International Workshop on

Energy Efficient Set-Top Boxes & Digital Networks

International Energy Agency, Paris, France.

4-6 July 2007

Summary Report

Contents

Presentations from the workshops can be downloaded from:

http://www.iea.org/textbase/work/workshopdetail.asp?WS_ID=285

Chairman's Summary

Almost 100 participants from 15 countries attended a series of meetings at the IEA in Paris held between the 4th and 6th July to discuss issues concerning energy efficient set-top boxes and digital networks, including a side meeting on televisions[1].

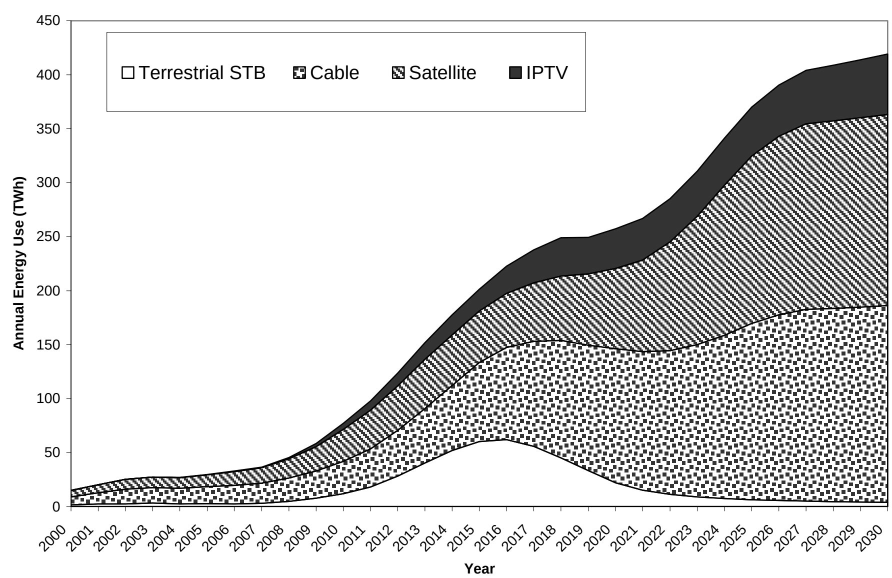
These meetings build on a previous IEA workshop held in 2004 on the subject of set-top boxes; and two related IEA recommendations made to the G8 Summits at St Petersburg [2006] and in Heiligendamm [2007]. These recommendations are provided in Appendix 5.

The aim of these 2007 IEA meetings is to assist countries to implement the IEA recommendations by:

- encouraging dialogue among countries; and between governments and industry
- developing consensus positions for policy approaches
- exploring the potential for international harmonisation
- identifying areas which need further exploration/work

IEA modeling based on industry projections shows that without policy intervention, electricity consumption from set-top boxes will rise considerably in most countries. By 2030 global demand may reach 400 TWh per year (see Figure 1), approximately equivalent to the total electricity of consumption in France in 2005. This figure does not include the consumption from TVs, media centres, gaming consoles and other products which are part of the package of home entertainment devices increasingly seen in today's households.

Figure 1: Estimated energy consumption from set-top boxes (IEA)



While many countries have moved to develop and implement policies for free-to-air digital TV converters ('Simple Set-top Boxes"), the vast majority of the estimated growth in electricity consumption will come from boxes associated with pay TV and which offer a wide variety of functionality.

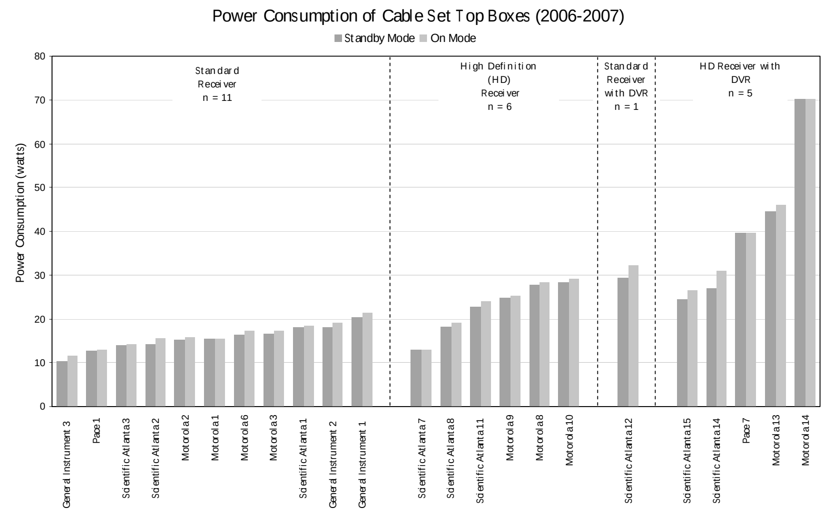
Indeed, one theme which ran throughout these workshops was the challenge of how to encourage greater efficiency amongst set-top boxes with different platforms whose functionalities are divers and evolving so rapidly.

[1] Co-ordinated meetings on closely related topics, organised by the European Code of Conduct for Digital TV Services and the International Taskforce for Sustainable Products took place earlier in the week.

A second major theme was the key role that TV Service Providers play in influencing the energy consumption of set-top boxes. This is not only because it is usually the Service Provider who either provides or specifies the box used by the end customer; but also because in practice Service Providers require boxes connected to their systems to be fully ‘on’ most of the time.

Recent measurements the U.S. which were presented at this workshop (see Figure 2) clearly illustrated the point that the power consumption of most set-top boxes used to provide pay-TV services did not vary between when they were ‘on’ and when they were in low power ‘standby’ mode.

Figure 2: U.S. Measurements of set-top boxes



Key: LH grey column=standby RH yellow column = on mode

These workshops recognised that the role of the Service Provider provides some unique challenges for energy efficiency policy which must be faced if the growth in pay TV services is to avoid substantial increases in electricity consumption.

Simple Set-top Boxes

While acknowledging that the simplest kind of set-top boxes for free-to-air TV services (sometimes referred to as digital television adaptors, digital-to-analogue converter boxes or DTAs) will represent a diminishing proportion of the overall set-top box market in the future, the roll-out of digital TV means that sales from 2007 to 2020 are still significant and may result in global annual electricity consumption of 60 TWh.

