 50 W of standby power on an average. This works out as 440 kWh per annum per household. i.e. 5% of the total residential electricity use. Considering over 100 million homes in the US, the standby consumption represents 5 GW of power.

The range of standby power for a single type of appliance can be very big, as it was found from the field measurements. For example, the standby power of a compact audio system can vary from as little as 1.3 W to as high as 28.6 W. This is largely due to the differences in features, design and choice of components. Certain appliances were found to consume nearly as much power when they were switched on or switched off. For example, there is practically no change in power consumption of most digital television decoders and many VCR and compact audio equipment.

A more recent investigation of standby power use of 190 appliances in 10 Californian homes showed that the total standby power in the homes ranged from 14 to 169 W, with an average of 67 W. Standby power accounted for 5 to 26% of the total annual electricity use, with an average of 9%. The appliances with the largest standby losses were televisions, set-top boxes and printers. The study concluded that the large variation in standby power of appliances providing the same services demonstrates the scope for manufacturers to reduce standby losses without degrading performance.[17]

OECD COUNTRIES[18]

The International Energy Agency (IEA) has adapted values from sources that can be readily compared and has summarised the estimates of residential standby power consumption in nine countries, as shown in Table 4.

Table 4. Estimates of residential standby power use in 9 countries

Country	**Average residential standby power (W)**	**Annual electricity use (kWh/year)**	**Fraction of total residential electricity use (%)**	**Notes**
Australia	86.8	760	11.6	Field survey or 64 households
France	27	235	7	Based on field measurements in 178 homes.
Germany	44	389	10	May include standby losses from storage water heater
Japan	46	398	9.4	Based on field measurements in 51 homes
Netherlands	37	330	10	Based on typical standby power use of major appliances. Does not include less common appliances.
New Zealand	100	880	11	Based on field study of 29 homes. Includes a few heated towel rails and malfunctioning appliances
Switzerland	19	170	3	Only includes TV, VCR, satellite receiver, stereo, some rechargeable appliances, cordless telephone and PC.
United Kingdom	32	277	8	Field estimate for 32 households
United States	50	440	5	Based on measurements of individual appliances and then adjusted for the number of each appliance in an average home.

Further, an attempt has been made to estimate the consumption of standby power in OECD countries by assuming the use of similar appliances and their penetration levels. Results are presented in Table 5.

It is significant to note that the total standby power demand of the OECD residential sector amounts to 15 GW, i.e. 1.5% of the total electricity consumption. IEA compares this figure with the total installed capacity of wind turbine world-wide, which is little over 10 GW. Electricity produced from the wind turbines around the world amounts to below 30 TWh per year whereas the standby energy consumption of OECD countries is a high 128 TWh per year.[19]

Table 5. Assessment of standby power in the residential sector of the OECD countries

OECD Member countries	Number of households (millions)	Average standby power (W/home)	Total standby power demand (MW)	Total standby energy (TWh/year)	Total national consumption (TWh/year)	Standby as % of national electricity
Australia	7.09	87	617	5.4	171	3.2
Austria	3.38	44	149	1.3	53	2.5
Belgium	3.85	27	104	0.9	78	1.2
Canada	11.7	50	585	5.1	514	1.0
Czech Republic	3.48	20	70	0.6	58	1.1
Denmark	2.35	39	92	0.8	35	2.3
Finland	2.2	39	86	0.8	7.4	1.0
France	23.14	27	625	5.5	410	1.3
Germany	36.03	44	1,585	13.9	527	2.6
Greece	3.65	20	73	0.6	42	1.5
Hungary	3.85	20	77	0.7	33	2.0
Iceland	0.0001	39	0	0	5	0.0
Ireland	0.87	32	28	0.2	18	1.4
Italy	22.69	27	613	5.4	273	2.0
Japan	41.37	46	1,903	16.7	1,001	1.7
Luxembourg	0.0001	44	0	0	6	0.0
Mexico	21.08	20	422	3.7	152	2.4
Netherlands	6.51	37	241	2.1	96	2.2
New Zealand	1.26	87	110	1	33	2.9
Norway	1.93	39	75	0.7	107	0.6
Poland	11.8	20	236	2.1	124	1.7
Portugal	3.66	20	73	0.6	34	1.9
South Korea	13.99	20	280	2.5	236	1.0
Spain	14.94	20	299	2.6	167	1.6
Sweden	3.97	39	155	1.4	136	1.0
Switzerland	2.98	27	80	0.7	52	1.4
Turkey	15.09	20	302	2.6	87	3.0
United Kingdom	21.93	32	702	6.1	337	1.8
United States	101.04	50	5,052	44.3	3,503	1.3
OECD	386	**38**	14,634	128.0	8,362	**1.5**

Standby power can be expected to increase with the rapid growth of home and office electronic products, both in developing and industrialised countries. Due to the lack of reliable data, it is difficult to estimate the quantum of standby power use in developing countries. There is however reason to believe that unless steps are taken to create greater awareness among users and to influence manufacturers for incorporating advanced energy-saving features of equipment in standby mode, the standby energy use in developing countries will become substantially higher with the current high growth trend in the demand for home and office electronic appliances.

Options to Reduce Standby Power Consumption

There are basically two options to reduce the standby power consumption: behavioural and technical.

