Electronic Devices & Networks Annex
EDNA

Energy Efficiency of the Internet of Things

Policy Options

Prepared for IEA 4E EDNA

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of the
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The Implementing Agreement on Energy Efficient End-Use Equipment (4E) is an International Energy Agency (IEA) Collaborative Technology Programme established in 2008, to support governments to co-ordinate effective energy efficiency policies. Twelve countries have joined together under the 4E platform to exchange technical and policy information focused on increasing the production and trade in efficient end-use equipment. However 4E is more than a forum for sharing information – it pools resources and expertise on a wide a range of projects designed to meet the policy needs of participating governments. Participants find that is not only an efficient use of available funds, but results in outcomes that are far more comprehensive and authoritative than can be achieved by individual jurisdictions.

Current members of 4E are: Australia, Austria, Canada, Denmark, France, Japan, Korea, Netherlands, Switzerland, Sweden, UK and USA.

Further information on the 4E Implementing Agreement is available from: **www.iea-4e.org**

Network connected devices, including the Internet of Things, are growing rapidly and offer enormous opportunities for improved energy management. At the same time, there is a responsibility to ensure that these devices use a minimal amount of energy to stay connected. 4E's Electronic Devices and Networks Annex (EDNA) works to align government policies in this area and keep participating countries informed as markets for network connected devices develop.

Further information on EDNA is available at: **www.edna.iea-4e.org**

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Executive Summary

The impact of the network standby energy consumption of mains-connected IoT devices on worldwide annual energy consumption is expected to be significant (estimated 46 TWh in 2025). However, this impact can be mitigated by using appropriate communication technologies. Low-power standards have been developed and are broadly deployed for battery-powered IoT edge devices, and considerable energy savings could be achieved by adopting these technologies in mains-connected devices, as well by deploying and correctly pre-configuring the optional power saving mechanisms available within various communication technologies.

To promote the use of energy efficient technologies, several policy options are presented, each with advantages and disadvantages:

- Vertical, horizontal and clustered Minimum Energy Performance Standards (MEPS)
- Comparative, Endorsement and Warning Labels
- Voluntary Agreements
- Awards Programs
- Consumer Awareness Campaigns
- Product Information Databases

In developing concrete policy proposals, the special characteristics of IoT markets and technologies have to be taken into account:

- The IoT market is forecast to grow rapidly.
- The technologies evolve constantly and rapidly.
- The IoT is not homogeneous, but comprises many diverse product categories.

Due to these characteristics, quickly implementable policies should be preferred. Otherwise a large-scale uptake of inefficient products is possible. Further there is the risk of wasted policy making efforts, if new technologies replace quickly those under consideration.

Policies covering a broad range of product categories would be desirable to keep pace with the rapid developments. Three measures fulfilling this requirement were identified:

- Clustered MEPS for network standby power of Smart Home edge devices
- Voluntary Agreement on Smart Home network standby
- Include IoT examples in general network standby awareness campaigns

If the scope is narrowed, four IoT product categories lend themselves to specific policies: Smart LED lamps, home security cameras, smart home gateways, and network-connected audio products. All these devices are expected to have a high installed base in the future and each represents a homogeneous product category. Therefore several policy options can be considered:

- Comparative labelling for network standby of home security cameras, smart home gateways, and network-connected audio devices
- Network standby energy information on comparative labels for smart LED lamps
- MEPS for network standby power of home security cameras, smart home gateways, smart LED bulbs, and network-connected audio devices
- Endorsement and warning labels for network standby of home security cameras, smart home gateways, smart LED lamps, and network-connected audio products (endorsing those with low network standby power)
- Voluntary agreement(s) on network standby of home security cameras

- Product information databases (such as the TopTen energy efficiency program) for home security cameras and smart LED bulbs

Two additional areas were identified, which may have a significant impact on the network standby energy consumption of the covered IoT applications: AC/DC power supplies and wireless routers and access points. The according proposed policy options are:

- Tightening the MEPS for external power supplies at low loads
- Voluntary Agreements that support low-power standards in wireless routers and access points

The following table gives an overview on the proposed policies.

