



4E Energy Efficient End-use Equipment
International Energy Agency

Connected Devices Alliance

Technical Report on Progress with
International Initiatives on Networked Devices

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1 Introduction

This report is presented by the UK Department of Energy and Climate Change (DECC) and the International Energy Agency (IEA), as the leads of the G20 Networked Devices Task Group. This was one of six initiatives under the 'G20 Energy Efficiency Action Plan: Voluntary Collaboration on Energy Efficiency', launched after the G20 Summit in November 2014.

Work under the G20 Networked Devices Task Group has been co-ordinated by the IEA's Energy Efficient End-use Equipment (4E) Implementing Agreement, which comprises 12 governments. Further governments have been involved through the Super-efficient Equipment and Appliance Deployment (SEAD) initiative of the Clean Energy Ministerial (CEM), and the International Partnership for Energy Efficiency Co-operation (IPEEC).

The report describes the objective, methodology and achievements of the initiative, as well as providing a detailed explanation of the key new projects that have been established during 2015.

2 Achievements of the initiative in 2015

In 2015, the United Kingdom and IEA have co-ordinated an on-going dialogue between representatives from governments and the global industry to identify and agree projects and policy options that will improve the energy efficiency of networked devices into the future.

The impetus provided in 2015 has led to the establishment of the **Connected Devices Alliance**, a network of 300 government and industry participants across the many key sectors that influence the energy consumption of networked devices and networks.

During 2015, the Connected Devices Alliance has tracked developments in technology, research and voluntary industry initiatives. A series of dialogues between industry and government representatives has led to a greater understanding of the issues, including the need to take globally co-ordinated action to:

- a) realise a world where devices and networks optimise energy management while delivering increased energy productivity across all sectors.
- b) maximise network-enabled energy savings and minimise the energy consumption from all networks and networked devices.

To achieve these goals, deliverables from the Alliance since January 2015 include:

- ▶ A set of global **Definitions** that will underpin the development of policies and initiatives in this field (refer Annex A).
- ▶ **Design Principles** to provide guidance on the key features of energy efficient networked devices, networks and communication protocols for designers, manufacturers and authors.
- ▶ **Policy Principles** to encourage a common global framework for the development of government policies and measures.
- ▶ A **Centre of Excellence**, "Connected Devices By Design", to provide governments and industry with an accessible source of information on best practices and energy savings opportunities in networked devices and the networks.
- ▶ The development of **Awards** to recognise significant achievements in technical protocols, industry initiatives and policies through the SEAD 'Global Efficiency Medal'.

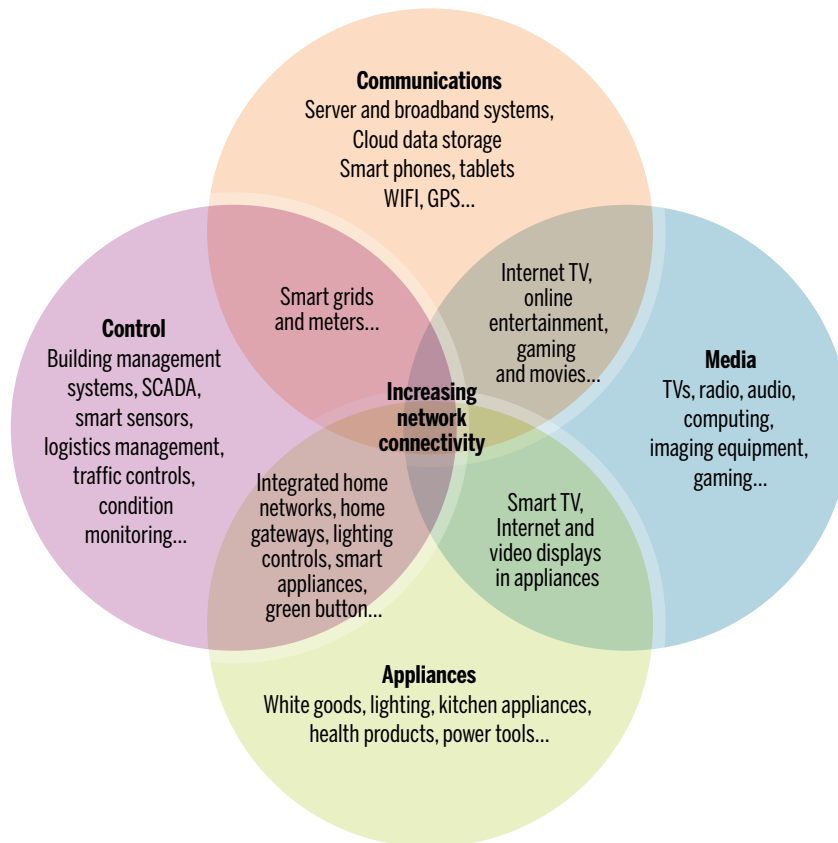
Further details on these outcomes are provided in Section 7 of this report.



3 The problem

Network-connected technologies, such as broadband connectivity, wireless mobility, cloud computing, e-commerce, social media, sensors and the “Internet of Things” are rapidly transforming the world in which we live. Network connectivity already touches many aspects of daily life and advanced technologies are creating new services and benefits permeating all areas including communication, entertainment, security and health.

Figure 1: The new age of information and communication technology



Notes: GPS = global positioning system; SCADA = supervisory control and data acquisition system. Data will be online.

Source: IEA (2013b), *Energy Efficiency Market Report 2013*, OECD/IEA, Paris, www.iea.org/w/bookshop/add.aspx?id=460.

While some of these services have the potential to improve the way we manage energy use in the future, network connectivity is responsible for additional energy consumption. The energy used by the network infrastructure (data centres, data security systems, etc) and network equipment (modems, etc.) is largely related to the data throughput. However, all networked devices (such as printers and televisions) consume some energy in order to maintain network connectivity – called ‘network standby’ (see short explanatory video: <http://edna.iea-4e.org/about>). Furthermore, the act of staying connected may prevent some devices from moving into lower power modes.

In its publication, *More Data, Less Energy* (<http://www.iea.org/etp/networkstandby>), the International Energy Agency (IEA) estimates there will be 100 billion networked devices by 2030 and 500 billion over the following decades, spread across developed and developing countries. Already, the annual consumption of devices connected to networks in homes and offices is estimated at over 600 TWh. This is greater than Canada’s total annual electricity consumption for 2011.

However, *More Data, Less Energy* also estimates that uptake of best available technologies could reduce the electricity demand of these devices by up to 65 per cent.

More Data, Less Energy made the following five key recommendations for addressing network standby:

- ▶ Assess, analyse and align existing policy approaches for globally traded devices.
- ▶ Pursue close interaction with industry.
- ▶ Establish international technology standards at the earliest possible date.
- ▶ Encourage development of communication protocols that support energy efficiency.
- ▶ Prioritise data collection.

The minimisation of the rapidly escalating energy cost of network-connectivity is the primary focus of the Connected Devices Alliance. Networked devices and network technologies are evolving at a rapid pace. The task of maximising the network-enabled energy management opportunities, while also minimising the additional energy consumption from networked devices and their traffic, is challenging. Given the global market for networked devices, the establishment of on-going collaboration amongst governments and with industry is a necessary precondition to achieve effective, internationally-harmonised solutions.

See Annex B for further details from *More Data, Less Energy*.

Unconstrained, all trends point to dramatic increases in the use of network enabled devices and associated energy demand – most of which is ultimately wasted while devices wait to perform their primary functions. By stepping in now, governments could harness the momentum to realise significant opportunities for energy savings, even as device deployment grows.

Source: 'More Data, Less Energy'

4 Objective of the G20 Networked Devices initiative

Concerns over the rapidly escalating electricity demand of networked devices led to the establishment of the Networked Devices Task Group, which is one of six initiatives under the 'G20 Energy Efficiency Action Plan: Voluntary Collaboration on Energy Efficiency', launched after the Brisbane G20 Summit in November 2014.

Led by the UK Government's Department of Energy and Climate Change (DECC) and the International Energy Agency (IEA), the focus of the initiative is the reduction of energy wastage that directly results from the connectivity of networked devices. As such, it aims to support the energy efficient delivery of the many benefits arising from the network connection of devices.

In recognition of the global trade in networked devices the initiative is developing a platform for international cooperation between governments, industry and experts and to:

- ▶ Expand relevant research and share information amongst participants.
- ▶ Accelerate the development of product standards for technologies that would enable devices to power down and use less energy when in standby mode.
- ▶ Develop policy frameworks to reduce energy consumption of networked devices when in standby mode.
- ▶ Consider goals for reducing the global standby mode energy consumption of networked devices.
- ▶ Report on progress with these issues and make recommendations to the G20 Summit in Turkey.