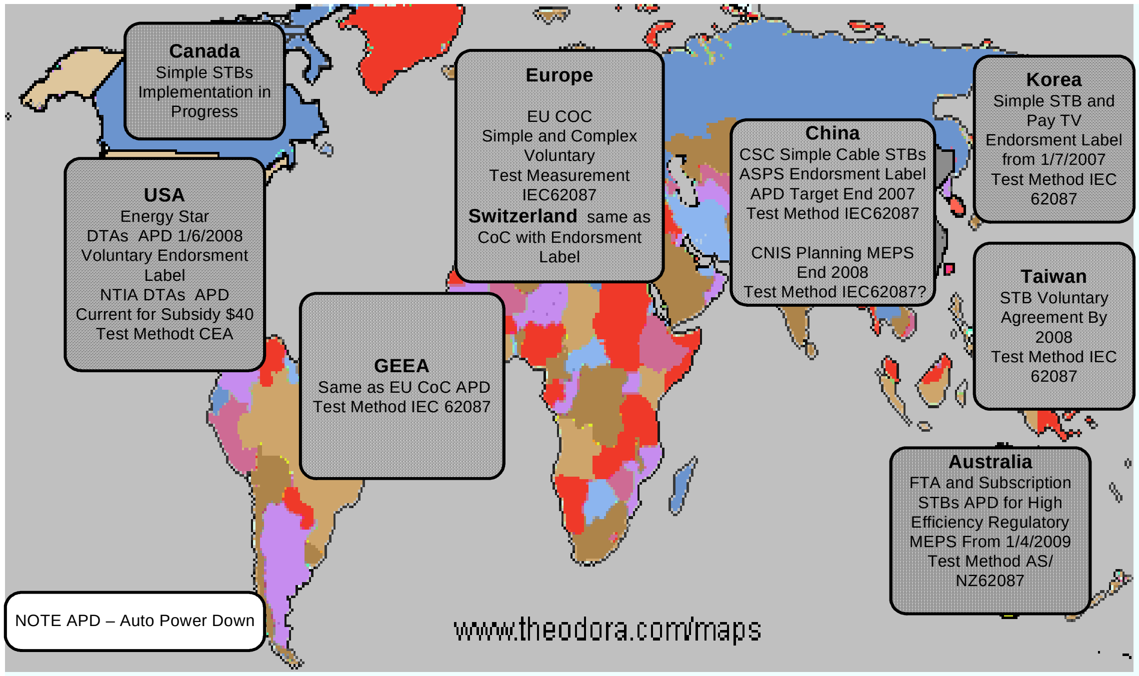
Low energy products are available in the market and provide up to 50% savings opportunities; however the uptake of these technologies will not occur without policy intervention.

Participants heard that since 2004 progress has been made in the development and implementation of policies for these products and several countries are moving ahead with voluntary and mandatory policies and programmes (see Fig 3 and Appendix 6).

The majority of countries use the international test methodology IEC 62087 to measure energy performance, although the CEA industry standards are used in the U.S. Both are similar and appear adequate for current purposes, although there is support for revisions to IEC 62087 with a view to ensuring that it is relevant for all current products.

Despite variations in products and platforms used in different markets, there is considerable harmonization amongst different programmes with respect to the performance criteria used.

Figure 3: National/regional programmes for Set-top Boxes (see also Appendix 6)

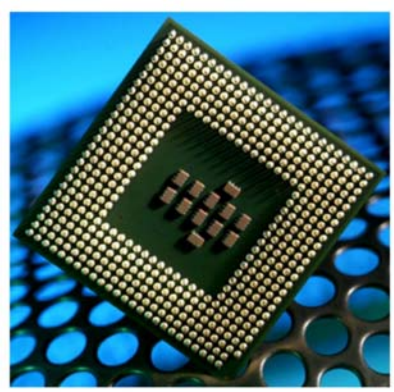


The key message was that if energy savings are to be made in this area, countries need to put in place and implement policy measures without delay. The range of programmes currently implemented and the existence of test methodologies removes the need for countries to develop unique approaches, and provides a basis for best practice policy in this area.

Complex Set-top Boxes

The IEA estimates that the global consumption of electricity by 'complex' set-top boxes (i.e. those with conditional access) may rise from 34 TWh in 2007 to 415 TWh by 2030.

The workshop provided an opportunity for participants to understand the issues faced by set-top box manufacturers, software providers, and TV service providers; and to be updated on national policy development.



Participants learnt that although the increasing functionality of boxes has tended to increase energy consumption, there are technical solutions. These opportunities are to be found in all co-ordinating aspects of set-top box design, including both the hardware and the software. However power management must be included in the design brief from the outset in order to optimize the considerable energy saving potential.

In addition to technical improvements to the hardware and software, very substantial energy savings can also be realized through changes in the way that TV Service Providers deliver services to their boxes. Enabling boxes to enter lower power states when not being used by the consumer, while still maintaining appropriate access for the Service Provider, is one example where major savings can be made.

However, at the moment there are only weak incentives for the Service Provider to invest in more efficient set top boxes or energy-saving actions since the customers pay for the electricity consumption associated with the services provided through the set-top boxes. Most consumers have limited opportunity to influence the overall energy consumption of their service, since the TV Service Provider typically establishes the technical specifications for set-top boxes used, and determines the power levels needed when consumers are not viewing content.

The only direct economic driver for Service Providers to improve efficiency identified in this workshop was the reduction of component failures due to overheating. On the other hand, it was noted that the addition of power management can cause confusion for consumers and an increase in technical enquiries, which are extremely costly.

Public relations benefits associated with reduced emissions of greenhouse gases have, in at least one case, given an impetus for Service Providers to act, suggesting that programmes to encourage carbon reductions may provide an incentive. The example of BSkyB in the UK, which has introduced a range of energy efficiency measures including an auto power down function, clearly demonstrated that many of the technical difficulties can be overcome with sufficient support from management.

It is clear that Government intervention is required to stimulate Service Providers to focus on energy efficiency, and a range of policy approaches were discussed - from information programs to mandatory regulations.

The European Code of Conduct on Digital Television Services, which was established in 2000 to set voluntary energy performance targets for many of these more complex set-top boxes (in addition to the simple devices), provides an excellent starting point for understanding the opportunity for new programmes.

Energy Star in the United States has recently launched a new programme, the details of which are still under negotiation. In addition to offering the Energy Star endorsement label for TV for compliant set-top boxes, a new programme is proposed for TV Service Providers. The first draft for Cable, Satellite, and Telecom Service Providers proposes criteria based on the deployment of a specified percentage of Energy Star compliant boxes, auto-power down functions, and user interfaces to inform subscribers of their efficiency opportunities.

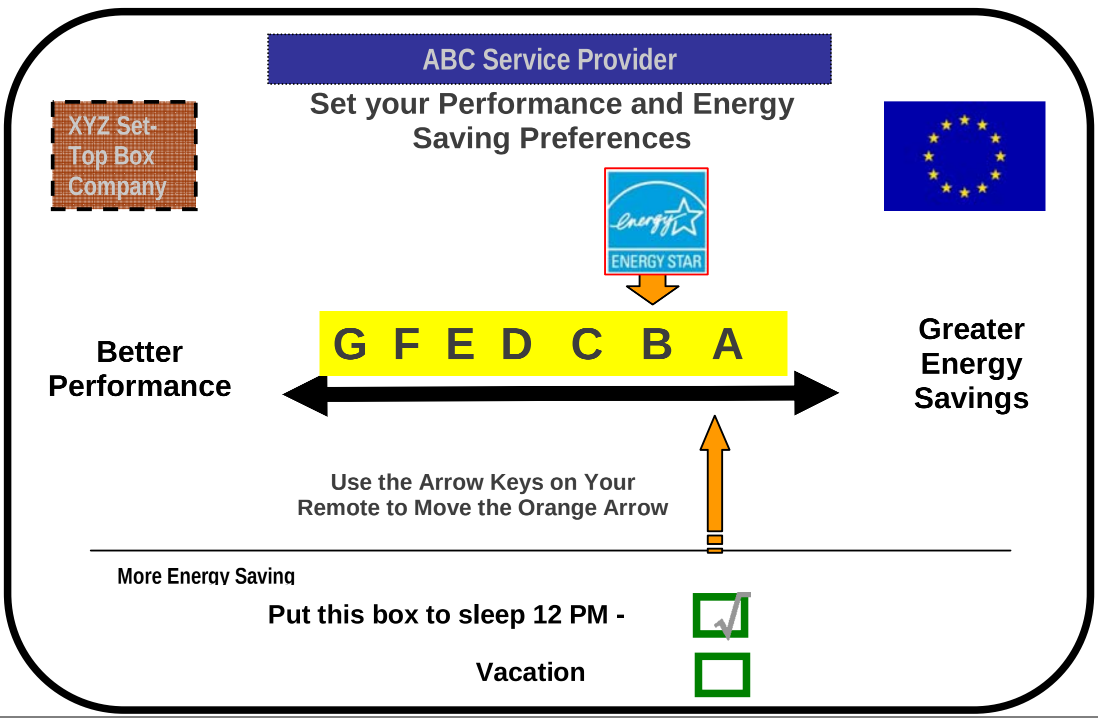
It was noted that Governments will inevitably seek greenhouse savings from set-top boxes and related areas, and that industry participation in voluntary schemes (such as those above) may delay or reduce the need for mandatory policies. There are also considerable opportunities for further innovative policy measures in this field, and industry collaboration in the design of effective policies should be encouraged. In this light, some other ideas were discussed by participants.