Table 1: Overview of policy proposals for investigated IoT applications

	Vertical MEPS (for single product category)	Horizontal MEPS (across many products)	Clustered MEPS	Comparative Label	Endorsement/Warning Label	Voluntary Agreement	Awards Program	Awareness Campaign	Product Database
Home Security Cameras	x			x	x	x			x
Smart Home Gateways	x			x	x				
Smart LED Lamps	x			x	x		x	x	x
Network-Connected Audio	x			x	x				
Smart Home Systems			x			x			
External AC/DC Power Supplies	x								
Wireless Routers / Access Points						x			
All IoT devices							x		

For more specific policy recommendations for the IoT edge devices covered by the presented project, further analysis of policy making and existing regulations in the IEA 4E EDNA member countries is needed.

1 Introduction

1.1 Background

Over the last few years the "Internet of Things" (IoT) has become an omnipresent term. The IoT expands the common concepts of "anytime" and "any place" to the connectivity for "anything". This technology is moving now rapidly from media hype to reality. It is predicted that by 2020 there will be 50 billion things connected to the IoT. Further it is estimated, that 200 devices per person could be connected to networks, potentially leading to several hundred billion devices [1].

The proliferation of IoT offers opportunities but may also bear risks. A hitherto neglected aspect is the possible increase in power consumption. IoT devices are expected to be network connected at all times. This implies that the devices are consuming electrical energy even when not in use for their primary function. Billions of such devices therefore raise concerns regarding excessive network standby energy consumption, even if the individual device has only moderate power needs.

Therefore IEA 4E EDNA has initiated a project to investigate the network standby power of mains-connected IoT devices and their estimated impact on worldwide network standby energy consumption. The study further assesses the related IoT communication technologies and standardization activities, and proposes policy options to minimize network standby energy consumption.

1.2 The Project "Energy Efficiency of the Internet of Things"

1.2.1 Objectives

The project had the following objectives:

1) Provide an overview of the structure of IoT and prioritise the device categories with the highest energy impact potential based on expected proliferation.
2) Assess the network standby energy consumption for prioritised categories based on current technologies and measurements, including analysis of the impact of options to reduce energy consumption.
3) Develop initial high-level policy options.
4) Identify the most important topics, which should be investigated in further work.

The findings for objectives 1), 2), and 4) were presented in the report "Internet of Things – Technology and Energy Assessment" [1] published in April 2016 by IEA 4E EDNA. The current report presents and discusses policy options to address objective 3).

1.2.2 Scope of Work

The overall project has focused on:

- Novel IoT edge devices[1], which have not yet been addressed by related work.
- The network standby energy consumption of these IoT edge devices.
- Mains connected devices.