The first one involves better consumer awareness and education on standby energy consumption. In countries like Germany, Switzerland, Denmark and the Netherlands, some local utilities conduct information and motivation campaigns to raise consumers' awareness and encourage the purchase of equipment with reduced standby consumption. This approach has its share of merits and drawbacks. It is not an easy task to convince the end-user about the economic and environmental benefits of adopting energy efficiency practices, particularly when the quantum of saving is not high at the individual level. Reaching out to each and every household in the country requires considerable human and financial resources; this may not be perceived as the most cost-effective option for public authorities. In addition, manufacturers are incorporating features such as programmable clocks and timers in more and more appliances that require continuous flow of electricity, even when the equipment is not in operation. Personal computers connected to a network are required to be in standby mode to avoid communication problem with peripheral devices or with the network manager. So it may not be practical to ask people to just unplug the appliances that are not in use.

The second option for reducing standby power consumption in most appliances is the adoption of technological innovations. It is estimated that redesigning appliance circuits can reduce standby power consumption up to 90%. In fact, manufacturers have introduced many power-saving features in the past decade, particularly for those products that are plugged in all the time. These features are typically the standby or sleep modes; when an appliance is required to perform fewer functions or it is waiting for a signal to be fully operational, it is generally designed to go into standby mode in which the product consumes much less power. Some parts of the appliance remain on standby till the power switch is activated or input received from a remote control device.

Sleep modes are incorporated into appliances that are frequently left on by the consumers during the period these are not in use. Some devices have programming option for switching off selected components when they are not in use for a stipulated time period. This is the case with portable laptop/notebook computers that go into sleep mode when the keyboard or the mouse is not used for a time period that can be set by the user. Most computers in the market today have two power-saving modes incorporated in the product design. This allows the machine to switch off some components after a predefined time period; if the computer remains unused for a longer predefined time period, it then enters into a deep sleep mode by switching off several key features. Unfortunately the appliances are delivered to the customer with the power management features switched off. Generally neither the distributor nor the customer is aware of the possibility of enabling the power management feature. Sometimes, users who do not accept long wake up time for recovery, disable the standby mode. In a survey conducted in office buildings in Thailand, it was found that users had not enabled the power management features in 90% of computers.[20]

One of the areas where substantial energy is consumed when the appliance is on standby or switched off is the power supply system. With the recent innovations, it is possible to reduce the no-load losses while providing very high conversion efficiencies. New generation power transformers adopting electronic components are capable of reducing the standby power consumption from 5 W to as little as 0.1 W. These transformers are also far more energy efficient, providing 70 to 75% efficiency compared to 40 to 45% of the traditional models they replace.
Some pieces of equipment having bigger and brighter displays tend to consume more power in standby mode. Liquid crystal displays are a good alternative but the quality and colour of display is compromised. Thanks to the advances made in light emitting diodes (LEDs), it is now possible to have low-power displays without sacrificing the brightness and colours.

Concerned with the huge monetary losses and environmental impacts of standby power consumption at the national level, governments in several countries have initiated programmes to address the issue. The "Energy Star" label of the US Environmental Protection Agency (US EPA) for consumer electronic products takes the standby power use into consideration. A number of similar approaches have been adopted in other parts of world, particularly in Europe, Australia, Japan. The International Energy Agency (IEA) has initiated promoting international action to reduce the standby power consumption of products to 1 W. These initiatives have, to a large extent, accelerated the design and development of new consumer electronic products with low standby power use.

A variety of technological solutions are being offered by manufacturers in electric switches, integrated circuits, power management software, and advanced power supplies and charging devices. The Lawrence Berkeley National Laboratory of the US Department of Energy has proposed a global plan to reduce standby losses to 1 W per appliance. To achieve this goal, one or more of the following technologies are suggested:

- Improving the efficiency of low-voltage transformer
- Move the power switch to the high-voltage side
- Energise only the components needed for the standby services, and
- Install “smart” recharge circuit in rechargeable appliances.

Products can be classified into 3 categories: on-off, standby, and networked.[21]

The on-off product provides the simplest solution: the product is either on or off, with off meaning the product is not performing any function. If the product is energised by an external power supply or transformer[3], the transformer is in no-load state when the product is switched off or not functioning. The product continues to consume some power in the transformer even when it is not functioning, except when the switch is placed on the primary side of the power supply.

The standby product performs some functions in standby mode, such as running a clock or internal timer, waiting for a command from the remote control, etc.

The networked product is typically connected to a network for communicating with external sources, and can be switched into standby either by the user or by external sources.

Some technical solutions that can deal with above categories of products and contribute to the lowering of the standby power losses are described below.

THE ON-OFF PRODUCT

The simplest solution to obtain zero Watt loss is to place the on-off switch on the primary side of the power supply or simply pull out the plug from the socket. However, this may not always be a practical solution.

[3] Switching power supplies convert AC power of the electric utility to a stable DC supply that is required for electronic products.

In most appliances, the on-off switch is placed between the power supply and the appliance. To minimise the no-load power loss of the transformer, one can opt for more efficient power supplies. The traditional wall adapters design using a linear supply has low efficiency and high no-load dissipation. Technical solutions exist to reduce the no-load power consumption to around 0.1 W, at least for small power supplies (see Box 1). For example, a new switching-architecture design from Power Integrations Inc. employs much fewer and smaller components and an integrated circuit as a core to develop power supplies featuring 70 to 75% full-load efficiency and 0.1 W no-load consumption. Interestingly, this new power supply costs less, occupies a smaller volume and weighs only a quarter that of a conventional unit. [22]

Box 1.
New Generation Energy Efficient Power Supplies

Sharp Corporation, a major electronics manufacturer, has developed a switching power supply that limits standby power loss to 0.3 W or less for office equipment applications such as fax machines and printers. These new energy-efficient switching power supplies use a self-exciting blocking oscillator system that senses whether the equipment is in operation or in standby state, and automatically reduces the switching frequency when on standby. For a model with a power capacity of 30 W, a switching frequency of 100 kHz during full operation is changed to a frequency of less than one-tenth as fast when in standby mode (to less than 10 kHz). The operating efficiency of such a device is said to be 80%.