The platform for international co-operation between governments and industry established under this initiative

5 Methodology

5.1 Approach

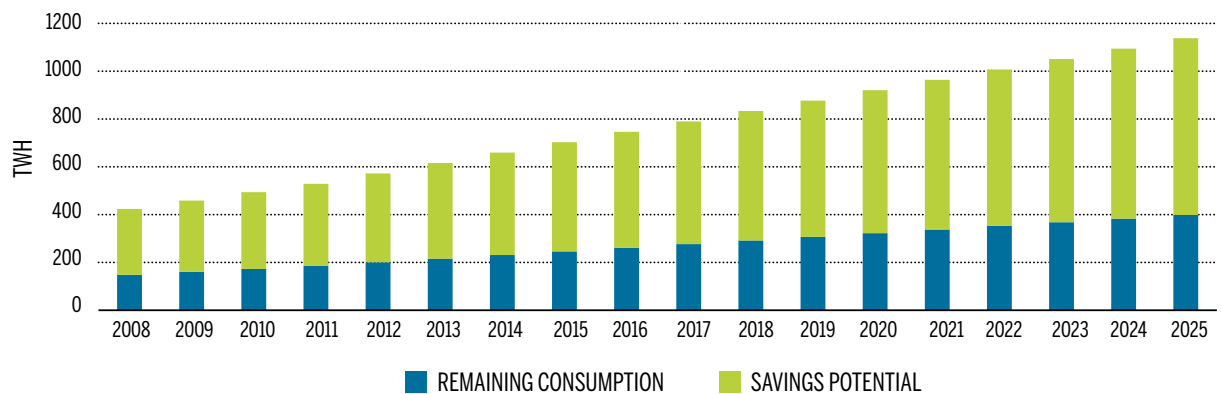
The Networked Devices initiative builds on the *More Data, Less Energy* publication (and other work in the field, identified in Annex C) and has featured a collaborative approach to the development of innovative solutions that have broad support within governments and industry. As a result, there has been considerable engagement with governments, their relevant agencies, and the extensive industry value-chain of networked devices. These include organisations involved in software, network design, network architecture, communication protocol development, technical standardisation processes, service provision, and device and component manufacturing.

The involvement of governments has been facilitated through the involvement of the Energy Efficient End-use Equipment (IEA-4E) Implementing Agreement and the SEAD initiative of the Clean Energy Ministerial (CEM), supported by the IEA and IPEEC.

IEA-4E and SEAD have also funded the co-ordination and communications activities of a project management team during 2015.

Although it is recognised that the pace of technology change will require long-term attention to the topic, the initial aim has been to build momentum by identifying a set of activities that can be implemented immediately and which are applicable globally. This will provide the foundation for further consideration of longer-term approaches that mirror the evolution of the connected world, including the adoption of supportive government policies and industry initiatives.

Figure 2: Current and projected global network enabled device electricity consumption and savings potential



Source: *More Data, Less Energy*, OECD/IEA, 2014

5.2 Development process

The Networked Devices Task Group has been managed by the UK Government's Department of Energy and Climate Change (DECC) and the International Energy Agency (IEA). An Advisory Group chaired by Dr Mike Walker (DECC and chair of IEA-4E) and comprising representatives from the IEA, SEAD and from the governments of Australia, Netherlands and the USA has met monthly and provided further support.

In January 2015, the Advisory Group approved a detailed work plan summarised in Table 1.

Table 1: Summary of main activities in development of initiatives

DATE	ACTIVITY	DESCRIPTION
Dec 2014-Jan 2015	Outreach to industry and governments	Outreach to industry and governments
19 & 20 Jan 2015	Joint Government/Industry workshop, IEA, Paris	Joint Government/Industry workshop, IEA, Paris
Feb 2015	Preparation of report to 1st ESWG Meeting, Antalya	Preparation of report to 1st ESWG Meeting, Antalya
Feb-June 2015	Working Groups consider 7 collaborative initiatives	Working Groups consider 7 collaborative initiatives
May 2015	Preparation of report to 2nd ESWG Meeting, Istanbul	Preparation of report to 2nd ESWG Meeting, Istanbul
21 May 2015	Government workshop, Copenhagen	Government workshop, Copenhagen
17 & 18 June 2015	Joint Government/Industry workshop, IEA, Paris	Joint Government/Industry workshop, IEA, Paris
June-July 2015	Drafting of recommendations	Drafting of recommendations
July-Aug 2015	Production of technical report	Drafting of this report

Three international workshops held over 5 days in Paris and Copenhagen have underpinned the consultative process and attracted government representatives from 18 countries and many of the largest companies and industry associations in the sector (see Table 2).

These include the 12 IEA-4E government members, additional countries/regions supporting the G20 'products' initiative (European Union, Germany, Singapore and Spain), Turkey and Mexico. Throughout 2015, the Networked Devices initiative has engaged with a total of 300 governments and organisations across the many key sectors that influence the energy consumption of networked devices and networks.

Table 2: Participants in the Connected Devices Alliances

INDUSTRY	GOVERNMENT
Alcatel-Lucent International	Australia (Department of Industry & Science)
AMD ARM Holdings	Austria (Austrian Federal Ministry of Transport, Innovation and Technology)
Broadcom	Canada (Natural Resources Canada)
CECED (European Committee of Domestic Equipment Manufacturers)	Denmark (Danish Energy Agency)
Cisco	European Commission
Consumer Electronics Association (US)	France (ADEME)
DELL	Germany (BAM Federal Institute for Materials Research and Testing)
DigitalEurope	Japan (NEDO)
EMC	Korea (KEMCO)
Ericsson	Mexico (Conuee)
Ethernet Alliance	Netherlands (Netherlands Enterprise Agency)
Information Technology Industry Council	Singapore
Hitachi	Spain (IDAE)
Hewlett Packard	Sweden (Swedish Energy Agency)
Intel	Switzerland (Swiss Federal Office of Energy)
Japan Electrical Manufacturers' Association	Turkey (Ministry of Energy and Natural Resources)
International Roundtable of Household Appliance Manufacturers Associations (IRHMA)	United Kingdom (DECC)
Osram	USA (Department of Energy)
PACE	
Philips	
Power Integrations	
Rockwell Automation	
Schneider Electric	GOVERNMENT
Silicon Labs	IEA
Sony Computer Entertainment	IEA-4E
ST Microelectronics	IPEEC
Technicolor	Super-efficient Appliance Deployment Initiative (SEAD)
Telecom Italia	UNEP
Telecommunications Technology Association	

Between the workshops, 26 teleconferences have been held to develop the specific proposals outlined in section 4 of this report.

Throughout 2015 there has been a close working relationship with the International Partnership for Energy Efficiency Co-operation (IPEEC), responsible for reporting this work stream to the ESWG.

6 The Emerging Connected World

The world of networked devices is changing rapidly and this is expected to continue for the foreseeable future. Devices that have traditionally been network-connected are changing: devices that were previously not connected to a network are becoming connected, and entire new categories of products are emerging on an almost daily basis. One of the roles of the Connected Devices Alliance has been to monitor this environment, particularly in the context of energy use, and build on the knowledge contained in *More Data, Less Energy*.

This section briefly describes a number of important developments in the area of networked devices, including those which have the potential to save as well as increase energy use. Note that this is not intended to be a conclusive list, merely a set of short case studies that help to describe current activities in the area of connected devices.

6.1 Gaming Consoles, Set-top Boxes and Televisions

There have been recent improvements in the network energy use of traditional networked devices, and one example of this is gaming consoles. One model of gaming console has reduced its network power consumption from 15W to less than 3W with the introduction of the next generation of the model. Set-top boxes are another area where significant technology improvements have occurred, driven in part by voluntary government-industry agreements in the European Union and the US (discussed further below). Connected “smart” televisions also appear to be a category which is relatively mature in the area of network connectivity, with recent testing by SEAD showing at least one model with very low network standby power.

6.2 Lighting

Lighting is an area where devices that were previously stand-alone are becoming connected to a communications network. As has occurred historically for other product categories, there is potential for early-generation models to neglect network energy consumption. The 4E Electronic Devices and Networks Annex (EDNA) recently tested one model of connected LED lamp that consumed 3W in network standby mode¹. At this level of consumption, any efficiency gains achieved from the technology transition from incandescent to LED would be eliminated by poor network energy consumption. EDNA also tested a number of similar models of connected LED lamp that consumed less than 0.3W, showing that low network energy consumption is technically feasible, even for first generation lamps.

6.3 Smart Appliances

There is considerable international activity underway in the area of connected household “smart” appliances. From an energy perspective, much of this activity is related to scheduling the operation of appliances to ensure more even demand for electricity from the grid.

The International Roundtable of Household Appliance Manufacturer Associations (IRHMA)² is currently investigating the suite of existing smart appliance communications protocols, with a view to identifying the best solution for harmonizing protocols.