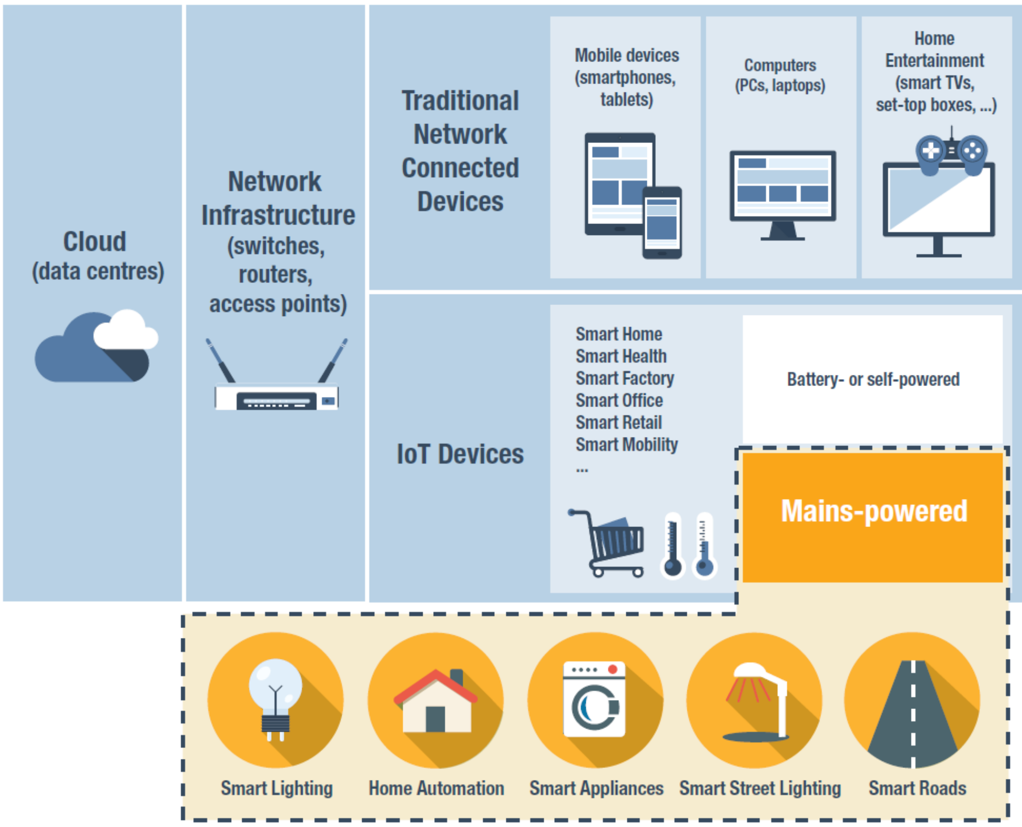
[1] Devices which are not needed in network operation, but respond to network signals (as opposed to network infrastructure equipment).

The following topics were out of scope:

- Traditional network-enabled devices (such as computers, smart phones, TV sets, etc.)
- Battery- or self-powered devices
- IoT as enabler for energy efficiency (control of device primary function to save energy)
- Smart Grid application area (energy utility demand-response)
- Privacy, security and interoperability issues in conjunction with IoT
- Big Data and Cloud Computing.

This scope is illustrated inFigure 1 . More details can be found in [1].

Figure 1: System overview and scope of study (highlighted in orange)



1.3 Summary of Technology and Energy Assessment

This section summarizes the findings of the preceding report "Internet of Things – Technology and Energy Assessment" [1] which forms the basis for the policy options discussed in the current report.

Since IoT comprises a very wide variety of industries and applications, the IoT space has first been structured according to application. Then the applications have been prioritised based on the estimated device proliferation. Further investigations focused on the applications Smart Lighting, Home Automation, Smart Appliances, Smart Street Lighting, and Smart Roads.

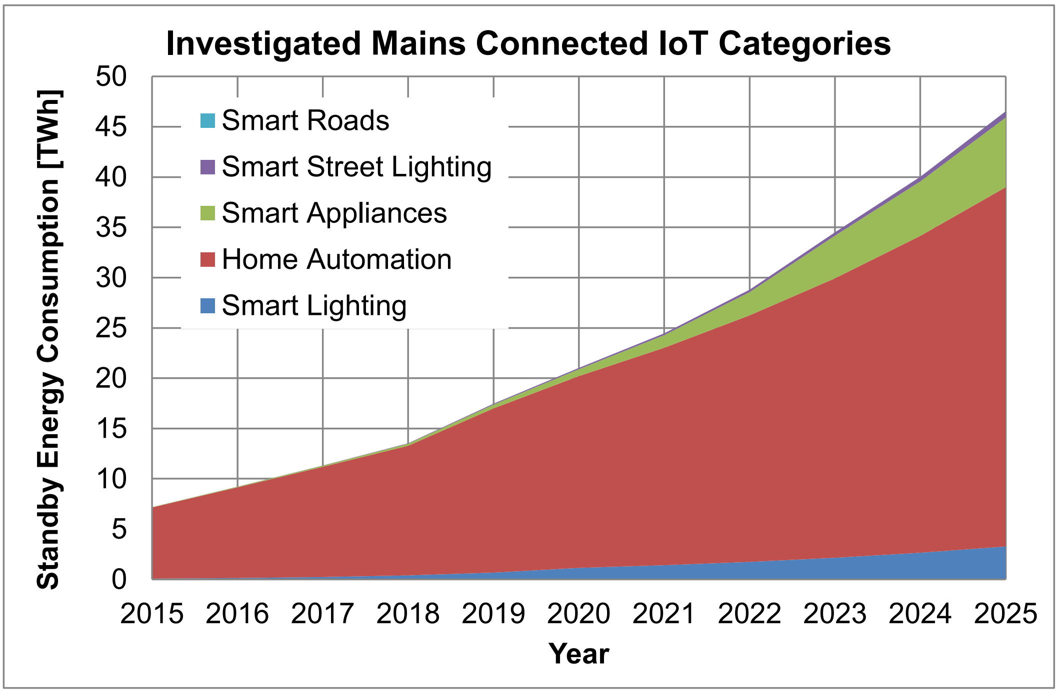
To evaluate the network standby energy impact of the prioritised IoT applications, energy consumption measurements were conducted on select edge devices in the areas of Smart Lighting and Home Automation. For practical reasons, no measurements of Smart Appliances, Smart Street