Bias Power Technology is another company that has come up with compact 0.25 W power supply. The pulse scheme of the unit is synchronised to the power utility AC input. The circuit is charged during the positive half cycle and discharge takes place during the negative half cycle during which the AC line is temporarily disconnected. Thus the technology effectively provides a constant AC/DC power source for various types of appliances, including battery chargers.

Earlier attempts to achieve 1-W standby power objectives were labelled as impractical by industry, mainly due to the high losses in the power supplies. With the introduction of new generation energy efficient power supplies, there is renewed interest for achieving 1-W target for 50% of appliances by

THE STANDBY PRODUCT

In this category, several products have on/off switches and products with external power supplies can also be found.

As the standby option is a desired feature in this product, the appliance cannot be switched off completely. The power loss can be reduced either by decreasing the standby power consumption or use an alternative source such as photovoltaic cell or battery to power the standby mode. The former can be achieved by considering ways at the designing stage of the appliance in order to:

- decrease the number of components to be powered in the standby mode,
- increase the efficiency of components that are essential for the standby function.

Alternatively, a special standby component may also be added, such as a smaller separate standby power supply only for maintaining the standby function.

In a simple operation, user intervention, manual or remote, is necessary to put the appliance into standby. In complex systems, the product itself can decide to go into standby on the basis of the period of inactivity. Thanks to the progresses made in microelectronics, appliances designed with power management feature can ensure that the appliance is always in a state with the lowest power consumption while satisfying the required functionality. For this, microprocessors are programmed to monitor activity levels of several parts of the appliance and follow certain decision rules to enter different states, e.g. standby or sleep mode. Power management can minimise not only the standby consumption, but also the power consumption of the appliance in operating mode. Boxes 2 and 3 present examples of industrial initiatives to reduce standby power of home and office appliances.

Box. 2

Reduction in the Standby Power of Home Appliances: An Example of VCR

A study conducted in Japan showed that a typical VCR remains in standby mode during approximately 96% of the day. The standby power of a VCR in 1991 was of the order of 7.5 W, which included losses from seven components: the circuit to receive remote control signals, the timer circuit for recording, the clock display circuit, the TV tuner circuit, the microcomputer for control, the transformer for the power supply, and the DC voltage stabilisation circuit. Considering the time the VCR was actually used for recording and playing, a whooping 85% of the daily total power consumption was due to the machine being in standby mode. Thanks to the adoption of innovative technologies, the standby power of the VCR has been brought down to less than 1.5 W by 2000.

A switching regulator system was adopted to improve the power efficiency by switching the voltage for circuits directly to a low DC voltage without the use of an AC power transformer. The controlling of the electronic switch is such that circuits never exceed the energy they require. As a result, the standby power consumption was reduced to approximately 2.6 W by 1998.

In 2000, a power control integrated circuit (IC) was developed which is capable of both increasing efficiency and reducing power loss during standby periods. Moreover, an electronic switch has been added to the power system to cut off the power supply to the motor drive circuitry during standby. These energy saving devices have helped to reduce the standby power consumption down

THE NETWORKED PRODUCT

Remotely manageable network products are required to provide permanent access to the network; therefore products cannot switch into standby without notification. This is the case of small personal computers and digital television decoders – also known as set-top boxes. Such networked products rely on sophisticated chips to control their operation and have fairly complex power management system that allows to respond well to both external and internal requests. Currently such types of products are left to work all the time.

Box. 3

Reduction in the Standby Power of Office Equipment: An Example of Photocopier

A conventional photocopier typically consumes about one-tenth of the energy in idle condition (sleep or off mode) as compared to when it is in copying mode. But as the machine remains idle for considerably long period in a day, it accounts for a great share of wasted energy. Photocopiers with energy saving features incorporated in them were not very popular in the past due to the long time needed for recovering from the sleep mode. Thanks to the technological innovations in the last few years, it is now possible to bring down the power consumption during off mode while the recovery time is reduced to an acceptable time period.

Ricoh photocopiers have won Demand Side Management award from the International Energy Agency for doing pioneering work in this domain. Earlier, a photocopier with a power demand exceeding 1.2 kW for copying accounted for 130 W of power on standby mode. This is mainly due to the need for maintaining the rollers at a high temperature using electric heaters. The new generation machine requires only 7 W of power, and the recovery time has been brought down from 85 seconds to less than 10 seconds. There are four basic areas where new technologies have been applied:

1. Fusing unit heater control configuration;
2. Main board circuit control;
3. Innovation applied to the controller; and
4. Increased efficiency of the power supply unit

In the energy-saving fusing unit, two heaters are controlled independently by detecting/tracking the surface temperature of the fusing rollers with the help of hi-response thermistors. Energy efficient circuit mechanism allows to move from operating stage to energy saving (when the machine is plugged in but not used) and power shutdown modes. Further recent improvements in the surge current prevention circuit have allowed the overall efficiency to rise to 76.5%. In addition, there has been a change in the 24 Volts converter interruption method during sleep mode. Over a period of a decade (1991-2001), the average energy consumption of the machine has reduced from 297 to only 34