The European Commission is also undertaking a preparatory study³ for smart appliances, analysing the technical, economic, environmental, market and societal aspects of smart appliances, with a view to considering appropriate policy approaches.

6.4 Cloud Computing

There has been a dramatic increase in the uptake of cloud computing and associated wireless connectivity, which represents a considerable change in the structure of network traffic. Since many networked devices will communicate with the cloud, the impact of these changes on net energy use will require further monitoring and analysis.

¹ <http://edna.iea-4e.org/tasks/smart-lamps>

² <http://www.irhma.org>

³ <http://www.eco-smartappliances.eu/Pages/welcome.aspx>

6.5 Intelligent Efficiency

Intelligent efficiency is loosely defined as the deployment of information communication technology (ICT) technologies to facilitate efficient control of energy-using equipment/networks, leading to system-wide and cross-sectoral energy savings. Intelligent efficiency is examined in more detail in section 7.7, however this is an extremely important area that should not be neglected - the ability for networked devices to be controlled by other networked devices, is a powerful tool for saving energy.

6.6 Communications Protocols

Communications standards and protocols are extremely important since they dictate how devices on a network interact and therefore may either hinder or facilitate energy efficiency. The following examples illustrate the growing awareness of the role for standards and protocols in ICT to maximise aspects of energy efficiency:

- ▶ The Institute of Electrical and Electronics Engineers (IEEE) has developed standard IEEE-1905⁴ which aims to enable enhanced power management of devices by optimising network power usage across a number of different technologies, e.g. within a residential environment.
- ▶ The IEEE has also developed the Energy Efficient Ethernet standard, which allows for low power consumption of Ethernet links during periods of low data transmission.
- ▶ The Universal Plug and Play (UPnP) Forum has published an Energy Management specification⁵ aimed at implementing energy management functionality across multiple devices.
- ▶ The Internet Engineering Task Force (IETF) has published an Energy Management MIB document⁶ (management information base) which describes a framework for energy management, including device power monitoring and power state control.
- ▶ The ANSI/CEA standard 2047⁷ enables consumer electronic devices to communicate their energy usage (measured or estimated) over a network as well as respond to basic demand/response commands.
- ▶ The Bluetooth Special Interest group has launched Bluetooth Smart⁸, which is a low energy version of the Bluetooth communications protocol.
- ▶ The Zigbee Alliance has developed Zigbee Smart Energy, a low power communications protocol for energy-related products and home entertainment systems.
- ▶ Low Power WiFi (IEEE 802.11ah) is an amendment of the IEEE 802.11 wireless networking standard with lower energy consumption, which allows large groups of stations and sensors to share the WiFi signal. The standard is expected to be finalized in 2016.
- ▶ The ECMA International Standard ECMA-393⁹ specifies maintenance of network connectivity and presence by proxies to extend the sleep duration of hosts.

6.7 Government Policies

A number of government policies exist aimed at addressing the energy use of networked devices. These are summarised briefly here and more detail is contained in Annex D.

- ▶ **Mandatory MEPS (Minimum Energy Performance Standards) - EU EcoDesign Networked Standby Regulation (801/2013 amending 1275/2008)**

The EU EcoDesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment entered into force in September 2013. This was implemented as a horizontal regulation because network connectivity is a feature of a large range of products, including products that will appear in the future.

⁴ <https://standards.ieee.org/findstds/standard/1905.1a-2014.html>

⁵ <http://upnp.org/specs/lp/energymangement1/>

⁶ <https://datatracker.ietf.org/wg/eman charter/>

⁷ <http://www.cea.org/Standards/Standard-Listings/R7-8-Modular-Communication-Interface-for-Energy-Ma/ANSI-CEA-2047.aspx>

⁸ <http://www.bluetooth.com/Pages/low-energy-tech-info.aspx>

⁹ <http://www.ecma-international.org/publications/standards/Ecma-393.htm>

► **Mandatory Energy Rating Label - Korean e-Standby Program**

In the mandatory Korean rating label program, appliances that do not meet the required standby power limits cannot be rated above level 2 on the scale of 1 to 5 (1 being the most efficient).

► **Voluntary Endorsement Label - Korean e-Standby Program**

Korea's e-Standby Program sets network standby limits for 11 electronic devices. At the core of the program is a table of network standby power limits that devices must meet in order to carry the e-Standby label.

► **Voluntary Endorsement Label - US Energy Star Program**

The US Energy Star program includes network standby requirements for various items of equipment, including:

- Small network equipment (modems, routers, switches, etc.)¹⁰
- Set-top boxes¹¹
- Home audio and DVD¹²
- Televisions (referring to new specification V7.0 in development¹³).

The Energy Star limits are typically expressed as a TEC (total energy consumption) metric which includes a calculation term for network standby mode (e.g. set-top boxes), or as a maximum power limit for the network standby mode (e.g. Televisions V7.0 which includes 3W limit for Standby-Active mode). Energy Star also includes enticements for various products (e.g. appliances) to include connected demand response capabilities.

6.8 Voluntary Industry Agreements

A number of voluntary industry and industry/government initiatives exist. These are summarised briefly here and more detail is contained in Annex D.

► **United States Voluntary Agreement on Set-Top Boxes**

The US Set-top Box Energy Conservation Agreement is a voluntary agreement, endorsed by the US government, between television service providers, set-top box manufacturers, and energy efficiency advocacy groups. It requires 90% of all new set-top boxes purchased and deployed after 2013 to meet Energy Star 3.0 efficiency levels, and 90% of all set-top boxes purchased and deployed after 2017 to meet more stringent Tier 2 requirements. The agreement is flexible and expected to consider new devices in the future. Participants will report measures taken and aggregated results will be presented on an annual basis.

► **European Union Voluntary Agreement on Set-Top Boxes**

The European Union is addressing the efficiency of network-enabled devices and other complex device categories through voluntary agreements and codes of conduct that cover the following device categories:

- Complex set-top boxes
- Imaging equipment
- Medical imaging equipment
- External power supplies
- Broadband equipment.

¹⁰ <http://www.energystar.gov/products/certified-products/detail/7588/partners>

¹¹ <http://www.energystar.gov/products/certified-products/detail/set-top-boxes-cable-boxes>

¹² http://www.energystar.gov/index.cfm?c=audio_dvd.pr_crit_audio_dvd

¹³ <http://www.energystar.gov/products/certified-products/detail/7625/partners>

The voluntary agreement for complex set-top boxes¹⁴ (CSTBs) requires signatories (primarily) to ensure that 90% of their products comply with energy consumption targets.

► **CEA/NCTA Voluntary Agreement on Home Internet Equipment¹⁵**

In June 2015 the US Consumer Electronics Association (CEA) and the National Cable & Telecommunications Association (NCTA) announced an industry commitment to improve the energy efficiency of modems, routers and other broadband equipment. The agreement sets targets aimed at improving the energy efficiency of small network equipment (SNE) by 10-20% and should cover around 80 million homes. It is modelled on the US voluntary agreement for set-top boxes.

6.9 US Government Study on Characterisation of Connected Equipment

The US Department of Energy is undertaking a characterisation study of connected equipment, which aims to develop characterisation protocols for connected buildings' end-use appliances and equipment¹⁶. Whilst not seeking to prescribe methods for device communications and interoperability, the study is expected to improve the understanding of these issues and develop performance metrics for evaluating the services that connected products can provide.

¹⁴ http://ec.europa.eu/energy/efficiency/ecodesign/doc/20121217_voluntary_industry_agreement_cstb.pdf

¹⁵ [http://www.ce.org/News/News-Releases/Press-Releases/2015-Press-Releases/New-Initiative-Will-Improve-Energy-Efficiency-\(1\).aspx](http://www.ce.org/News/News-Releases/Press-Releases/2015-Press-Releases/New-Initiative-Will-Improve-Energy-Efficiency-(1).aspx)

¹⁶ <https://www.federalregister.gov/articles/2014/06/05/2014-13051/physical-characterization-of-grid-connected-commercial-and-residentialbuildings-end-use-equipment>

7 Connected Devices Alliance Key Projects

At the first Paris meeting in January 2015, participants identified 7 areas with the potential to provide innovative solutions within the short timeframe. Each of these have been explored in detail through working groups comprising representatives from industry and governments, and through further workshops, resulting in concrete recommendations. These projects are summarised below.

7.1 Vision, Goals and Definitions

A working group of 16 industry and government representatives (see Annex E) held a series of 5 teleconferences to address the request of G20 governments to consider: “options for goals for reducing the global standby mode energy consumption of networked devices”¹⁷.

The working group determined that an over-arching vision and goals would help to define the scope of the Connected Devices Alliance and provide an incentive to undertake a range of ambitious activities, including the investigation of network standby targets for specific categories of equipment. As such, these should help governments and industry to better understand the aims of the initiative.