Lighting and Smart Roads were conducted, and the authors relied on vendor information, literature data or their own estimates.

The collected data have shown a wide spread of network standby power values between devices of the same category. This may be attributed, in part, to their respective communication technologies, but may be also related to the implementation of a specific technology.

To assess the potential impact of the prioritised IoT applications on worldwide energy consumption, a forecast on the proliferation of the associated edge devices was established based on market research data. In a second step, a worldwide annual network standby energy consumption forecast was calculated based on the proliferation forecast, the expected usage times and the network standby power data. The overview is presented in Figure 2.

Figure 2: Worldwide network standby energy consumption of investigated IoT applications



The predicted worldwide network standby energy consumption of the prioritised IoT edge devices increases with an annual growth rate of 20%, and reaches 46 TWh in the year 2025, which is equal to Portugal's entire annual electricity consumption in the year 2012. The most significant application is Home Automation with a share of 78% (36 TWh), followed by Smart Appliances with 15% (7 TWh) and Smart Lighting (7%, 3 TWh). Smart Street Lighting and especially Smart Roads are negligible compared to the other prioritised applications.

To get an understanding for the reasons behind the wide range of network standby power values of the investigated edge devices, an analysis of the available communication technologies was completed. This analysis shows that technologies with low network standby power are already established or emerging for the prioritised IoT applications. The comparatively high network standby power found in some products is the result of either a poor implementation of a technology or the use of an inappropriate technology. Further, the low efficiency of external power supplies at low loads may contribute to unnecessary high network standby power in mains-connected devices.

The analysis of relevant standardization activities has shown that IoT applications requiring battery powered edge devices are a major driver for novel low-power communication standards specifically developed for IoT. Since the consumer would not accept low battery lifetimes, low-power network standby modes and communication mechanisms are therefore already supported by these standards. Fortunately, also for existing communication standards such as Wi-Fi and Bluetooth, major improvements regarding low power have recently been made.

Based on this analysis, it is concluded that the expected future contribution of mains-connected IoT devices to worldwide annual energy consumption is significant. However, this impact can be mitigated by using the appropriate communication technologies and by incorporating the low-power standards developed for battery powered IoT edge devices into mains-connected devices. Further the deployment of the power saving mechanisms provided by these standards and their correct pre-configuration is important.

Network-connected audio products have been identified as an area for further work. Preliminary research shows that these products have proliferated quickly and that their network standby power varies considerably.

2 Policy Options in General

A number of generic energy efficiency policy options are typically proposed by policy-makers in conjunction with network enabled equipment [2]. They are briefly summarized in the following sections. Detailed descriptions and discussions can be found in [2].

EDNA also uses the policy types listed in Table 2 to categorise policies. These represent a much broader set of policies than is required for this report.