Introduction of a standby mode with low power consumption would help in reducing the power to a great extent. A timer controlled time window that can be programmed through the network to function during a predefined time period can help to reduce the power wastage. However, this may not always be acceptable, especially when the service of the appliance may be required at any moment. Industry's focus now is to develop better power management systems with very low power levels for networked appliances that will never be switched off. *Instantly Available* is an Intel technology initiative that enables PCs to retain connections and still be aggressively power managed. End-users' benefits include connectivity in the "off" state with low power consumption, silent operation, and the possibility of resuming fast instead of rebooting. While the full power demand is 80 W, the PC requires only around 5 W in sleep mode.[4]

The Shikoku Electric Power Company has launched an "OpenPLANET" system that provides connectivity and remote management features to any electronic device in a building through a server and a combination of networks. The system is capable of providing information services to the customer and lowering the operating costs of the appliance through energy and load management.[5]

[4] For more details about "Instantly Available", go to the web-site: http://developer.intel.com/

[5] For further information on OpenPLANET system, see the following web-site: http://www.openplanet.co.jp

IMPROVING EFFICIENCY OF COMPONENTS

Improving the efficiency of some components will help to reduce the standby power as well as the overall energy consumption of an appliance. Apart from the power supplies, other components whose efficiencies can be improved include voltage regulators, integrated circuits and visual displays.

Some appliances require various voltage levels to operate different circuits. Depending on the efficiency of the voltage regulator, some amount of power is dissipated as heat. So the power losses increase with greater number of such regulators. Ideally, the appliance should be designed to have fewer voltage levels to reduce the number of voltage regulators. Moreover, efficient voltage regulators such as the low-dropout types may be adopted to reduce the power loss effectively.

Efficient integrated circuits have been designed to economise energy use in battery-operated products. Similar circuits could be adopted in appliances to limit standby power consumption.

COST IMPLICATIONS OF ADOPTING TECHNOLOGIES TO REDUCE STANDBY POWER

As discussed above, there have been substantial technological innovations in the past decade to deal with standby power consumption. But it is difficult to assess the cost implications of bringing about such changes in the final products. There are costs involved in the redesigning, procurement of alternative components and manufacturing; these may affect the final price the customer has to pay. Incremental costs to reduce the standby power of many appliances are found to be quite low. In some cases, the outcome has been cost savings and additional benefits.

Following the proposal of US EPA to limit standby power of audio and DVD products to 2 W by January 2003 and 1 W after that date, a study was undertaken to analyse different technology options and their added costs.[23] The report concludes that manufacturers can meet EPA 2-W standby power limit without loss of product performance and at estimated incremental costs ranging from minus US$ 2 to less than US$ 0.50 per product unit. Further, given the pace of innovation and market trends, manufacturers should meet EPA 1-W specification without loss of product performance at no incremental cost per product unit. In some cases, cost savings are possible with the adoption of high-side switcher or shifting from vacuum fluorescent displays (VFD) to liquid crystal displays (LCD) that can reduce the standby load and allow the manufacturers to select less expensive power supplies.

Even when technological improvements have minimal impacts on pricing, the incremental costs are multiplied several-folds in the retail market. Manufacturers are therefore reluctant to add any cost to their products in the fear that the price-conscious customer may opt for another model sold at a slightly lower cost.

POLICIES TO CURTAIL STANDBY POWER

With the technological advances and falling prices in the electronic sector, one can expect greater proliferation of home and office electrical products, both in developing as well as industrialised countries. One can therefore expect the standby power use to account for an even greater share of electricity in the future. Eliminating unnecessary electricity losses from standby consumption certainly provides an attractive option for some governments who are struggling to find financial resources to cope with the rapid growth in power demand and for others looking for alternatives to reduce CO_2 emissions in a cost-effective manner.

Several policy instruments addressing the different stakeholders and the different levels of action can be used to tackle the problem of standby power losses (see Box 4). Traditional policy instruments at the disposal of the governments can be classified into 4 categories:[24]

- Administrative instruments intervening in the form of direct regulatory restriction within the market activities and dictating to various groups of stakeholders certain product-related ways of action (e.g. setting minimum standards or rules as well as the duty to label products);
- Economic instruments creating a general setting for free market activities (e.g. taxes and charges, licenses, subsidies and incentives) and influencing the purchasing patterns of public organisations or large institutions so that there is some impact of their actions on the market;
- Negotiating solutions, agreements and co-operative deals, voluntary self-obligations, general voluntary agreements between business community and government by which both parties hope for benefits; and
- Information instruments such as general customer awareness campaigns and product information by independent testing organisations.

The instruments actually selected by public authorities are much influenced by the specific socio-economic conditions prevailing in the country. Lately, businesses and industry are showing due concern and interest on the environmental impacts of their economic activities and have taken proactive steps to address the national and global concerns. This has resulted in better co-operation between industry and government for eliminating least efficient products from the market and for introducing new technologies that assure low power consumption.

The policy tools that are being adopted by governments in different parts of the world are elaborated below.

Box 4.

Stakeholders Consultation to Develop a National Strategy on Standby Power Consumption

The Australian Geenhouse Office along with the NSW Sustainable Development Authority and the New Zealand Energy Efficiency and Conservation Authority co-ordinated a stakeholder forum to discuss the scope of the standby power issue and to develop strategies to reduce its impacts. The forum was attended by representatives of manufacturers, importers, regulators and academics. A consensus was reached by all participants that the Government needs to clearly signal the importance of the issue to stakeholders and the community. An unanimous recommendation made at the forum consisted of asking the Government to announce its support for a 1 W standby target.

Some of the immediate actions proposed included:

- collection and publication of product-specific data
- collection of baseline data on residential usage
- consumer information programmes
- urgent and specific action to ensure that set-top boxes used with digital television have a minimum standby power consumption

It was recommended to focus strategies on encouraging manufacturers to redesign products, with consumer information playing a useful role. While it was important to promote voluntary action, it may not suit all products; thus other options may be found as more appropriate in some cases.