It was determined that the vision and goals should address the complementary objectives of reducing network standby energy consumption while also pursuing additional savings through intelligent efficiency. This is embodied in the following statement:

Participating representatives from industry and governments in the NDTG recognise the need to take globally co-ordinated action to:

- ▶ Realise a world where devices and networks optimise energy management while delivering increased energy productivity across all sectors.
- ▶ Maximise network-enabled energy savings and minimise the energy consumption from all networks and networked devices.

The working group also recognised that common terminology and definitions in this area would help to improve the understanding of these complex technical issues, and between governments and industry. A set of unified definitions was therefore developed and is included in Annex A, together with a technical explanation of the issues, shown in Annex F.

7.2 Guiding Principles

A working group of 12 industry and government representatives (see Annex E) held a series of 5 teleconferences with the aim of developing guiding principles for the design and operation of energy efficient networked devices and networks. The group also developed a set of corresponding policy principles. The work built on previous work by both the IEA and the Consumer Electronics Association (CEA) in this area.

The working group agreed on a set of Guiding Principles as follows¹⁸:

¹⁷ G20 Energy Efficiency Action Plan: Voluntary Collaboration on Energy Efficiency, launched after the Brisbane G20 Summit in November 2014.

¹⁸ Note that the definitions presented in Annex A are integral to these guiding principles

DESIGN AND OPERATION PRINCIPLES

1. Networked device design should follow standards-based communication and power management protocols to ensure compatibility and interoperability, and should take advantage of standards and protocols that actively support energy efficiency.
2. Networked devices should not impede the efficient operation of a network (for example by injecting bottlenecks or faults, or impeding power management activities in other devices).
3. Network-wide energy efficiency optimisation should be a primary development consideration. Network power management should coordinate with individual device power management techniques to achieve this.
4. Connection to a network should not impede a device from implementing its internal power management activities.
5. Networks should be designed such that legacy or incompatible devices do not prevent other networked devices on the network from effective power management activities.
6. Networks and networked devices should have the ability to scale power levels in response to the amount of the service (level of functionality) required by the system.
7. Edge devices without networking functionality should enter network standby, if appropriate¹, after a reasonable period of time when not being used. Edge devices with networking functionality should provide power management capabilities for each function consistent with that function's role in the network.²
8. Networking and networked infrastructure devices should not autonomously go to network standby mode. These devices should support power scaling.
9. Consumers should be informed about and have control over device power management, when applicable, including networked device low power modes that may affect the user experience.
10. The design and operation of networked devices should be compatible with, and promote the positive effects of, using consumer electronics and information and communication technology (ICT) to enable energy to be used more efficiently, often referred to as "Intelligent Efficiency."

¹ Appropriate: edge devices whose role is to constantly monitor, would not be considered appropriate for network standby. Edge devices whose role is to complete a task, conduct no other service and can tolerate an extended resume sequence, should autonomously go into network standby.

² Power management consistent with its role in the network: e.g. an edge device with networking functionality such as a printer with an integrated access point controller may put edge device functionality (printer) into a network standby state while maintaining operation of networking functionality (access point).

POLICY PRINCIPLES

1. Government and industry should seek harmonised policy approaches that benefit the global marketplace for consumer and commercial technology products and services, and that enhance the productivity and efficiencies achieved via networks.
2. Policy, including government procurement and best-practice sharing, should support continued device, network and intelligent efficiency innovation.
3. Energy efficiency requirements should be performance-based and technology neutral. Policy should account for the different capabilities of networked devices.
4. Policy should neither impede the functionality of networked devices or efficiency of the network nor impair the implementation of standards for enabling device or network security.

7.3 Standards and Protocols

A working group of 11 industry and government representatives (see Annex E) held a series of 4 teleconferences to investigate ways to stimulate the development of standards and protocols that help to reduce the energy used to connect mains-powered devices to a communications network. Of particular interest were those which govern how networked devices communicate and manage energy consumption.

The working group based its discussions on the Open Systems Interconnection (OSI) model¹⁹ for networking, which defines seven layers that typically form part of a communications network. Most recognised international standards organisations (IEEE, IEC, ISO, IETF) focus their activities on a subset of the seven OSI layers (typically the lower layers) rather than on all seven. However a functioning network requires all seven layers to be implemented.

International standards typically define a wide range of possible features in order to provide a broad platform for development and options for implementation. The eventual implementation then depends upon, not only these international standards, but also on more prescriptive standards developed by various alliances, consortia and other (smaller) standards bodies.

The working group found that the building blocks for energy efficiency generally exist in the (lower layer) standards developed by international standards organisations, and many of these include energy efficiency features. However, the energy efficiency aspects of these are often optional - they need to be specified by device and network designers in order to take advantage of them. In other words, there is an important on-going role to encourage the **adoption** of existing, energy efficient protocols.

This is not to say that there are no technical gaps in standards and protocols, where further technical effort could be focused. One potential example here is the issue of device latency - where a device will attempt to communicate with another device, but the first device cannot tolerate any delay in the second device waking up from a low power state. This is the kind of technical gap that may form a starting point for improving some standards and protocols.

To these ends, the working group concluded that the following would be useful in the area of standards and protocols:

- ▶ Encourage the uptake of energy efficient standards and protocols by including suitable text in the Guiding Principles (refer to section 7.2).
- ▶ Encourage the authors of standards and protocols (standards organisations) to adopt the Guiding Principles (refer section 7.2) when developing and updating standards and protocols.
- ▶ Encourage the authors of standards and protocols by providing them with awards and recognition for leadership in this area (refer section 7.6).

7.4 Energy Aware Devices

A working group of 5 industry and government representatives (refer Annex E) held a series of 3 teleconferences with the aim of investigating the potential for networked devices to communicate information on energy use to end-users and compelling efficient product design.

The fact that networked devices can communicate presents an opportunity to communicate real-time information on device energy use. “Energy aware” devices could yield several benefits: openly displaying device energy use may encourage better device design (albeit that disclosure occurs only after purchase). It would also allow consumers to access detailed energy use information at the device level, and real-time device energy data could be used by demand response and intelligent efficiency systems.

Device energy can be measured using dedicated hardware, although this is expensive. Alternatively, it may be feasible to build an energy estimation algorithm into the firmware of electronically-controlled devices. This concept was prototyped using an LED lamp, retrofitted with code to predict its energy consumption²⁰, to demonstrate that energy estimation is relatively straightforward (inexpensive) to build into electronically-

controlled devices. For networked devices, energy use could be displayed on a smartphone app or similar, but could also be displayed on the LCD display of non-networked devices. Due to privacy concerns however, data should not be transmitted beyond the user without permission.

There are currently a number of industry initiatives and products that involve disclosing real time device energy use, particularly in ICT²¹. The IETF E-Man MIB²² provides a framework for energy awareness in large ICT infrastructure and ANSI/CEA standard 2047²³ covers this for consumer electronics. The Energy Star specification for servers²⁴ also requires complying products to provide real-time power data.

The working group concluded that the most useful, immediate action would be to encourage voluntary (device) programs to incorporate “Energy Awareness”, e.g. in the same manner that Energy Star does for computer servers.

7.5 Centre of Excellence

A working group of 5 industry and government representatives (refer Annex E) held a series of 3 teleconferences with the aim of developing a virtual library to increase the understanding of energy saving opportunities and provide information on best practices that can be attained by networked devices and the networks within which they operate.

The working group determined that the aim is to provide open, independent and authoritative information to inform energy efficiency policy development. Its primary audience would be governments, industry, academics and NGOs. To ensure credibility, all materials posted will be subject to a brief review process and to assess usefulness and appropriateness.

To this end, it was agreed that papers should meet the following criteria:

- ▶ Increase the level of understanding of an issue or issues that directly concern the energy consumed by networked devices or their networks.
- ▶ Provide information or guidance relevant to the development of energy efficiency policy.
- ▶ Avoid direct product related sales pitches, and criticism of competing products or approaches.
- ▶ Focus on data and argument in support of the energy claims of particular approaches, configurations, techniques.
- ▶ Are clear and understandable by non-technical readers, and where required include glossaries and footnotes to provide explanations.
- ▶ Are clearly identified by author and affiliation and include references, preferably to independent studies or analysis.

It was agreed to establish a pilot website hosted by IEA-4E in order to demonstrate the concept. A review panel will be established to assess whether materials submitted meet the criteria identified above (rather than providing a check on the veracity of the contents). The panel will comprise 3 to 5 people drawn from industry, governments and relevant organisations, such as the American Council for an Energy-Efficient Economy (ACEEE), the European Council for an Energy Efficient Economy (ECEEE) and Lawrence Berkeley National Laboratory (LBNL). It is proposed that the current working group should form the nucleus of the review panel under the overall management of 4E, adding others as it sees fit. This will allow the early consideration of materials already put forward and to populate a pilot website.