One example, illustrated in Figure 4, was for a set-top box control panel displayed on the TV screen, which benchmarked the performance of the box and provided the customer with options to reduce energy consumption by turning off features not required.

Another policy approach discussed was to make the Service Provider responsible for the electricity bills of set-top boxes, thereby providing a strong incentive to the Service Provider to implement energy-saving measures. Such actions might be necessary if voluntary programs prove ineffective or the split incentives problem could not be otherwise solved.

Figure 4: Illustrative set-top box control panel

Control Panel with European A - G Rating



The workshop showed that the development of policy in this area will require the collective input from all stakeholders, and that meetings like these also provide the opportunity to share experiences amongst different countries which are facing similar issues. International collaboration not only enables us to examine the effectiveness of different approaches but also to explore the potential for future harmonization, which is of benefit to manufacturers and policy-makers.

Digital Networks

In the future, there will be a growing number of networks joining the devices within buildings which provide lighting, entertainment, IT, communication, climate, security and other services. Increasingly the activities of one piece of equipment will influence the energy consumption of others. The workshop on Digital Networks addressed the question of how to minimize energy consumption by future networked equipment.

While networks have the potential to increase energy efficiency through increased control and power management capabilities, the experience with electronic networks is that this will not occur naturally. Commercial pressures will tend to place other design priorities ahead of energy efficiency – for example promoters of specific technologies will resist opportunities for interoperability in order to maintain market share. (See background paper in Appendix 3)

The workshop began by hearing presentations from experts in the fields of electronic equipment, lighting controls, building HVAC and self-powered sensors. Each described the emergence of digital networks in their field which will lead to more connectivity amongst equipment to provide a range of services in buildings and to consumers. Connectivity provides many opportunities for increasing the management of energy use, so that services such as lighting and space conditioning are tailored to meet occupancy requirements, and so electronic devices are powered down when not required. However, the presentations also showed that energy efficiency is seldom a priority in the design of future connected devices, with the consequence that the ability to minimize energy consumption of connected equipment may be limited unless steps are taken soon.

Participants also heard from presenters who have been involved in existing energy efficiency projects related to networked electronic devices. This highlighted the difficulties of tackling power management issues once the protocols and standards governing networks have been put in place, and once proprietary protocols have been introduced.

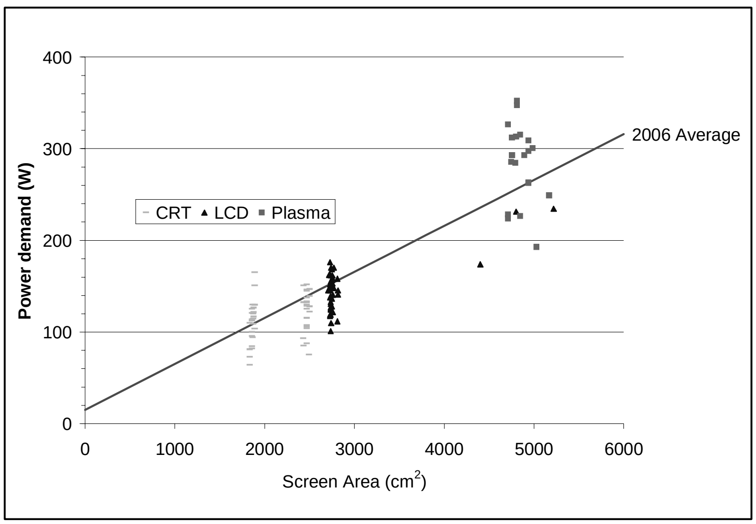
The alternative is to ensure a foundation is adopted for devices to be interoperable with each other and with people in ways that maximise energy efficiency. As a result participants in the workshop reviewed a set of proposed Guiding Principles (see Appendix 4) for the design of energy efficient networks and equipment linked to the network. These principles specify the behaviour of equipment on a network, and provide a design framework for any networked device to ensure the lowest possible use of energy.

Considerable work will be needed to enshrine these Guiding Principles into the many diverse industry and international standards that accomplish this interoperability, and into the specifications of energy efficiency programmes such as Energy Star, the UK Market Transformation Programme and the European Code of Conducts.

Televisions

In most countries the energy consumption of televisions has been growing rapidly over recent years, driven by the increased penetration rates and screen sizes, which have more than offset the savings due to the switch from CRT to LCD technology. As a result, many countries are developing national energy efficiency programmes. This workshop provided an update of international harmonisation initiatives and enabled participants to discuss further opportunities.

In the workshop participants heard of the progress with the revised test method IEC 62087 for television on mode, which will be published early in 2008. This modernizes the existing standard to provide an accurate basis for the comparison of on mode performance of all TV technologies; and the first measurements according to this methodology was presented for approximately 250 models from the UK and US.



Participants also gained an insight into the proposed approaches being considered by Energy Star, the UK Market Transformation Programme and the Australian Greenhouse Office. Typically energy efficiency specifications will be technology neutral (i.e. applying equally to all types of TVs), and will include requirements for both standby and on mode consumption. On mode performance will be measured on the basis of energy consumption per unit display area (W/cm^2 or $W/inch^2$).

There is now the opportunity for international collaboration amongst national programmes to agree on a uniform set performance requirements which would be used for all programme types. These 'tiers' should reflect a range of stringencies so that they would be applicable to both voluntary and mandatory programmes, suitable for promoting the best performing products or establishing minimum performance levels.

This degree of harmonisation has been achieved previously for external power supplies and provides considerable benefits to both manufacturers and Governments, and this approach was endorsed by the workshop participants.

Forward Directions

It is evident from this series of workshops that product design and markets are developing at an increasingly rapid rate. Consequently there has been a growth in national energy efficiency programmes, many of which are dealing with similar issues for products which are globally traded. Considerable progress on international harmonisation has been made since the last IEA Set-top Box workshop, and previous international meetings on televisions; however it is clear that there are still substantial challenges ahead.

A number of projects were identified during the three days of workshops, including:

- The need to involve and seek greater participation from developing countries and particularly those where many of the products under consideration are manufactured.
- The need to provide clear guidance to countries considering policies for simple set-top boxes (DTAs) so that these can be adopted without delay. The International Task Force for Sustainable Products and IEA will consider producing a brief fact sheet for dissemination.
- An international test procedure suitable for complex set-top boxes to measure the energy performance in all modes of operation. Standards Australia will be asked to request a new work item under TC100 to undertake a review of IEC 62087 and recommend revisions if necessary.
- Further test data for set-top boxes and televisions should be collected for analysis to support policy development for these products.
- The development of energy performance tiers for televisions, with particular reference to Energy Star, EU Eco-design, China Standards Certification Center and the Australian Greenhouse Office. The International Task Force for Sustainable Products and IEA will consider how best to co-ordinate this activity.
- Approach IEC regarding Digital Networks and the adoption of the Guiding Principles into future standards. The IEA will make a presentation to TC100 in October 2007 on this topic.