Source: NAEEEC, Standby power consumption: Developing a national strategy, A consultation paper prepared by the National Appliance and Equipment Energy Efficiency Committee, April 2000

STANDARDS

Energy efficiency standards are procedures and regulations that are widely used around the world to define the energy performance of products that are important energy consumers. Most users of home appliances are not concerned about energy efficiency and make purchasing decisions by taking into consideration features other than energy, such as size, shape, colour, overall performance, price, etc.

Manufacturers naturally focus on those parameters during the designing and production process and do not generally make adequate efforts to improve the energy efficiency of their products. Standards ensure that efficiency is incorporated into product design. In some instances, the sale of products not adhering to the minimum standard is prohibited.

Standards can be classified into three categories: prescriptive standard, minimum energy performance standard, and class-average standard. The prescriptive standard imposes a specific feature or device to be installed in all new products. The performance standard defines a minimum efficiency or upper threshold of energy consumption to be achieved for the product, without specifying the technology to be adopted or the designing details. In the case of class-average standard, average efficiency of a product is defined such as to provide an option to the manufacturer to select the level of each model as long as the overall average is attained.

While aiming to eliminate less energy efficient products from the market, well-designed standards take into consideration the cost-effective feature to achieve the target set. This assures good acceptance and effective implementation of the regulation by the industry, and results in very large energy savings.

Standards bring in changes in the behaviour of a limited number of manufacturers instead of aiming at changing the behaviour of all end-users. The energy savings achieved in practice are generally assured and can be easily quantified. While implementing standards, all manufacturers, distributors and retailers are treated equally.

Energy efficiency standards exist in many parts of the world for household appliances and office equipment that consume high amount of energy in active mode. But only a few of them include criteria for measuring the standby power. The only existing standard for standby power that is purely regulatory is the “Top Runner” programme in Japan and standards for different products will become mandatory at specified future dates (see Box 5).

Under the Swiss energy regulation, the first phase of regulation consists of voluntary agreements. If voluntary agreements do not meet their objectives, ordinances are put in place to enforce energy efficiency standards. As regards the standby power consumption, the Swiss government has established voluntary agreements with two industrial associations. Target values related to standby and “off” mode energy consumption of 12 different categories of products were put in place between 1993 and 1995 with target dates from 1995 to 1999. From the 1st January 1999, the new energy law has superseded the energy consumption regulations while it still retains the target value instrument.[25] At the end of the defined period, 53% of household appliances and 97% of office equipment had met the targets. The average standby power consumption of new printers fell from 17 W in 1994 to 7 W in 1999. Although 40% of the printers had reduced their standby power use below 4 W, none of them had attained the target of 2 W.[26]

The effectiveness and acceptability of standards depend a lot on the time allocated between the development of standards and their implementation. This is particularly relevant in the context of standby power because the technology is evolving very rapidly which can change the achievable standard within a very short span of time. So if the standard enforcement period is long, there is risk of the standard being obsolete before it is implemented. On the other hand, if there is compulsion to implement standards very fast, industry would find it difficult to cope with the required technological changes and the unacceptable costs associated with it.

Box 5.
Japanese Initiatives to Reduce Standby Power through the "Top Runner" Programme

The "Top Runner" programme was established in March 1999 under Japan's framework legislation on energy efficiency as a regulatory measure for getting rid of energy inefficient products from the Japanese market. Starting with energy efficiency targets for 11 different products, the programme is expected to expand to include several other high-energy consuming products. The target value is set as the current performance level of the appliance with the highest energy efficiency (reference year is 1997 for all products except for motor vehicles). For example, energy efficiency of VCRs must be improved by 59% by 2003, and those of computers and magnetic disk units by 83% and 78%, respectively, by 2005. Targets are set for each product group in which the same target should be pursued and the compliance is assessed using the weighted average method than considering it product by product. Depending on the product category, the target period ranges from 4 to 12 years after which Top Runner standards will become mandatory minimum standard for both locally manufactured and imported products.

Progresses in technologies and environmental regulations are taken into account while setting the standards. This implies present targets will be revised if there is any technological breakthrough achieved before the target year. To accelerate the development of new technologies that can reduce standby power use, a research budget of Yen 500 million was allocated for a period of 2 years. The New and Industrial Technology Development Organization (NEDO) co-ordinates the activities of inviting proposals and selecting projects through examination by a group of experts.

In order to accelerate the efforts of manufacturers in meeting the targets ahead of the scheduled period and to widely disseminate information on the energy efficiency of different products among consumers, an energy efficiency labelling scheme is being established for household electrical appliances that include refrigerators/freezers, air conditioners, television and fluorescent lamps. The new label will indicate the annual consumption of the product concerned and degree to which the Top Runner target has been achieved.

Source: Ministry of Economy, Trade and Industry (METI), Japan.

Governments should not underestimate the costs of evolving test protocols and measurement facilities to ensure proper monitoring and enforcement of standards. This is particularly relevant to the large number of appliances that consume a lot of standby power.

VOLUNTARY APPROACHES

The standby power consumption issue is being addressed by a vast number of countries around the world through voluntary approaches. These can be either informal agreements without any legal bindings or negotiated instruments with penalties imposed in the case of non-compliance of agreed targets. In order for the voluntary agreements to be effective, it is desirable to have good understanding between government and industry. Moreover, proper monitoring system should be evolved and negotiations should not be very lengthy.