²⁰ <https://www.youtube.com/watch?v=CosIGTOMYk8>

²¹ Examples of ICT energy disclosure industry initiatives and products:

<http://www.cisco.com/c/en/us/products/switches/energy-management-technology/index.html>

<http://www.cnet.com/how-to/calculate-your-pcs-energy-use/>

<https://support.apple.com/en-au/HT201464>

<https://software.intel.com/en-us/articles/intel-power-gadget-20>

²² <https://datatracker.ietf.org/wg/eman/charter/>

²³ <http://www.ce.org/Standards/Standard-Listings/R7-8-Modular-Communication-Interface-for-Energy-Ma/ANSI-CEA-2047.aspx>

²⁴ http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer_servers/Program_Requirements_V2.0.pdf?ea31-43fd

7.6 Awards

A working group of 7 industry and government representatives (refer Annex E) held a series of 3 teleconferences with the aim of developing an awards program to incentivise industry.

With these objectives in mind, the following general types of awards were discussed:

- ▶ **Award for best-performing product:** It was felt that awarding a specific product solely for a standby energy criterion might be difficult and take considerable time to develop and implement.
- ▶ **Award for most-improved product:** This has several potential advantages, such as not having to carefully define product categories and functionalities, and could be developed and implemented relatively quickly.
- ▶ **Incorporation of network energy into existing product awards:** Another option is to add a network energy criterion to existing awards. This would involve factoring in standby power measurements for awards categories and for products that have a network standby mode. However, for many products network standby may represent only a small proportion of the product's overall energy use, and therefore the award may have limited appeal.
- ▶ **Product award for small network equipment:** The primary role of small network equipment is to provide the network, thus network energy is a significant part of their energy use. An award for these products could leverage the Energy Star program for Small Network Equipment²⁵.
- ▶ **Standards/protocols award:** This could be awarded to recognise best practice in the area of the development of communications standards and protocols (refer section 7.3).
- ▶ **Program award (standards development, technology components, etc.):** A program or project award could recognise a standards body, innovative hardware, innovative software, etc.

The working group felt that the most appropriate next steps were to:

- ▶ Consider a standards/protocols award, in the short term.
- ▶ Consider a stand-alone product and/or program award, in the longer term (with additional resources)
- ▶ Incorporate into existing awards programs, such as the SEAD Global Efficiency Medal.

7.7 Intelligent Efficiency

A working group of 7 industry and government representatives (refer Annex E) held a series of 3 teleconferences with the aim of investigating how the Connected Devices Alliances could stimulate Intelligent Efficiency (IE).

Intelligent efficiency is loosely defined as the deployment of ICT technologies to facilitate efficient control of energy-using equipment/networks, leading to system-wide and cross-sectoral energy savings. The ACEEE explains intelligent efficiency as the deployment of affordable next-generation sensor, control, and communication technologies that help gather, manage, interpret, communicate, and act upon disparate and often large volumes of data to improve device, process, facility, or organisation performance and achieve new levels of energy efficiency. The key opportunities for increased energy savings through intelligent efficiency include: real-time feedback (to humans), automation (bypass humans) and substitution/dematerialisation (displace energy intensive activities).

There are several organisations currently pursuing ways to further the benefits of intelligent efficiency, and a number of studies that seek to identify its potential²⁶. In addition, there are numerous practical examples of its deployment.

²⁵ <http://www.energystar.gov/products/certified-products/detail/small-network-equipment>

²⁶ E.g. The Digital Energy and Sustainability Solutions Campaign (DESSC) report entitled 'ICT-Enabled Intelligent Efficiency: Shifting from Device-Specific Approaches to System Optima'.

It was noted that the difficulty in assessing quantified and verifiable savings resulting from intelligent efficiency may inhibit progress. Further, there is a lack of understanding by governments regarding the type of policies that could be deployed to improve the uptake of intelligent efficiency solutions.

This Working Group was keen to avoid duplication with any on-going work, however it determined that the Connected Devices Alliance could add significant value by undertaking the following projects:

- ▶ Promote key intelligent efficiency documents through the Centre of Excellence (see Annex G).
- ▶ Develop a measurement methodology(ies) for intelligent efficiency.
- ▶ Investigate the opportunities and types of government policies that may be used to stimulate better outcomes through intelligent efficiency.

8 Recommendations to Governments

The work undertaken in 2015 has significantly increased government and industry understanding of the potential energy implications of the increasingly connected world, as well as potential solutions. It is clear, however, that the rapid evolution of technologies central to the connected world will require longer-term attention by governments.

The Connected Devices Alliance provides a solid platform for further global collaboration between industry and governments, and should be supported to deliver and implement a 4-year work plan in pursuance of the stated goals.

This would enable the continued monitoring of the impacts of networked devices and their networks, and the expansion of the Alliance to include wider representation from key organisations and governments.

With sufficient support, the Alliance would aim to deliver the following new initiatives:

- ▶ **Voluntary Targets:** Develop appropriate network standby targets for different categories of end-user products to encourage improved efficiency and global harmonisation.
- ▶ **Voluntary Principles for Energy Efficiency in Digital Devices:** Promote the adoption of the agreed principles by device manufacturers, authors of technical standards/protocols and policy makers.
- ▶ **Centre of Excellence:** Populate and promote the online “Connected Devices By Design” site.
- ▶ **Awards:** Launch recognition awards through the SEAD ‘Global Efficiency Medal’.
- ▶ **Energy Aware Devices:** Encourage appliances and equipment to become ‘smarter’, such that they provide or display real time information on their energy consumption.
- ▶ **Voluntary Protocols and Standards:** Accelerate technical protocols and standards that enhance the efficiency of networked devices through identifying technical gaps; adoption of principles by standards developers, network architects and authors of technical standards/protocols; and awards for these organisations.
- ▶ **Intelligent Efficiency:** Stimulate the use of information and communications technologies (ICT) to improve energy management by disseminating information through the Centre of Excellence, developing measurement methodologies and identifying supportive government policy options.

²⁰ <https://www.youtube.com/watch?v=CoslGTOMYk8>

²¹ Examples of ICT energy disclosure industry initiatives and products:

<http://www.cisco.com/c/en/us/products/switches/energy-management-technology/index.html>

<http://www.cnet.com/how-to/calculate-your-pcs-energy-use/>

<https://support.apple.com/en-au/HT201464>

<https://software.intel.com/en-us/articles/intel-power-gadget-20>

²² <https://datatracker.ietf.org/wg/eman/charter/>

²³ <http://www.ce.org/Standards/Standard-Listings/R7-8-Modular-Communication-Interface-for-Energy-Ma/ANSI-CEA-2047.aspx>

²⁴ http://www.energystar.gov/ia/partners/prod_development/revisions/downloads/computer_servers/Program_Requirements_V2.0.pdf?ea31-43fd

Annex A: Definitions

Device Power management	The capability of a device to adapt its power to the required functionality. Examples of device power management are power scaling, and transitioning into a low(er) power operating mode.
Edge device	An end-user device that is connected to a network. Edge devices range from electronic devices such as smart TVs to appliances, heating, cooking and lighting equipment.
Latency	The time it takes for a device or part thereof to change state or mode so that it can respond to a request or to provide a requested function.
Network or Network System	A digital communication infrastructure with a topology of links, an architecture, including the physical components (devices), organisational principles, communication procedures and formats (protocols). Networks can interconnect with other networks and contain sub-networks.
Network power management	The capability of a community of networked devices to manage power optimally across the community. Examples of network power management include consolidation of resources, managing the state of network links, and proxying.
Networked infrastructure device	A device connected to a network that is shared by more than one edge device (client). A server would be an example of such a device.
Networked devices	A general term meant to cover all devices that are connected to networks and make up the network. Edge devices, networked infrastructure devices, and networking devices are all subsets of networked devices.
Network idle	The inactive status of a network (link) which a device is connected to (i.e. is not processing a "payload"). Under this condition, the device(s) connected may still be required to support various functions to support its network connection and operation.
Network standby	A low power mode in which a device has the capability to maintain a persistent network presence after its operation has been suspended.
Networking device	A device connected to a network whose main functions are to pass along data traffic, routing data between networked devices, and optimising available bandwidth and transmission delays according to a wide variety of requirements. A WiFi access point would be an example of such a device.
Networking functionality	The functionality to pass along data traffic and routing data between networked devices. For networking devices, the networking functionality is the main function. For edge devices, the networking functionality may be one of the (secondary) functions, e.g. a network printer with an integrated wireless access point.
Power scaling	The capacity of a device to dynamically change its power level in relation to its variable workload; it may involve voltage and/or frequency scaling.
Standards and protocols	Widely-accepted technical documents which specify how networked devices communicate or manage energy consumption. Published by standardisation organisations or recognised standards developing organisations / alliances. Does not refer to regulatory standards.