- The IEA has made recommendations to the G8 Leaders at the Summits in 2006 and 2007 regarding Set-top boxes and Networked equipment (see Appendix 5). The IEA will make further recommendations as appropriate to the 2008 Summit in Japan.
- It was generally agreed that a follow-up meeting should be held, possibly in California in 2009.

International workshops such as these provide an opportunity for Governments, industry and experts to identify the opportunities for collaboration, co-operation and harmonisation, but are necessarily infrequent and do not in themselves tackle on-going projects.

In recent years, 'Communities of Practice' have arisen which have drawn together interested parties to undertake projects to foster international co-ordination focused around specific products, eg. Compact fluorescent lamps and televisions. In order to provide a more structured framework for these types of activities, the IEA has launched a new Implementing Agreement on Efficient End-Use Electrical Equipment, supported by member countries. It will provide a mechanism for countries to work collaboratively on specified tasks in support of policy development (For further details see http://www.iea.org/textbase/work/workshopdetail.asp?WS_ID=315).

The new Implementing Agreement is currently defining its scope of work with the intention of encouraging participation by non-IEA countries and relevant industrial partners, and will be operational during 2008. Many of tasks identified during the three days of IEA workshops, amongst others, could ultimately be undertaken through this mechanism.

Mark Ellis

International Energy Agency

Paris

8th August 2007

Presentations from the workshops can be downloaded from:

http://www.iea.org/textbase/work/workshopdetail.asp?WS_ID=285

Appendix 1: Agendas

Day 1 – July 4

SETTING THE SCENE	
9.15	***Welcome and Opening Address*** Mr Claude Mandil, Executive Director, International Energy Agency, Paris
9.30	***Energy efficient Set-top boxes: a challenge for everyone*** Alan Meier, Lawrence Berkeley National Laboratory, USA
10.00	***Categorising STBs – simple or complex?*** Hans-Paul Siderius, SenterNovem, Netherlands
10.30	*Coffee*

SIMPLE SET-TOP BOXES Moderator: Stephan Kolb, European Commission DG-TREN	
11.15	***Achieving energy efficiency in simple STBs*** Paul Fellows, CEO, TVONICS Qiao MU, Skyworth Digital Technology, China
12.15	***Summary of National Programs & Test Methods for simple STBs*** Bob Harrison, UK Market Transformation Programme & Keith Jones, Digital CEnergy, Australia
12.45	*Lunch*
14.15	***Key elements of performance criteria for simple STBs*** Mark Ellis, International Energy Agency, Paris
14.30	***Discussion and Conclusions***
15.30	*Coffee*

TELEVISIONS Moderator: Noah Horowitz, Natural Resource Defense Council	
16.00	***Update of TV Test Method*** Jon Fairhurst, IEC TC100 TV Power Measurement Project
16.20	***Proposed principles for energy efficient TV policies*** Katharine Kaplan, Energy Star, USA
16.40	***How to specify energy efficiency in all TV modes*** Kevin Lane, UK Market Transformation Programme
17.00	***Energy performance benchmarks for TVs*** Keith Jones, Digital CEnergy, Australia
18.30	*IEA Reception*

Day 2 – July 5

COMPLEX SET-TOP BOXES Moderator: Chris Baker, UK DEFRA	
9.00	***A roadmap for STBs in the future*** David Holliday, BSkyB, UK
9.40	***The energy performance of current products*** Noah Horowitz, Natural Resource Defense Council, USA
10.15	***The role of service providers and energy efficiency*** Terence Smith, Austar, Australia
11.15	***Coffee***
11.45	***How to improve the efficiency of complex STB*** Paul Entwistle, Pace, UK Dave Clark, Scientific Atlanta, USA Christopher Stone, Motorola, USA
13.00	***Lunch***
Moderator: Melanie Slade, Australian Greenhouse Office	
14.30	***What would a coherent policy to maximize efficiency for complex STBs encompass?*** Matthew Armishaw, Bob Harrison, UK MTP, and Keith Jones, Digital CEnergy, Australia
15.00	***How to ensure efficient home entertainment networks?*** Bruce Nordman, Lawrence Berkeley National Laboratory, USA
15.30	***How to encourage service providers to lead energy efficiency?*** Chris Baker, DEFRA, UK
	Coffee
16.00	***A policy for efficient complex STBs*** Paolo Bertoldi, JRC, European Commission
16.30	***Priorities for Action: panel discussion*** David Holliday, Katharine Kaplan, Noah Horowitz, Chris Baker, Mark Ellis, Alan Meier
18.00	***Close***
18.30	***Reception sponsored by PACE***

Friday, July 6

Session 1	***THE NETWORK CONTEXT***
9:15	***Welcome by Workshop Chair*** Mark Ellis, IEA
9.25	***What we learned about network issues from the previous 2 days*** Mark Ellis, IEA
9.35	***"The problem - opportunities & threats" and the vision for 2027*** Alan Meier, LBNL
9.45	***The 7-layer OSI network model*** Bruce Nordman, LBNL
9.10	***Energy requirements for networks*** Bruce Nordman, LBNL
10:10	***Coffee break***
Session 2	***VISIONS FOR 2027***
10:40	***Introduction by Session Chair*** Bill Belt, CEA (invited)
10.45	***Electronics*** Richard Banks, Microsoft
11.15	***Lighting*** Ronald Tol, Philips Lighting
11.45	***Climate Control*** Friederich Kupzog, TU Wien
12.15	***Wireless sensors/actuators/controls*** Armin Anders, Enocean
12:45	***Lunch***
Session 3	***INSTANCES WHERE PROGRAMMES HAVE TACKLED NETWORKING*** ***3 minute updates***
14.15	***Introduction by Session Chair*** Alan Meier, LBNL
14.20	***Digital Television Adapters in the U.S.*** Noah Horowitz, NRDC
	Energy Star computer specification Tom Bolioli, Terra Novum
	LBNL network project Bruce Nordman, LBNL
	Network-induced energy consumption in Korea Nam-kyun Kim, KERI
	EU Codes of Conduct: Broadband equipment Paolo Bertoldi, EU
	Thermostats: T-stat as network Alan Meier, LBNL
	Market Transformation Program activities Kevin Lane, UK MTP
	Energy Efficiency Network Project in Japan *speaker to be determined*, METI
	IEC TC 100 Activities Jon Fairhurst, Sharp
15.00	***Discussion***

Session 4	WHAT ENERGY EFFICIENCY REQUIRES FOR FUTURE NETWORK ARCHITECTURE
15:20	***Introduction by Session Chair*** Nigel Jollands, IEA
15.25	***Introducing the Guiding Principles*** Bruce Nordman, LBNL
15.35	***Discussion*** • What principles should guide energy efficiency for networks? ***Concrete Actions*** • What areas of research are needed? • What technical and industry standards needs to be developed or amended? • What directions can we recommend for energy efficiency policy?
16.30	***Next Steps — How to implement***
17.10	***Summary from Session Chair*** Nigel Jollands, IEA
17.20	***Summary from Workshop Chair*** Mark Ellis, IEA
	WORKSHOP ADJOURNS
17:30	***Informal dinner to continue discussion***

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Appendix 2: List of Participants