Voluntary agreements between industry and government enables industry to negotiate goals that are achievable and cost-effective within the proposed time frame (see Boxes 6 and 7). If targets are too strict, industry will not be attracted towards a voluntary programme. On the other hand, very lenient target will not achieve any significant savings. Experiences show that voluntary agreements have become very effective and flexible instruments in many parts of the globe, particularly in minimising the compliance costs to the industry. In some cases, the targets have not only been met but also exceeded within the agreed time period.

Box 6.

European Agreements to Reduce Standby Power Consumption

Voluntary codes of conduct are being developed by the European Commission in collaboration with two trade associations, the European Association of Consumer Electronics Manufacturers (EACEM) and the European Information and Communication Technology Industry Association (EICTA). These codes aim at reducing the standby power consumption of external power supplies and battery chargers, audio systems, and integrated receiver decoders. The European Union proposes to introduce these codes of conduct by 1 January 2003. The associations concerned have recommended their members to sign the code with the European Commission.

For audio systems, the target is set to reduce the standby power to 5 W by January 2001, 3 W by January 2004 and 1 W by January 2007. As for the wall-packs and battery chargers, the no-load power consumption target is set at 1 W by 1 January 2001 and 0.75 W by 1 January 2003. Manufacturers have slowly started signing the codes of conducts for different appliances.

The European Commission has also concluded voluntary agreements with EACEM to bring down the standby energy consumption of televisions and video cassette recorders. As specified by the agreement, the sales-weighted average standby power consumption of all units of a given manufacturer was not to exceed 6 W by 2000. Data available show a continuous drop in standby power consumption of the European televisions, from 7.5 W in 1995 to 3.7 W in 1999, which is well below the set target for 2000.

Source: European Commission, Directorate-General Energy and Transport

Monitoring and reporting are the two key elements in voluntary agreements as they can be effective in creating greater awareness. Some voluntary agreements require mandatory monitoring and reporting while others depend on the self-assessment of industries themselves. Yet another example is the contracting of a third party organisation for monitoring the compliance of set targets.

As more and more products are being sold across borders, industry is evolving voluntary standards for their universal acceptance and facilitating global trade. An industrial standard can be developed with the government involvement, but later incorporated into government regulation. Some widely recognised and international organisations such as the International Standardisation organisation (ISO) or the International Electro-technical Commission (IEC) are

often instrumental in making products technical specifications which are followed by most manufacturers, particularly those wishing to have one standard for their products irrespective of where they are sold.

Industry trade associations have also been instrumental in not only setting voluntary standards, but also developing and adopting test methods for products. They take into account the needs of the consumers as well as acceptability by the public regulators. Typical examples of such associations actively involved in evolving industrial standards are the American Association of Mechanical Engineers (ASME), the British Standards Institution (BSI) and the Japanese Industrial Standards (JIS).

The Japanese industry associations are very active in launching voluntary activities to reduce standby power consumption. The Japan Electronics and Information Technology Industries Association (JEITA), the Japan Electrical Manufacturers' Association (JEMA), and the Japan Refrigeration and Air Conditioning Industry Association (JRAIA) have pledged to reduce the standby power of television, air conditioner, audio system, and other household electrical appliances.[27] For example, the standby power of products in which standby power is integral to design will be reduced to 1 W or lower by the end of 2003 (for air conditioners, the target is end of 2004). For other major household electrical appliances, the aim is to attain values as close to zero as possible by the end of 2003.

Box 7.

Voluntary Agreement to Reduce Standby Power of Electrical Equipment in Korean Market

It is estimated that there are 90 million pieces of office equipment and home electronic products in Korea and an additional 20 million products are sold every year. Standby losses of these products represent over 2% of all the electricity consumption in the country.

The *Energy-saving office equipment and home electronics programme* is a voluntary agreement between the Government of Korea and the manufacturers. Launched in April 1999, it aims at encouraging manufacturers to produce and sell energy saving products that meet the standards set by the Korean Government. Altogether 12 items are covered under this agreement: computers, monitors, printers, fax machines, copiers, scanners, multifunction devices, televisions, video cassette recorders, home audio products, microwave ovens, and battery chargers.

The Ministry of Commerce, Industry and Energy (MOCIE) and the Korea Energy Managers Corporation (KEMCO) are responsible for promoting the products that qualify for the standard set to reduce the standby electric power. To recognise the efforts of the industry, it is mandatory for the government and related organisations to purchase products having energy saving labels. Companies interested in participating in the programme can apply to KEMCO with the energy saving product reporting form, test results, and photograph or pamphlet of the products. The test results can be obtained from the designated test organisations. The application results can be accessed through internet where a database of energy saving products is maintained.

Thirty-eight manufacturers had participated in the programme by 1999 and 656 models had met the standard set to save standby power losses. As many as 4 million energy-saving products representing 43% of market share had been sold, saving 2184 GWh of electricity.

Source: KEMCO, KEMCO's program to reduce standby power in electrical equipment on the Korea Market, 2001.1

LABELLING

Appliance labelling is a convenient tool for providing required information to the consumer for making purchase decisions and selecting efficient models. Energy-efficiency labels are affixed to manufactured products to describe their energy performances. The effectiveness of energy labels depends on how information is presented to the consumer. Moreover, most appliances sold in the market should be labelled instead of only a few products. Further, if consumers do not make effort to make distinction between efficient and inefficient appliances, increased awareness and labelling may not have much effect.

There are typically three types of labels found across the globe: endorsement labels, comparative labels and information-only labels. The endorsement labels are given if the performance of the appliance meets a set of specified criteria. Comparative labels allow consumers to compare performance among similar products. Information-only labels simply provide data on a product's performance.[28]

Appliance labelling can provide an effective way to monitor the market and compile information on market transformation. Public authorities and power utilities can use labels as energy efficiency benchmarks to offer incentives for buying energy efficient products.