Annex B: Stock and sales modelling Methodology

More Data, Less Energy makes the following 5 key recommendations for addressing network standby, in addition to many more detailed suggestions for action. These provided a useful starting point for determining potential actions taken by the Connected Devices Alliance during 2015.

► **Assess, analyse and align existing policy approaches for globally traded devices**

Policies have been implemented for some networked devices in the European Union, the United States and the Republic of Korea. Sharing the experiences with these may provide insights into the type of policy measures likely to be most effective.

► **Pursue close interaction with industry**

In a rapidly evolving environment, it is critical to create close relationships that allow technology and policy development to be mutually supportive. Policy needs to be stable enough to build industry confidence, yet flexible enough to allow innovation within the policy frameworks. To the greatest extent possible, co-ordination or joint initiatives are desirable.

► **Establish international technology standards at the earliest possible date**

International standards for definitions, metrics and test procedures are valuable to all stakeholders across many levels. They also serve the public good by ensuring consumers are informed about the quality and energy efficiency of devices on the market. Governments and industry have a role to play in ensuring international standards developed are fit for policy making purposes.

► **Encourage development of communication protocols that support energy efficiency**

Programmes and initiatives could be used to incentivise and reward the creation of communication protocols that enable energy savings. This could be achieved through certification schemes or labelling, for example, that recognise front runners, or by adjusting policy to reflect the top achievements in industry. Such incentives should, however, remain technology-neutral.

► **Prioritise data collection**

Access to information on the network standby of devices and systems, and technological breakthroughs, will be important to track progress and highlight further opportunities. At a more detailed level, there is a need to better understand and benchmark the power used by different functions in devices, and the barriers to uptake of advanced technologies.

Analysis of this data will be used by governments to inform their policy response and also in reporting back to the G20.

Annex C: Stock and sales modelling Methodology

The Energy Efficient End-use Equipment (IEA-4E) Implementing Agreement and the Super-Efficient Equipment and Appliance Deployment (SEAD) initiative have been instrumental in raising the issue of energy implications of networked devices over many years.

The Energy Efficient End-use Equipment (IEA-4E) Implementing Agreement is part of the energy technology network established by the IEA to share information and transfer experience in order to support good policy development in the field of energy efficient appliances and equipment.

The SEAD initiative of the Clean Energy Ministerial (CEM) and the (IPEEC) brings together governments to work together to turn knowledge into action to save energy.

In 2012 and 2013, the IEA, the IEA-4E Standby Power Annex and SEAD organised workshops in Stockholm, Toronto and Paris to discuss the issue of network standby with key stakeholders including governments and industry. These formed part of the development process for '*More Data, Less Energy*', which was jointly published by the IEA and IEA-4E.

In 2014, the IEA-4E also published '*Beyond Network Standby: A Policy Framework and Actions for Low Energy Networks*' which elaborates a path forward for efficiency policy in the area of networks and complements '*More Data, Less Energy*'.

In 2014, IEA-4E launched the Electronic Devices and Networks Annex (EDNA), which will continue international collaborative work on efficient network devices and networks.

Many other agencies have also undertaken work in this area, for example:

- ▶ ACEEE Report – Energy Efficiency and Productivity Benefits of Smart Appliances and ICT – Enabled Networks: An Initial Assessment. Blog post with a link to the report -<http://www.aceee.org/blog/2014/11/internet-everything-could-be-huge-boo>.
- ▶ ACEEE Intelligent Efficiency Conference November 2014 - <http://aceee.org/conferences/2014/ie/program>.
- ▶ EPA and ITI work on systems efficiency - http://www.energystar.gov/index.cfm?c=prod_development.prod_development_epa_workshop.

Annex B of '*More Data, Less Energy*' provides additional information on industry and government initiatives.

FURTHER INFORMATION ON THE ABOVE ORGANISATIONS IS AVAILABLE FROM:

- International Energy Agency (IEA)
- International Partnership for Energy Efficiency Cooperation (IPEEC)
- Department of Energy and Climate Change (DECC)
- Energy Efficient End-use Equipment (IEA-4E)
- Super-efficient Equipment and Appliance Deployment (SEAD) initiative
- American Council for an Energy-efficient Economy (ACEEE)

Annex D: Examples of Policy Responses for Networked Devices

► Mandatory MEPS (Minimum Energy Performance Standards) - EU EcoDesign Networked Standby Regulation (801/2013 amending 1275/2008)²⁷

The EU EcoDesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment entered into force in September 2013. The Regulation also introduces special requirements for televisions and coffee machines.

A horizontal regulation was adopted since networked connectivity is a feature of a large range of products, including products that will appear in the future. Products that are able to be reactivated over a network would typically be IT- and Consumer electronics equipment, such as:

- Personal computers
- Displays
- Networked storage
- Imaging equipment
- Networked equipment.

Examples of products excluded from the power consumption limits in the regulation are workstations, desktop thin clients, small-scale servers and computer servers.

The network standby limits are indicated in the table below:

Table 3: EcoDesign networked standby regulations

NETWORKED PRODUCT	TIER 1 (1 JAN 2015)	TIER 2 (1 JAN 2017)	TIER 3 (1 JAN 2019)
HiNA network products	12W	8W	8W
Networked products with HiNA function(s)	6W	3W	2W
other networked products (LoNA)			

Source: OJ L 225, 23.8.2013, p. 1-12.

Note: HiNA = High Network Availability

► Voluntary Endorsement Label - Korean e-Standby Program

Korea's e-Standby Program uses a device-by-device approach to set network standby limits for 11 electronic devices, based on a combination of power limits. The table below (sourced from *More Data, Less Energy*) shows the network standby power limits that devices must meet in order to carry the e-Standby label.

Table 4: Korean networked standby power limits in e-Standby Program

TARGET DEVICES	POWER LIMITS FOR NETWORK STANDBY MODES	NETWORK FUNCTIONALITY	AVAILABILITY OF NETWORK STANDBY MODE(S)
Computers	Total energy consumption including sleep mode, transition time and off mode	Available	Available (Wake-on-LAN mode)
Printers, fax machines, copiers, multi-function devices	Total energy consumption including sleep mode, transition time and off mode	Available	Available
Scanners	≤ 15 min (transition time) ≤ 5-10 W (standby mode) ≤ 0.5 W (off mode)	Available	Available
Building door phones, cord/cordless phones	≤ Various (standby mode)	Available	Available (backlight off control)
Set-top boxes	≤ 1 W (optional, passive standby) ≤ 10-20 W (active standby)	Available	None
Modems	≤ 0.75 W (off mode) ≤ Various (standby mode)	Available	Available (backlight off control)
Home gateways	≤ 10 min (transition time) ≤ 10-20 W (sleep mode)	Available	Available (backlight off control)

Source: Adapted from Jung, S. (2013), "Korea's energy efficiency Program in terms of networked standby"; presentation at the Networked Standby Policy Framework Workshop, IEA 4E/SEAD and Natural Resources Canada, Toronto, 7 March, www.iea.org/media/workshops/2013/networkedstandby/5SangjukJUNGKoreasEnergyEfficiencyPrograms_TTA_130305.pdf.

► **Voluntary Endorsement Label - US Energy Star Program**

The US Energy Star program includes network standby requirements for various items of equipment, including:

- Small network equipment (modems, routers, switches, etc.)²⁸
- Set-top boxes²⁹
- Home audio and DVD ³⁰
- Televisions (referring to new specification V7.0 in development³¹).

The Energy Star limits are typically expressed as a TEC (total energy consumption) metric which includes a calculation term for network standby mode (e.g. set-top boxes), or as a maximum power limit for the network standby mode (e.g. Televisions upcoming V7.0 which includes 3W limit for Standby-Active mode).

► **Mandatory Energy Rating Label - Korean e-Standby Program**

In the mandatory Korean rating label program, appliances that do not meet the standby power limits in the table below (sourced from 'More Data, Less Energy') cannot be rated above level 2 on the scale of 1 to 5 (1 being the most efficient).

²⁸ <http://www.energystar.gov/products/certified-products/detail/7588/partners>

²⁹ <http://www.energystar.gov/products/certified-products/detail/set-top-boxes-cable-boxes>

³⁰ http://www.energystar.gov/index.cfm?c=audio_dvd.pr_crit_audio_dvd

³¹ <http://www.energystar.gov/products/certified-products/detail/7625/partners>

Table 5: Network standby power limits in Korea’s energy efficiency standards and labelling program

TARGET DEVICES	POWER LIMITS FOR NETWORK STANDBY MODES	NETWORK FUNCTIONALITY	AVAILABILITY OF NETWORK STANDBY MODE(S)
Air conditioners	≤ 1 W (passive standby) ≤ 3 W (active standby)	Available (some)	Available (Ethernet communication)
Gas boilers	≤ 3 W (sleep mode)	Available (majority)	Available (serial communication)
Gas water heaters	≤ 3 W (sleep mode)	Available (majority)	Available (serial communication)
Washing machines	≤ 2 W (active standby)	Available	–
Drum washing machines	≤ 2 W (active standby)	Available	Available (Ethernet communication)
Dish washers	≤ 3 W (active standby)	Available	–
Televisions	≤ 0.5 W (passive standby) ≤ 2 W (active standby)	Available	None

Note: W = watt.