Title	Firstname	Name	Company	Country
Mr.	Armin	ANDERS	ENOCEAN	Germany
Mr.	Alain	ANGLADE	ADEME	France
Mr.	Matthew	ARMISHAW	AEAT	U.K.
Mr.	Marc	AUBREE	France Telecom	France
Mr.	Richard	BANKS	MICROSOFT	U.K.
Mr.	Chris	BAKER	DEFRA	U.K.
Mr.	Marc	BARBONI	ON Semiconductor	U.S.A.
Mr.	Christophe	BASSO	ON Semiconductor	U.S.
Ms.	Sharon	BECKER	Greenpeace International	Netherlands
Mr.	Bill	BELT	Consumer Electronics Association	U.S.
Mr.	François	BENARD	Philips Set-Top Boxes	FRANCE
Mr.	Paolo	BERTOLDI	European Commission	E.U.
Mr.	Jim	BEVERIDGE	MICROSOFT	
Mr.	Thomas	BOLIOLI	Terra Novum	U.S.A.
Mr.	Don	BROOKS	Foxtell Management Pty Limited	Australia
Mr.	Hans-Joachim	BRUCH	Energieeffizienz und Satellitensystem-Beratung	Germany
Mr.	Roland	BRÜNIGER	Swiss Federal Office of Energy	Switzerland
Ms.	Sheila	CASSELLS	BSkyB	U.K.
Mr.	Mete	CESMECI	VESTEL Dijital	Turkey
Mr.	Dave	CLARK	Scientific Atlanta	U.S.
Mr.	Chip	COOKSTON	Scientific Atlanta	U.S.
Mr.	Laurent	CRINON	Sigma Designs Europe	
Mr.	Rafael	DAVID	Electrobrás	Brazil
Ms.	Muriel	DESCHANEL	MICROSOFT	FRANCE
Ms.	Dominique	DUMORTIER	ON Semiconductor	U.S.
Mr.	Mark	ELLIS	IEA	France
Mr.	Paul	ENTWISTLE	PACE	U.K.
Mr.	Jon	FAIRHURST	IEC TC100 TV Power Measurement Project	U.S.
Mr.	Richard	FASSLER	Power Integrations	U.S.
Mr.	Paul	FELLOWS	TVONICS	U.K.
Mr.	James	FIELD	NDS Ltd.	U.K.
Ms.	Hélène	FONTAINE	AMD	France
Mr.	Rafal	FRAC	Permanent Representation of Poland to the OECD	Poland
Mr.	George	FULLAM	Intellect UK	U.K.
Mr	Boris	HARLE	Conexant Systems	France
Mr.	Bob	HARRISON	MTP	U.K.
Mr.	David	HOLLIDAY	BSkyB	U.K.
Mr.	Mikael	HOLST	Energimyndigheten	Sweden
Mr.	Noah	HOROWITZ	NRDC	U.S.
Mr.	Marc	JANIN	CODDE	France
Ms.	Emilie	JOHANN	Greenpeace International	France
Mr.	David	JONES	PANASONIC	U.K.
Mr.	Keith	JONES	CENERGY	Australia
Ms.	Katharine	KAPLAN	US EPA	U.S.
Mr.	Nam-Kyun	KIM	KERI	Korea
Mr.	Yungrae	KIM	KEMCO	Korea
Mr.	Juergen	KNOPP	Siemens	Germany

Title	Firstname	Name	Company	Country
Mr.	Stephan	KOLB	E.U. Commission	E.U.
Mr.	Friederich	KUPZOG	TU Wien	Austria
Mr.	Kevin	LANE	UK Market Transformation Programme	U.K.
Ms.	Carole	LE GOFF	Thomson	France
Mr.	SangHak	LEE	Korea Electronics Technology Institute	S. Korea
Mr.	Maphuti	LEGODI	SA Department of Minerals and Energy	South Africa
Mr.	Alan	LLOYD	STMicroelectronics	U.K.
Mr.	Shudong	LUO	Huawei Technologies	Germany
Mr.	Darcy	MARTINEZ	EPA Energy Star	U.S.
Mr.	Alan	MEIER	LBNL	U.S.
Mr.	Matthias	MEIER	Motorola	Germany
Mr.	Rafael	MEIRELLES DAVID	Eletrobras	Brazil
Mr.	Peter	MILES	EchoStar Europe	U.K.
Mr.	Qiao	MU	Skyworth Digital Technology	China
Mr.	Shailendra	MUDGAL	Bio Intelligence	France
Mr.	Robin	MURRAY	MTP	U.K.
Mr.	Bruce	NORDMAN	LBNL	U.S.
Mr.	Alexandre	NOVGORODCEV	INMETRO	Brazil
Ms.	Denise	OAKLEY	MTP	U.K.
Mr.	Ki Won	PARK	KEMCO	Korea
Mr.	Simon	PARNALL	NDS	U.S.
Mr.	Neil	QUARMBY	Texas Instruments	U.S.
Mr.	Bertrand	QUENARD	ON Semiconductor	France
Mr.	Blair	SCHODOWKSI	Scientific Atlanta	U.S.
Mr.	Theo	SCHOENMAKERS	Philips	Netherlands
Ms.	Victoria	SEMMEL	BSConseil	France
Mr.	Hans-Paul	SIDERIUS	Novem	Netherlands
Ms.	Melanie	SLADE	AEAT	Australia
Mr.	Terence	SMITH	AUSTAR	Australia
Mr.	Lutz	STOBBE	Fraunhofer IZM	Germany
Ms.	Christopher	STONE	Motorola	U.S.
Mr.	James	THOMSON	Cullen international	Belgium
Mr.	Ronald	TOL	Philips Lighting	Netherlands
Mr.	Robert	TURNER	PACE Micro	U.K.
Mr.	Klaus	VERSCUHERE	Cisco	Belgium
Mr.	Jan	VIEGAND	Danish Energy Authority	Denmark
Mr.	Andreas	WITSCHI	Swisscom	Switzerland
Mr.	Zhou	XINGHUA	National Computer Quality Supervising Testing Center	China
Ms.	Yanbing	ZHAO	China Standard Certification Center	China

Appendix 3: Buildings as Networks - Danger, Opportunity, and Guiding Principles for Energy Efficiency

Alan Meier and Bruce Nordman[2], Lawrence Berkeley National Laboratory
Mark Ellis, International Energy Agency
May 13, 2007

Summary

The coming twenty years will see a dramatic transformation in the patterns of energy consumption in buildings. Each year an increasing proportion of both devices and end uses in buildings will be influenced or dominated by controls that are defined by digital networks. Some of these networks will be established specifically to save energy but more often the controls and networks will be installed for other reasons, and can just as easily increase rather than reduce consumption. The efficiency community needs to be a lead actor in defining these networks' creation and evolution, to assure that efficiency is a primary goal in their design and deployment. The alternative is to forever try to tame the energy consumption of networked products and technologies after they have been designed and installed.

The past twenty years of increasing networking of electronics shows the danger of a lack of attention to energy minimisation. Apart from niche wireless devices, energy has not often been a concern of the electronics industry in the myriad ways that devices are networked with each other. Consumption of electronics has risen dramatically in this time, partly due to increases in the stock of devices and services delivered, but a significant amount is wasted from lack of considering energy in network design. We should expect a similar outcome for other energy end uses.

Engaging with the industries that create the products — and the standards they will rely on to operate — will require significant investment by the efficiency community. However, in most cases there will be no incremental cost for manufacturing or deploying the more efficient products. Furthermore, there are likely to be few available projects for industrialized countries that rival efficient networks as an energy efficiency resource in terms of size and cost-effectiveness. The most effective and least costly time to address this issue is now.