Product labelling can carry different types of information; it can be related to only the energy performance of the equipment or to its many other attributes. Some labels include environmental criteria, such as the environmental impact of using a specific product, and are known as eco-labels. Mostly popular in Europe, these eco-labels often include the electrical power consumption of the device, during operating and in standby modes. Examples of such voluntary eco-labels include the EU eco-label promoted by the European Union, the *Baluer Engel* (or the Blue Angel) in Germany, and the *Nordic Swan* scheme in Finland, Norway and Sweden.

The most widely recognised labelling programme in the world is undoubtedly the "Energy Star", developed by the Environmental Protection Agency of the USA. Started in 1992 as an outcome of dialogue between the government, manufacturers, energy utilities, retailers, etc., this voluntary programme is designed to identify and promote energy efficient products in order to reduce carbon dioxide emissions. Operated jointly by the US EPA and the US Department of Energy (DOE), the programme establishes partnerships to promote products that meet certain energy efficiency and performance criteria cost-effectively. According to the EPA, more than 100 million Energy Star compliant products were sold in the USA in 1999 alone (see Box 8 for more details on the Energy Star programme). As many Energy Star compliant products are designed and manufactured by global multinational corporations and sold world-wide, consumers in almost all parts of the world recognise the Energy Star logo. In fact, the US EPA has licensed the Energy Star trademark to several countries, including Australia, Japan, New Zealand and Taiwan, and negotiations are on with the European Union and Canada. Several other countries are discussing to adopt some elements of the Energy Star program.[29]

In Europe, the Group for Energy Appliances (GEA) was initially started as a voluntary programme in 1996 (now established as a foundation since May 2001) in order to improve the efficiency of mainly home electric and electronic appliances. The products include audio and video systems, set-top boxes, wall-packs and battery chargers, personal computers and peripherals. With a membership of energy agencies from 8 European countries and the

European Energy Network (EnR), GEA aims at uniform communication and co-operation between European public and private energy agencies or organisations and relevant parties, such as manufacturers, importers and the European Commission. Each GEA member undertakes information campaigns that suit the national consumer market. The participating members use the GEA forum to exchange information on current activities as well as those planned for the future.

The GEA scheme is dynamic as criteria are revised regularly in close co-operation with industry involved. GEA works in good partnership with industry and industrial associations. The GEA label is voluntary in nature, which indicates that appliances have energy performances that are within 25% of the most efficient products sold in the market.[6]

[6] A full list of products with GEA label and their performances can be downloaded from the GEA web-site (http://www.gealabel.org). Also, there are national web-sites for different participating countries where activities to promote GEA label products are recorded along with the distribution list.

Box 8.

The Energy Star Program Transforming Markets for Energy Efficiency Products

The mission of the Energy Star program is to realise significant reductions in emissions and energy consumption by permanently transforming markets for energy-consuming products. Launched in 1992, it was initially aimed at computers, monitors and printers. Now the Energy Star label has expanded to cover over 30 consumer product categories, including residential heating and cooling equipment, major appliances, office equipment, lighting, consumer electronics, and many more products. The programme has forged partnership with over 1200 enterprises who have signed agreement to produce at least one product that meets the Energy Star criteria. Research support is extended to products and industry in order to explore new programme opportunities and update specifications of existing products. Evaluation criteria include the potential for improvements in unit energy savings, size of the stock, turnover rates, industrial acceptance, and visibility of the product with consumers.

Energy Star has achieved the greatest market penetration in the office equipment market. It is estimated that 80% of computers, 95% of monitors, and 99% of printers sold in the USA are Energy Star compliant. Focus has also been on reducing power consumption of products that are not actively in use. Over 1000 Energy Star compliant television, VCR, audio and DVD products are flooded in the market. Televisions, VCRs, home audio and DVD products using Energy Star logo consume up to 75% less energy than conventional models when switched off.

Efforts have been made to forge partnerships with national programmes for mutual benefits. Synergistic interaction with the Federal Energy Management Program (FEMP) has helped in market transformation and in lowering the price of Energy Star products. Thanks to the interaction with the Federal appliance standards program, development of Energy Star specifications has become much simpler by adopting the reference efficiency levels for some Energy Star products.

Source: US EPA (web-site: http://www.epa.gov/nrgystar); LBNL (web-site: http://enduse.lbl.gov/Estar.html)

OTHER COMPLEMENTING POLICIES

Other policies complementing the ones described above include market transformation initiatives, technology procurement programmes, introduction of economic instruments, awareness campaigns, database development, etc.

The International Energy Agency is developing an initiative on International Collaboration on Market Transformation, with the main objective of increasing the market share of energy-saving products and accelerating the use of the most efficient technologies. The focus is on energy rating, labelling, quality marks, and procurement of energy-efficiency products. The initiative will include information exchange and research and co-operative market transformation projects that will allow interested countries to jointly participate in accelerating market transformation.

The UK Market Transformation Programme (UKMTP) is a government initiative to provide energy consumption information to consumers and help them make purchase decisions. Its aim is to build consensus among stakeholders on market projections for energy consumption and develop scenarios for 10 to 20 years so that appropriate measures can be considered to limit energy use.

Technology procurement programmes encourage innovation by guaranteeing the purchase of very efficient products by large institutions and private companies; due to the size of bulk purchase contracts, the cost of the product can be lowered considerably. Moreover, the publicity gained by the technology supplier through the procurement programme helps to enhance visibility and marketability of the product. Since technology procurement is aimed at bringing in significant innovations in the design of the product, the time period between the launching of procurement contract and delivery of product can be lengthy. This can lead to some uncertainties in the mind of the buyer about when the product will actually be delivered and whether it will meet the defined energy efficiency criteria.