Source: Adapted from Jung, S. (2013), “Korea’s energy efficiency program in terms of networked standby”; presentation at the Networked Standby Policy Framework Workshop, IEA 4E/SEAD and Natural Resources Canada, Toronto, 7 March, www.iea.org/media/workshops/2013/networkedstandby/5SangjukJUNGKoreasEnergyEfficiencyPrograms_TTA_130305.pdf.

► **Voluntary Industry Agreement - United States Voluntary Agreement on Set-Top Boxes**

The US Department of Energy (US DOE) recently drafted provisions to include set-top boxes and network equipment as devices covered in its Energy Efficiency Program for Consumer Devices, spurring industry to launch a voluntary agreement in 2013.

The US Set-top Box Energy Conservation Agreement is a voluntary agreement between the US government, oversight bodies and device providers and manufacturers. It requires 90% of all new set-top boxes purchased and deployed after 2013 to meet Energy Star 3.0 efficiency levels, among other agreement targets. The agreement is flexible and expected to consider new devices in the future. Participants will report measures taken and aggregated results will be presented on an annual basis.

Participants will meet regularly to review and update energy efficiency measures, and to host on-going discussions with the US DOE, the US EPA and other interested government agencies and stakeholders on new technologies and equipment. To create accountability and support transparency, the agreement’s terms include detailed processes for verification of set-top box performance in the field, annual public reporting on energy efficiency improvements, and posting device energy consumption information by each company for its customers.

As part of the agreement, “light sleep” is being implemented in an increasing number of new and existing set-top boxes - it involves powering down hard disks, in-band tuners and video outputs, and automated power down. Enabling light sleep provides energy savings in the region of 20%. “Deep sleep” functionality in the next generation of cable set-top boxes will be field tested and deployed if successful. The agreement is expected to improve set-top box efficiency by 10-45% by 2017.

► **Voluntary Industry Agreement - European Union Voluntary Agreement on Set-Top Boxes**

The European Union is addressing the efficiency of network-enabled devices and other complex device categories through voluntary agreements and codes of conduct that cover the following device categories:

- Complex set-top boxes
- Imaging equipment

- Medical imaging equipment
- External power supplies
- Broadband equipment.

The voluntary agreement for complex set-top boxes³² (CSTBs) requires signatories (primarily) to ensure that 90% of their products comply with the following energy consumption targets:

Table 6: EU voluntary agreement for complex set-top boxes

BASE FUNCTIONALITY	TIER 1 ANNUAL ENERGY ALLOWANCE (kWh/year)	TIER 2 ANNUAL ENERGY ALLOWANCE (kWh/year)
Cable	45	40
Satellite	45	40
IP	40	35
Terrestrial	40	35
Thin Client/Remote	40	35

The Agreement also contains allowances for additional functionalities (refer Annex D of the Agreement).

► **Voluntary Industry Agreement - US CEA/NCTA Voluntary Agreement on Home Internet Equipment³³**

In June 2015 the US Consumer Electronics Association (CEA) and the National Cable & Telecommunications Association (NCTA) announced a voluntary agreement for modems, routers and other broadband equipment. The agreement sets requirements aimed at improving the energy efficiency of small network equipment (SNE) by 10-20% and should cover around 80 million homes. It is modelled on the US voluntary agreement for set-top boxes and requires broadband service providers and equipment manufacturers to publicly report SNE energy use including annual progress reports by an independent third party. Additionally, the agreement mandates annual verification audits to ensure SNE devices are performing at the efficiency levels specified in the agreement, and regular consultation and engagement with regulatory authorities and other stakeholders.

³² http://ec.europa.eu/energy/efficiency/ecodesign/doc/20121217_voluntary_industry_agreement_cstb.pdf

³³ [http://www.ce.org/News/News-Releases/Press-Releases/2015-Press-Releases/New-Initiative-Will-Improve-Energy-Efficiency-\(1\).aspx](http://www.ce.org/News/News-Releases/Press-Releases/2015-Press-Releases/New-Initiative-Will-Improve-Energy-Efficiency-(1).aspx)

Annex E: List of Participants in Working Groups

WORKING GROUP 1 - VISION AND GOALS:

Katherine Delves	Natural Resources Canada
Jeremy Domm	US Department of Energy
Gabrielle Dreyfus	US Department of Energy
Mark Ellis	Operating Agent for IEA-4E
Sylvie Feindt	Digital Europe
Peter Gibson	Intel
Chris Hankin	Information Technology Industry Council (ITI)
Doug Johnson	Consumer Electronics Association
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Nathan Moin	Hewlett Packard
Jason Ord	Hewlett Packard
Vida Rozite	International Energy Agency
Samuel Thomas	International Energy Agency
Klaus Verschuere	Cisco
Mike Walker	UK Department of Energy and Climate Change
Johanna Whitlock	Swedish Energy Agency

WORKING GROUP 2 - GUIDING PRINCIPLES:

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Sylvie Feindt	Digital Europe
Chris Hankin	Information Technology Industry Council (ITI)
Doug Johnson	Consumer Electronics Association
Tom Moriarty	Dell
Stephen Palm	Broadcom
Vida Rozite	International Energy Agency
Shahid Sheikh	Intel
Samuel Thomas	International Energy Agency
Gary Verdun	Dell
Henry Wong	Intel

WORKING GROUP 2 - STANDARDS AND PROTOCOLS:

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Steven Beletich	Operating Agent for IEA-4E Electronic Devices and Networks Annex (EDNA).
David Egan	Silicon Labs
Zachary Hu	Midea
Doug Johnson	Consumer Electronics Association
Oleg Logvinov	ST Microelectronics
Roberto Minerva	Telecom Italia
Stephen Palm	Broadcom
Donna Sadowy	AMD
Gary Verdun	Dell
Henry Wong	Intel

Annex E: List of Participants in Working Groups cont'd

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Doug Johnson	Consumer Electronics Association
Klaus Verschuere	Cisco
Jan Viegand	Viegand Maagøe (for the Danish Energy Agency)

WORKING GROUP 5 & CENTRE OF EXCELLENCE:

Mark Ellis	Operating Agent for IEA-4E
Chris Hankin	Information Technology Industry Council (ITI)
Stephen Pattison	ARM
Donna Sadowy	AMD
Mike Walker	UK Department of Energy and Climate Change

WORKING GROUP 6 & AWARDS:

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Gabrielle Dreyfus	US Department of Energy
Chad Gallinat	US Department of Energy
Doug Johnson	Consumer Electronics Association
Nathan Moin	Hewlett Packard
David Walker	Australian Department of Industry and Science
Mike Walker	UK Department of Energy and Climate Change
Debbie Weyl	CLASP

WORKING GROUP 7 & INTELLIGENT EFFICIENCY:

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Peter Gibson	Intel
Chris Hankin	Information Technology Industry Council (ITI)
Rona Newmark	EMC
Shahid Sheikh	Intel
Gary Verdun	Dell

Annex F: Technical Explanation of Issues Relating to the Connected Devices Alliance³⁴

Scope

MDLE (2014, p. 44) distinguishes between:

- ▶ Data centres, networks, and other network infrastructure, and
- ▶ Edge devices and user premise network equipment (small network equipment: SNE)

Data centres, networks and other infrastructure constitute the ICT infrastructure. ICT infrastructure is an essential part when looking at “intelligent efficiency” (see “Energy efficiency” below).

Edge devices and small networking devices account for 42% or 570 TWh of total ICT energy consumption in 2012 (MDLE 2014, p. 44). Note that the boundary between edge devices and small networking devices is blurred because several edge devices have network functions, e.g. a set-top box can have a network access point or a lamp can function as a mesh in a (home) network. Therefore, edge devices are differentiated into edge devices without and with networking functionality.

Many devices which connect to a network are battery powered, e.g. mobile phones, some smoke alarms, etc. These battery powered products have an intrinsic motivation to use as little energy as possible so that they function as long as possible without recharging or replacing the battery. Therefore, the scope of the G20 Action is restricted to grid connected devices, including DC powered devices e.g. by PoE or USB.