Background

The electricity delivery system is a vast and extraordinarily complex network — one we have had for over a century. Information networks are also not new; for example the telegraph network arose over 150 years ago. Traditional light switches and thermostats are very simple network examples. The telephone system is also quite old, though originally — and still partially — analog rather than digital. Computer networks emerged as entirely digital from the beginning. Consumer electronic devices have long been networked — until recently almost entirely through analog connections, though they are now undergoing a rapid shift to digital. The **digital** nature of current network developments is the key to their power and potential for energy efficiency.

> **Direct and Induced Consumption**
> Networks increase energy consumption in two ways. There is **direct** consumption from network interface components, and products whose only function is to provide network connectivity. In addition, networks **induce** consumption by causing products to be in a higher power state than they would otherwise be due to being connected to the network (key examples are PCs and set-top boxes).

Computer networks, in particular the Internet, were not designed with energy use or efficiency in mind. The number of network nodes was small, and consequently, so was the aggregate **direct** consumption of network hardware; also, the fact of being networked did not change the consumption of devices on the network. So, the lack of attention to energy use was completely understandable[3]. When power management was introduced into personal computers, network connectivity was not considered in its design; it was simply lost when going to sleep. When connectivity was acknowledged, with the introduction of "Wake On LAN", the energy efficiency community was not

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[3] While it is excusable and understandable that energy was not considered the first time the Internet was invented, to repeat this the second time would not be. See the "Future Internet" project at http://www.nsf.gov/pubs/2007/nsf07507/nsf07507.htm

involved (while Wake On LAN "works", it is not widely used and so saves only a modest amount of energy). Meanwhile, most energy used by desktop PCs (at least in the U.S.) occurs when no one is present. There is an enormous infrastructure of hardware, software, protocols, applications, users, expectations, and the like which do not support energy efficiency of networked PCs in allowing them to go to sleep without compromising a basic — and often desired — capability to stay connected to the network. Fixing this problem after the fact is possible, but much more difficult and expensive than doing so when the network technologies were originally developed.

Building Networks

While we can expect the various networks to be interconnected and interoperate, it is helpful to think of them as distinct networks to assess consumption and savings, requirements for efficiency, and policy needs. The network types are:

- **Electronic networks**
  These are oriented to either information technology, or to audio/visual entertainment – consumer electronics. These two are merging and are characterized by large volumes of data.
- **Lighting networks**
  Lighting is not traditionally considered a heavily networked end use, but it is arguably the first (albeit non-digital) example of networking in buildings with multiple fixtures often attached to a set of controls (switches, sometimes multiple). More recently occupancy and other sensors have been added, along with controls like dimming. Data rates are usually very low.
- **Climate control networks**
  Heating and cooling systems have sensors, actuators, thermal systems, and human interfaces. Like lighting, these are also a crude network, and also have yet to enter the digital age in most buildings. These networks have been traditionally closed but would benefit from greater interaction and integration with other building networks. Data rates also low.
- **Security networks**
  These include smoke and carbon monoxide detectors, fire alarms, security systems (window/door sensors, occupancy sensors), doorbells, security cameras, and leak detectors. Except for some cameras, all tend to have dedicated wiring.
- **Other networks**
  These cover principally appliances, and miscellaneous controls such as for windows. These are likely to be appended to other networks, not a driver of networks on their own.

In many buildings these networks will share information from sensors about occupancy and special states such as fire or other emergency. Expressing preferences and monitoring of building operation also will require interconnections.

For consumer electronics (CE), people have long been accustomed to powering on and off televisions and devices connected to them with remote controls, and manually with power buttons. For devices other than the TV display, this is an annoyance (if consumers are even aware that other devices are on), with the result that devices are often left powered on during times of non-use. As CE devices become cheaper, and can be more easily networked with others (that may be in different rooms), the likelihood of devices being on when not in active use is rising. TV set-top boxes are typically on continuously, to provide connectivity both upstream and downstream. As with computers, those concerned with energy use and efficiency have not been involved in developing the standards for inter-device control. Manufacturers who do so are more focused on simply making things work at all, content protection, and with features which appeal to consumers — rather than to any focused effort on power controls (which is unlikely to increase sales).

In both cases, there has been additional confusion sown by poorly-designed and inconsistent user interfaces around power controls. Industry did not address this topic, but energy efficiency motivated work did (IEEE 1621) and has had success in rectifying this problem.

While there is little about networked electronics to indicate that energy efficiency will be a cost burden, the reality is that without specific attention to energy efficiency, it usually doesn't happen. The only entities likely to bring this specific focus are those whose primary concern is efficiency; however these organizations struggles to deal with the highly technical nature of integrating power management into networks.

The Traditional End Uses

Energy use in buildings is largely a matter of assembling and operating many individual and isolated components, with most of these are largely static. Products put into buildings are generally independent of each other in that the efficiency of one won't affect the consumption of another (aside from internal loads affecting space conditioning). By contrast, digital networks make behavior of one product a factor in the energy consumption of others on the network, possibly driving it up *or* down.

In a Perfect World

Consider a room in an office building or house that today that has space conditioning that serves an entire floor, and a single ordinary light switch. A future version of this room might include:

- Sensors for occupancy, temperature, and ambient light.
- Controls that take into account presence (including *who* is present), time of day and week, past preferences, past occupancy patterns, and provide for control from diverse locations (including computers and phones present, mobile phones, and remote devices).
- Dynamic capabilities that control the temperature and volume of heat or cool delivered, automatic window opening, shading control, and diverse (now solid state) lighting control.
- Lighting patterns that change depending on what the occupant is doing — using a computer, meeting with someone, eating lunch, or sleeping.
- Climate control designed to follow preferences, the outdoor climate (as an indicator of clothing), and occupancy (allowing greatest deviation from target conditions when an occupant is least likely to be present).
- Preferences expressed through many means, including perhaps hand gestures, to make control of the space as unobtrusive and natural as possible.
- Displays for electronic information coordinated with occupancy and lighting, and — being quite large — may be the largest user of energy in the space. With widespread availability and use of videoconferencing, lighting will similarly adjust when cameras are in use.

Presence

Consider the concept of "presence". In future, we will want building spaces (and even some outdoor spaces) in residences and commercial buildings to be responsive to the presence of people, to assure that desired services are delivered (e.g. light, thermal comfort, vision, monitoring, information displays) and that unneeded services are not delivered.

We will often want all services to be driven off a common base of "presence"; this requires sensors which assess presence characteristics, and methods to determine just how present someone is (e.g. you don't want the person emptying rubbish bins in the evening to "wake up" every office he/she visits). Presence could be responsive to factors such as: who enters a room, how many people do, what time of day or day of the week it is, and any gestures the people make. We will want a common platform for 'presence' to avoid proliferation of sensors and controls, a common method of setting this across energy services, and user interface standards (so that when you want into a room in a building you've never been into you have a good idea how it works, as you do for cars). This requires integration at many layers of the network hierarchy.

Some key characteristics of this future are that it is highly dynamic, to follow conditions to optimise the service delivered, and (ideally) to minimise energy requirements. The dynamic nature will mostly occur in how each devices operates. However, as people move devices into our out of spaces — or within the space — the mix of which products are present will also change, possibly changing the behavior of all devices. Devices include controls (e.g. a mobile phone), task lights, and displays. As conditions in the space and outdoors change, and as energy prices change, the space will continually readjust. Another key aspect of dynamic systems is to respond to anomalous conditions, be they those of the user (e.g. a guest or unusual usage), or to error conditions as when devices malfunction or are removed, to both respond as well as possible, and to diagnose and report the malfunction.