Economic instruments can provide incentive to the consumer for saving energy through the purchase of more efficient appliances. Typical instruments include energy taxes, tax credits, fees and rebates, etc.

Energy taxes increase the cost of energy and the energy bill of the consumer. Their effectiveness depends on the response of the consumer in adopting energy cost saving alternatives. If demand for energy efficient appliances increases and the manufacturer makes efforts to meet this demand, then energy tax becomes an effective tool. Experience shows that energy taxes alone do not have a significant impact on the energy efficiency of the product. However, tax credit or tax exemption measures are found to be more effective in influencing the decision-making of consumers by providing them direct financial incentives and increasing the demand for energy efficiency products.

Fees raise the cost of energy efficient products and rebates reward consumers for buying more efficient products. When the two instruments are combined, the fees collected from the sale of inefficient products can be channelled to finance rebates for efficient products. Rebates have been offered by power utilities in several countries to encourage the use of efficient electrical appliances and avoid the construction of expensive power plants that would have been required to meet the high demand during utility peak periods.

FUTURE DIRECTIONS AND THE NEED FOR INTERNATIONAL COLLABORATION

Experiences gained around the globe show that voluntary labelling seems to be the most widely accepted measure for addressing the issue of standby power losses. So far, the “Top Runner” is the only mandatory programme in the world to deal with standby power consumption, but no other country plans to enforce mandatory standards.

At the same time, positive interaction and partnership between government and industry have led to substantial innovative technological progresses, and targets have been set realistically and met cost-effectively.

Policy instruments and programmes adopted by several countries to contain the standby power losses were elaborated in the previous section. Despite the success of various initiatives reported, much needs to be done for covering all products that consume standby power and for pushing majority of products to reach the 1 W goal in standby mode. Most initiatives of the countries so far do not separately deal with the issue of standby power use; they are generally considered as an added feature to the energy efficiency standards and labels of the appliances concerned.

The electronic industry is evolving very fast and the standby power consumption is expected to rise further with the proliferation of new electronic products and development of networked homes and offices. There is a consensus among policy makers and stakeholders that it should be possible to decrease the standby power consumption considerably at a much lower cost than that invested in power plants which are simply run to provide the standby power. An added advantage of such electricity savings will be the cost-effective reduction of CO_2 emissions.

There are several global players involved in manufacturing and distributing home and office electrical/electronic products. Differences in standards and their implementation criteria laid out in different countries can create hurdles for these players who have to spend more time and resources to comply with the specific requirements of each country. With present market conditions, products manufactured in one country are often distributed in many others; producers have to plan their production schedule for manufacturing several versions of the same appliance according to the demand. Due to the fierce competition in the market, any increase in production costs for complying with standby power regulations cannot be easily passed on to consumers.

The problem is further complicated by the fact the electronic industry is changing very rapidly and more and more new products are introduced to the market. It will be rather difficult for individual countries to cope with the rapid changes taking place in the market.

The above drawbacks call for co-ordinated efforts among countries for developing universally accepted solutions that can transform the market and encourage manufacturers in employing low-loss designs and components. Such international co-operation can help to streamline the number of regulations and policies that vary from one country to another, thereby reducing the administrative burdens and associated costs on government programmes. They will also help manufacturers to reach economies of scale for adopting advanced standby technologies and management features into their products. By undertaking in-depth analysis of the current situation at the global level in terms of the dynamics of the market, major players, main barriers, etc., forecast can be made on the future market trends, technological innovations, introduction of new products, market volume, etc.

Instead of duplicating efforts, existing regional and international forums and programmes can be used as platforms for addressing standby power loss issues. For example, the Asia Pacific Economic Co-operation (APEC) has an action programme for energy that is working towards common action on standards and protocols. The objectives are an increased harmonisation of energy standards of products and appliances for reducing costs to both governments and businesses. Similarly, the International Energy Agency (IEA) which primarily deals with energy issues for developed countries, can provide legal frameworks for international co-operation and facilitate the evolution of an international approach to standby power. In fact, IEA Implementing Agreement on Demand Side Management already deals with energy efficiency research and focuses on market transformation activities to create greater demand for energy efficient products.

International collaboration could aim at establishing an international voluntary programme that takes into account views and achievements of industries and governments, and harmonise the existing regulatory schemes. It will help to avoid the proliferation of labels and labelling schemes launched by individual countries and eliminate the confusion created for the industry. In this context, the Energy Star programme of the US EPA seems to have a world-side acceptance in view of its adoption by several countries around the globe and on-going negotiations with some governments. An *International Energy Star programme* could be adopted for defining the limits of standby power use, and harmonised with existing regulatory schemes, such as the Top Runner Programme of Japan.

Countries in the Asia-Pacific region who have just taken note of the magnitude of the problem and/or have not yet set up policies and programmes to deal with standby power losses can actively support and participate in such an international voluntary programme that could:

- take care of developing guidelines for lowering standby power of existing as well as new appliances and products, and enhancing voluntary agreements with the industry;
- initiate research and development activities with industry participation for exploring new techno-economic solutions to reduce standby power use;
- help in revising the existing energy labels of appliances to include information on standby power use (No need is perceived for evolving a separate label for indicating the standby power use of appliances).

This will allow the countries of the region to concentrate their efforts on educating and informing consumers about the issue of standby power, thus accelerating the demand for energy efficient products and appliances.

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