Power versus energy

The G20 Action aims in the short term to reduce the standby mode energy of networked devices, or in other words, reduce network standby energy consumption. Energy consumption is the result of the multiplication of power consumption and time:

$$\mathbf{E = P \times T.}$$

Therefore, a higher power over a shorter time can result in the same energy consumption as a lower power over a longer time. Similarly, a somewhat higher power when the product is in network standby (e.g. to enable proxying), can reduce overall energy consumption because the product spends less time in high power modes (MDLE 2014, p. 92-93). Thus, a total energy consumption (TEC) target provides more flexibility to achieve higher efficiency levels. However this requires the assumption or the measurement of a usage pattern; see also MDLE (2014, p. 93) for the problems.

For “cycling” within a mode, e.g. a product that “checks” the network every 20 seconds or has in general different power levels while being in a certain mode, the power versus energy discussion is solved by the measurement standard (IEC 62301. Ed. 2). According to this measurement method, the power consumption is taken as the average power consumption over a certain period that should include at least two cycles and lasts not less than 10 minutes.

Power management, power scaling, network standby/idle and latency

▶ Power management, power scaling

In general the following strategies can be followed to reduce energy consumption of products (see also MDLE 2014, p. 64):

- Use efficient components (to reduce power consumption).

- Power scaling: the capability of the product to vary its power consumption to the performance (in active mode); two variants can be distinguished:
 - Stepped power scaling: turning off unneeded or redundant parts, e.g. the number of fans, additional power supplies, extra RAM;
 - Continuous power scaling: the power varies continuously with the performance, e.g. the decrease of traffic through a router results in a decreasing power consumption or the increase of brightness of a television results in an increasing power consumption.
- Energy management: reduce the time spent in high-power modes and increase the time spent in low-power modes.

Note that these strategies are related and at some points overlap. This document uses the term power management to indicate the capability of a product to adapt its power consumption (automatically) to the required functionality. This includes power scaling (in active mode) and switching into a low power mode when primary function(s) are not being used. Note that the principle of power management can be applied at the component level (e.g. switching on and off the cores of a processor) at the product level or at the system level (e.g. switching servers off in a data centre when the utilisation of the data centre is low).

► Network standby/idle

Network standby (for a product) means that a product is connected to a network and is not delivering its (primary or secondary) functions, but is waiting for a signal through the network to resume or start a (primary or secondary) function (MDLE 2014, p. 16). It is noted that the term “standby” has connotations with “sleep” or “inactive” which are seen to be inappropriate for network equipment. Network equipment never sleeps because it always has to maintain the network connection(s) even if no “pay load” is processed. For the case that only the network connection is maintained, the term “network idle” is suggested. Network equipment is in “network idle” when the product does not receive and process any “pay load” but the necessary network connections are maintained.

► Latency

To reduce the energy consumption of a product that has network standby or idle, the time in which the product is in network standby or idle needs to be as long as possible and the power consumption in network standby or idle needs to be as low as possible (in any case lower than the power consumption in on-mode).

The first condition (time) means that the product needs to be switched to network standby or idle as soon as possible when the primary or secondary functions are no longer needed. In general, the important issue is the resume time or latency for an application getting back to work. The low power mode with network standby or idle needs to be designed in such way that it meets the resume time requirements of the user or of the network protocol³⁵. The latency is for the largest part determined by the (physics of the) process when the reactivation signal has been received. For a laser printer where the drum needs to be heated before printing can start, the resume time can be several minutes, whereas for networking products the resume time can be milliseconds.

Note that the issue of *latency* also relates to power scaling (both stepped and continuous). Also here the main issue is not decreasing the performance (and the power consumption) when the load decreases, but increasing the performance fast enough to match increasing load.

Energy efficiency of network standby

Two perspectives to value network standby exist: the product and the system perspective. In the *product perspective* the energy consumption of a product with network standby for a certain product cycle (TEC) or the power consumption in standby can be used as measure: the “better” product is the product with the lower TEC or the lower power consumption in standby³⁶.

³⁵ Or, the other way around, to enable the protocol to deal with larger latencies.

³⁶ This assumes that both products perform their (main) function(s) equally well.

However, this does not take into account the usefulness of the product connected to a network regarding decreasing energy consumption or increasing energy efficiency of other products or its own. Through the network connection, a product may be able to control other products or can receive information from elsewhere to control its performance. In the **system perspective** these wider implications of both energy consumption and savings are taken into account. On the consumption side are the energy consumption of the network(ed) products and the relevant ICT infrastructure, whereas on the saving side the energy savings count. In a simplified formula:

$$\text{Energy efficiency} = \frac{\Sigma \text{ energy savings}}{\Sigma (\text{energy consumption network(ed) products, ICT infrastructure})} \times 100\%$$

In this case the “better” product is the product with the higher energy efficiency. However, the energy savings should at least compensate for the energy used to generate the savings, meaning that the energy efficiency should be higher than 100%.

For a networked thermostat that uses cloud computing and data to determine an optimal heating curve, the energy savings would be the savings of the heating device using the optimal heating curve. The numerator would be the energy consumption of the relevant network infrastructure including the part of the data centre where the calculations are performed and the data is stored, and the network consumption of the heating device.

At the moment no methodology is available to assess energy efficiency of network standby at a system level.

Annex G: Technical Explanation of Issues Relating to the Connected Devices Alliance³⁴

Center for Climate And Energy Solutions (C2ES)

- ▶ C2ES (2012), Leading by Example: Using Information and Communications Technology to Achieve Federal Sustainability Goal, September 2012.
The report is available here: <http://www.c2es.org/docUploads/federal-sustainability-ict.pdf>.
- ▶ C2ES (2013), Leading by Example 2.0: How Information and Communication Technologies Help Achieve Federal Sustainability Goals, June 2013.
The report is available here: <http://www.c2es.org/docUploads/how-ict-help-achieve-federal-sustainability-goals.pdf>.

American Council for an Energy-Efficient Economy (ACEEE)

ACEEE publications are available from: <http://aceee.org/publications> and include:

- ▶ ACEEE (2012), Defining a Framework for Intelligent Efficiency, Report E125, June 2012.
- ▶ ACEEE (2013), Intelligent Efficiency: Opportunities, Barriers and Solutions, Report IE 13J, October 2013.
- ▶ ACEEE (2014a), The Energy Savings Potential of Smart Manufacturing, Report IE 1403, July 2014.
- ▶ ACEEE (2014b), Smart Freight: Applications of Information and Communications Technologies to Freight System Efficiency, An ACEEE White Paper, July 2014.
- ▶ ACEEE (2014c), The Energy Efficiency and Productivity Benefits of Smart Appliances and ICT-Enabled Networks: An Initial Assessment, Report Number F1402, November 2014.

Digital Energy and Sustainability Solutions Campaign

- ▶ ICT-Enabled Intelligent Efficiency: Shifting from Device-Specific Approaches to System Optima, John A. “Skip” Laitner Matthew T. McDonnell Ryan M. Keller. A Working Paper Prepared for the Digital Energy and Sustainability Solutions Campaign.
Available from: <http://digitalenergysolutions.org/knowledge-center/white-papers/ictenabled-intelligent-efficiency-shifting-from-devicespecific-approaches-to-system-optima>.

GeSI Projects and Reports

The Global e-Sustainability Initiative publications are available from http://gesi.org/ICT_sustainability_portfolio and include:

- ▶ GeSI (2012) GeSI SMARTer 2020: The Role of ICT in Driving a Sustainable Future.
- ▶ GeSI (2015) GeSI SMARTer 2030: available from <http://smarter2030.gesi.org>.
- ▶ Evaluating the Carbon-Reducing Impacts of ICT - an Assessment Methodology.
Available from <http://gesi.org/portfolio/project/4>.

ACEEE IE Conference

On November 16-18, 2014, ACEEE held its first Intelligent Efficiency Conference to facilitate the sharing of ideas and the forming of partnerships that can advance adoption of intelligent efficiency in the marketplace. Presentations from that Conference can be downloaded from:

- ▶ <http://aceee.org/conferences/2014/ie-program>
A second IE Conference is planned for December 6-8, 2015, in Boston.

The Intelligent Transportation Society of America

The following report is available here: <http://digitalenergysolutions.org/dotAsset/933052fc-0c81-43cf-a061-6f76a44459d6.pdf>.

- ▶ ITS America (2014), Accelerating Sustainability: Demonstrating the Benefits of Transportation Technology, August 2014.

EPA/ITI Workshop

On June 26th, 2014, the US Environmental Protection Agency (EPA), in conjunction with the Information Technology Industry Council (ITI), held a joint workshop to explore roles for the ENERGY STAR program and others in promoting energy savings using such system effects, pathways to defining and measuring systems/intelligent efficiency, and opportunities for leadership and education. Materials from that Workshop and work program are available here:

- ▶ https://www.energystar.gov/index.cfm?c=prod_development.prod_development_epa_workshop.