The Default Future

As with the introduction of electronics, and most high-tech building controls to date, the forces driving building networking will be to improve the quality of the space for the benefit of the occupant, *not* saving energy. Other lessons from electronics will also likely apply in the absence of efforts to the contrary:

- Promoters of specific technologies will ignore or resist opportunities for interoperability, as they try to gain maximum market share for their unique technologies.
- Efficiency will be an afterthought, with other features driving the process (trade publications and trade shows provide overwhelming evidence for this).

- Standards will be critical to facilitate some degree of interoperability, but aspects of these standards that could aid energy efficiency will generally be absent or ill-formed. Clear opportunities for harmonization across standards (e.g. in terminology) will not be taken.
- User interfaces will be neglected, with individual manufacturers seeing this as an opportunity to differentiate their products, at the expense of users and of energy efficiency.
- Little or no coordination will occur across domains. In electronics this manifests itself as the "IT" and "CE" domains, with different physical, application, and device infrastructure. For buildings, this is the end-use domains such as space conditioning, lighting, security, electronics, and others.

User Interfaces

The traditional ISO 7-layer OSI model of interoperable networks only addresses how electronic devices on the network interact with each other, but since these networks ultimately serve to deliver services to people, humans can be seen as the missing "8th" layer" with standards for that communication needed to make it happen effectively.

Lighting control user interfaces are an area that will shortly require standards for to avoid widespread confusion as different companies develop incompatible and/or confusing systems of terms, symbols, colors, metaphors, etc.

Achieving a Better Future

To arrive at a future in which digital networks optimally support energy efficiency, we should place ourselves into that long-run future — perhaps the year 2027 — and identify those features of network architecture not widely present in 2007 that are most important for energy efficiency. We can then begin to describe key details of these features, how to develop them further as ideas, and how to market them to industry (many), standards organizations, and energy policy organizations.

Guiding Principles

Energy efficiency efforts around building-related networks need some "guiding principles" that can be used to evaluate existing and proposed network technologies. These need further development, but an initial list of Guiding Principles are as follows:

A. The existence of one device on a network should not cause another device to stay awake when it might otherwise go to sleep.
B. The network should be designed such that a legacy or incompatible device will not prevent the rest of the network from effectively using power management.
C. Devices should expose their own power state to the rest of the network and be able to report estimated or actual power use levels.
D. Product interfaces — for people or other products — should follow (international) standard principles and designs.
E. Products or devices that influence energy consumption should adhere to (international) standards for behavior and communication appropriate to their function.
F. Products and connections should have the ability to modulate energy use in response to the amount of service required.
G. Energy efficiency efforts should not favor any particular hardware — or even software — technology. All network technologies must be the target for efficiency efforts. Future buildings will include many different technologies; those in any particular building will be diverse, and always changing.
H. Harmonization of basic principles underlying efficient design for networked devices should cross all end uses and be global.

Conclusions

For the past two decades, we have seen an inexorable increase in the degree and sophistication of digital networking across electronics (both information technology and consumer electronics). This has greatly increased the services they provide, but spawned the creation of devices whose only function is to provide connectivity, increased the power levels drawn by these devices, and critically, driven up the time spent fully on for many of them. Electronic networks have been designed and implemented with little regard for energy consumption, and without the involvement of the energy efficiency community, so the resulting large increases in consumption are no surprise. Many aspects of set-top box energy consumption will apply to emerging networks in appliances and equipment.

Appliances and equipment in buildings are just beginning this transformation, a path which will lead to them becoming highly networked and controllable, across the major traditional end uses such as space conditioning, lighting, and security. As in the past, for the most part this will be done for reasons other than saving energy, such as greater comfort, control, security, productivity, and entertainment. A likely outcome is *increased* energy use, even aside from the energy needed to power the network itself.

This future is not inevitable. Action now can lay a strong foundation for devices to be interoperable with each other and with people in ways that facilitate maximum energy efficiency. This action will require careful attention from an efficiency perspective to many diverse standards that accomplish this interoperability — a few of these already exist but can be amended; many others are yet to be developed. The efficiency community is not generally literate or involved in network standards development.

Appendix 4: Draft Principles for Energy Efficient Digital Networks and Network-connected Devices

To ensure that digital networks and network-connected devices support the minimisation of direct and induced energy consumption, the following the principles should be adopted:

Digital Networks:

A. All network technologies should actively support power management.

B. Connection to a network should not impede a device from power management activities.

C. The network should be designed such that a legacy or incompatible device does not prevent the rest of the network from effective power management.

D. Connections should have the ability to modulate their own energy use in response to the amount of the service required by the system.

E. Terminology and concepts relating to energy management used in the design of all networks should be internationally harmonised.

Network connected devices:

A. Devices should not impede power management activities in other connected devices.

B. Devices should expose their own power state to the network and be able to report estimated or actual energy use.

C. User interfaces should follow (international) energy management standard principles and designs.

D. Devices and connections should have the ability to modulate their own energy use in response to the amount of the service required by the system.

E. Terminology and concepts relating to energy management used in the design of all devices should be internationally harmonised.

F. The behaviour and communication of devices relevant to energy consumption should adhere to (international) standards.

Energy Efficiency Policy:

Governments should ensure that electronic devices enter low-power modes automatically after a reasonable period when not being used.

Governments should ensure that network-connected electronic devices minimise energy consumption, with a priority placed on the establishment of industry-wide protocols for power management.

Energy efficiency efforts should not favour any particular hardware or software technology.

Energy efficiency policy should identify digital networks as a promising method for attaining energy efficiency.

Appendix 5: IEA energy efficiency policy recommendations for the G8 2006 and 2007 Summits

The IEA recommends G8 Leaders adopt a suite of 16 energy efficiency measures. This package follows up on the Gleneagles G8 Plan of Action, which mandates the pursuit of a clean, clever and competitive energy future.

These measures set out an ambitious road map for improving energy efficiency at a global scale. Implementation of IEA energy efficiency recommendations can lead to huge energy and CO_2 savings. The IEA estimates that if implemented globally, the proposed actions could save between 4,400 – 6,800 $MtCO_2$/yr by 2030. This is equivalent to the USA's total CO_2 emissions in 2004.

Buildings

[2007] **Building Codes for New Buildings**

Countries that do not currently have mandatory energy efficiency standards for new buildings in Building Codes should urgently set, enforce and regularly update such standards. Those countries that currently have mandatory energy efficiency standards for new buildings should significantly strengthen those standards. Energy efficiency standards for new buildings should be set by national or state government and should aim to minimise total costs over a 30-year lifetime.

[2007] **Passive Energy Houses and Zero Energy Buildings**

Countries should support and encourage the construction of buildings with very low or no net energy consumption (Passive Energy Houses and Zero Energy Buildings) and ensure that these buildings are commonly available in the market. Governments should set objectives for PEH and ZEB market share of all new construction by 2020. Passive Energy Houses or Zero Energy Buildings should be used as benchmark for energy efficiency standards in future updates of building regulations.

[2007] **Existing Buildings**

Governments should systematically collect information on energy efficiency in existing buildings and on barriers to energy efficiency. Standardised indicators should also be calculated for energy efficiency in buildings for international comparison, monitoring and selection of best practices. Based on this information governments should construct a package of initiatives to address the most important barriers to energy efficiency in buildings. This package should set standards to ensure that energy efficiency improvements are achieved during the refurbishment of all buildings. Also, the package should increase awareness of efficiency in the building sector and raise the market profile of a buildings' energy performance.

Equipment

[2007] **Mandatory Energy Performance Requirements or Labels**

All countries should adopt mandatory energy performance requirements and, where appropriate, comparative energy labels across the spectrum of appliances and equipment at a level consistent with international best practices. Adequate resources should be allocated to ensure that stringency is maintained and that the requirements are effectively enforced.

[2006] **Standby Power**

The IEA concludes that international best practice consists of a "horizontal" 1-Watt regulatory limit on standby. The IEA recommends that all countries adopt the same 1-Watt limit and apply it to all products covered by an International Electrotechnical Commmission definition of standby power with limited exceptions.

[2007] **Low-power Modes for Electronic Equipment**

All countries should adopt policies which require electronic devices to enter low-power modes automatically after a reasonable period when not being used. Countries should ensure that network-connected electronic devices minimise energy consumption, with a priority placed on the establishment of industry-wide protocols for power management.

[2006] **Television "set-top" boxes and digital television adaptors (DTAs)**

The IEA concludes that international best practice with respect to energy efficient set-top boxes are policies that establish is a minimum efficiency standard for Digital Television Adaptors. These regulations should specify the maximum power levels while "on" and "off" and ensure that the consumer can easily switch the unit to the lower power level. A second aspect of best-practice is to ensure that government-subsidized units meet higher efficiency requirements.

Lighting

[2006] **Best Practice in Lighting Policy**

The IEA recommends that the G8 endorse the objective of across-the-board best practice in lighting.

[2007] **Phase-out Incandescent Lamps**

Governments should move to phase out the most inefficient incandescent bulbs as soon as commercially and economically viable.

In aiming for this objective there is a need both for appropriate time scales and performance targets to be established. Also government and industry actions must be coordinated internationally to ensure a sufficient supply of good quality higher efficiency alternative lamps. The IEA is well placed to facilitate such a coordinated transition were this to be requested by international stakeholders.

Transport

[2006] **Fuel-Efficient Tires**

The IEA concludes that international best practice with respect to fuel-efficient tires consists of two elements:

- Maximum allowable levels of rolling resistance for major categories of tires;
- Measures to promote proper inflation levels of tires.

[2007] **Test procedures**

Governments should adopt new international test procedures for measuring the rolling resistance of tyres to set maximum rolling resistance limits and for road-vehicle tyre labeling. In addition, all governments, in cooperation with international organisations including UNECE, should make the fitting of tyre-pressure monitoring systems on new road vehicles mandatory.

[2007] **Mandatory Fuel Efficiency Standards for Light-duty Vehicles**

All governments should:

- introduce new mandatory fuel efficiency standards for light-duty vehicles if they do not already exist, or, where they do exist, make those standards more stringent,
- announce the more stringent content of the proposed standards as soon as possible, and
- harmonize, if appropriate, as many aspects of the future standards as possible.

Industry

[2007] **High-quality Energy Efficiency Data for Industry**

Governments should support the IEA's energy efficiency indicator work that underpins critical policy analysis by ensuring that accurate energy intensity time series data for industrial sectors is reported regularly to the IEA.

Cross-Sectoral

Recommendations

[2007] **Increased Investment in Energy Efficiency**

Governments should:

- adopt, and publicise to the private sector, a common energy efficiency savings' verification and measurement protocol, to reduce existing uncertainties in quantifying the benefits of energy efficiency investments and stimulate increased private sector involvement,
- review their current subsidies and fiscal incentive programmes to create more favourable grounds for private energy efficiency investments,
- collaborate with the private financial sector to establish public-private tools to facilitate energy efficiency financing.

[2007] **National Energy Efficiency Strategies and Energy Intensity Reduction Objectives**

All countries should set goals and formulate action plans for improving energy efficiency in each sector of their domestic economies, utilizing on-going IEA works for developing sectoral energy efficiency benchmarks and compiling good practices. Energy efficiency policy agencies should be adequately resourced. Best practice action plans should:

- assess energy consumption by end-use in all sectors,
- identify the economy's energy savings potentials.
- establish objectives and adequate methods for evaluating the success of the plan.

[2007] **Monitoring and Reporting Progress with Concrete Recommendations**

Governments should agree to track progress in implementing each of the concrete recommendations and to provide the IEA with regular updates. The IEA will then present an assessment of progress to the 2008 G8 Summit in Japan.

Appendix 6: National Programs for energy efficient Set-top Boxes and related equipment

Country	Programme	Scope (products)	Summary of Requirements				Program Type	Date
			Max Passive Standby (sleep)	Max Active Standby	Max Active/On	Other		
Australia	Australian Greenhouse Office	Standard definition converter for terrestrial signals	1 W or 2 W	8 W or 7W + FAs to limit of 15W	8 W or 7W + FAs to limit of 15W		Minimum Energy Performance Standards	Targeted for: 01.10.2007
		High definition converter for terrestrial signals	1 W or 2 W	12 W or 11 W + FAs to limit of 19W	12 W or 11 W + FAs to limit of 22W			
Canada	Energy Efficiency Regulations	Simple digital-to-analog converter box for terrestrial signals	1 W		8 W	Regulation not yet defined	Minimum Energy Performance Standards	Pre-publication date December 2008. Effective date TBD
China	China Standard Certification Center (CSC)	Simple STBs (Cable only)	1 W		8 W	Automatic power down (After 4 hours of inactivity)	Endorsement Label	Targeted for end of 2007
	China National Institute of Standardization (CNIS)	To be determined	To be determined				Minimum Energy Performance Standards	Targeted for 2008
EU	European Code of Conduct for Digital TV Services	Complex STBs	3 W	7 W (C) 6 W (T, D) 8 W (S) + FAs to limit of 15W			Voluntary Agreement	Current to 31.12.2007
		Digital TVs with integrated receiver and decoder	1.5W	8 W (C) 7 W (T) 9 W (S) + FAs to limit of 16W				
		Analogue PVR	3 W	6 W				
		Simple STBs (no CA)	2 W		7 W (C, T, D) 10 W (S)			
		Simple STBs (High Definition TV) – SD o/p	2 W		11 W (C, T, D) 14 W (S)			
		Simple STBs (High Definition TV) – HD o/p	2 W		12 W (C, T, D) 15 W (S)			

Country	Programme	Scope (products)	Summary of Requirements				Program Type	Date
			Max Passive Standby (sleep)	Max Active Standby	Max Active/On	Other		
GEEA	Group for Energy Efficient Appliances	Same or similar to EU Code of Conduct	Same or similar to EU Code of Conduct			Automatic power down		
Korea	Energy Boy Standby Power Program	TV with integral pay TV set-top box			8 W + FAs to limit of 15W		Endorsement Label	Replaces current requirement from 01.7.2007
		Simple digital-to-analog converter box for terrestrial signals	1 W		8 W + FAs to limit of 15W			
		Pay TV set-top box box	1 W (optional)	8 W + FAs to limit of 15W				
Switzerland	Swiss Federal Office of Energy	Same as EU Code of Conduct	Same as EU Code of Conduct				Endorsement Label	Current from: 01.1.2006
Taiwan	Standby Power Promotion Alliance	Set Top Box	2W				Voluntary Agreement	By 2008
US	Energy Star	Simple digital-to-analog converter box for terrestrial signals (DTA)	1W		8W	Automatic power down	Endorsement label	Current from: 31.1. 2007
		Set top boxes other than DTAs	To be determined				Endorsement label	Proposed effective date: 01.6.2008
	National Telecommunications and Information Administration (NTIA)	Simple digital-to-analog converter box for terrestrial signals (DTA)	2W			Automatic power down	Criteria for national subsidy of US$40 per STB (max 2 per household)	Current

Key	
FAs	Functional adders
T	Terrestrial
C	Cable
S	Satellite
D	DSL