Table 2: Overview of Policy Types

Main type		Subtype 1		Subtype 2	
Economic Instruments	E	Direct investment	D	Funds to sub-national governments	F
				Infrastructure investments	I
				Procurement rules	P
				RD&D funding	R
		Fiscal/financial incentives	F	Feed-in tariffs/premiums	F
				Grants and subsidies	G
				Loans	L
				Tax relief	Tr
				Taxes	T
				User charges	C
		Market-based instruments	M	GHG emissions allowances	A
				Green certificates	G
				White certificates	W
Information and Education	I	Advice/Aid in Implementation	A		
		Information provision	I		
		Performance Label	L	Comparison label	C
				Endorsement label	E
		Professional training and qualification	T		
Policy Support	P	Institution creation	I		
		Strategic planning	S		
Regulatory Instruments	R	Auditing	A		
		Codes and standards	C	Building codes and standards	B
				Product standards	P
				Sectoral standards	S
				Vehicle fuel-economy and emissions standards	V
		Monitoring	M		
		Obligation schemes	Ob		
		Other mandatory requirements	O		
Research, Development and Deployment (RD&D)	RD	Demonstration project	D		
		Research programme	R	Technology deployment and diffusion	Dp
				Technology development	Dv
Voluntary Approaches	V	Negotiated Agreements (Public-private sector)	N		

		Public Voluntary Schemes	V	
		Unilateral Commitments (Private sector)	C	

2.1 Minimum Energy Performance Standards (MEPS)

MEPS specify the maximum energy or power demand of devices, which manufacturers must ensure in their models of a regulated category when using the test method that accompanies the MEPS. MEPS may define two measures: modal power, expressed in watts (W), and total annual energy consumption (TEC), expressed in kWh. The modal power specifies the maximal power consumption for one or more low power modes. TEC provides the an annual estimate of energy consumption across various modes, based on an assumed use profile.

There are three types of MEPS: Vertical, horizontal and clustered. Vertical MEPS are set on a device category basis. Horizontal MEPS cover a range of different device categories. Clustered MEPS combine a few device categories with similarities in main functions, network interactions and energy demand. An example of horizontal MEPS is the European Union's Standby Regulation 1275/2008/EC (amended by Regulation EU/801/2013 to include network standby).

The following two tables give an overview on the main advantages and disadvantages of Vertical and Horizontal MEPS. Clustered MEPS aim to achieve a compromise between the pros and cons of Vertical and Horizontal MEPS.

Table 3: Main advantages and disadvantages of Vertical MEPS

Vertical MEPS	
Advantages	Disadvantages
• Pushes inefficient devices out of market • Can be tailored to each specific device category • Resulting energy savings can be quantified	• Complex and time consuming to develop, especially for a large number of device categories • Costly to update for quickly evolving device categories • Requires good definitions for each of the device categories covered

Table 4: Main advantages and disadvantages of Horizontal MEPS

Horizontal MEPS	
Advantages	Disadvantages
• Pushes inefficient devices out of market • Covers broad range of devices, thereby creating a large volume demand for efficient solutions/components • Resulting energy savings can be quantified	• Sub-optimal requirements for some of the covered devices

2.2 Comparative, Endorsement and Warning Labels

Energy labels provide information to enable the consumer to make informed purchasing decisions with the aim of stimulating the sales of the most efficient products. Comparative labels rate the energy performance of a device model compared with other models. Typically the models are classified into energy efficiency groups. Endorsement labels are awarded to device models that fulfil specified energy efficiency criteria. Another option is labels that signify compliance with certain minimum energy performance standards for network standby consumption.

Examples of endorsement labels are the United States' ENERGY STAR label and Korea's High-Efficiency Appliance Certification and "Energy Boy" label [3]. Warning labels indicate that a product does not meet a certain energy efficiency standard. As first country Korea has introduced in 2008 a mandatory standby warning label scheme, which covers products such as TV sets, computers, and set-top boxes [4].

Table 5 lists the main advantages and disadvantages of Labels in conjunction with network standby.

Table 5: Main advantages and disadvantages of Comparative and Endorsement Labels

Comparative and Endorsement Labels	
Advantages	Disadvantages
• Achieve high consumer awareness • May steer consumers to better than average products • Encourage manufacturers to improve devices	• Problematic for network standby only, since network standby is only a part of overall device energy consumption

2.3 Voluntary Agreements

Voluntary agreements may be executed between public or regulatory authorities and industry groups or consortia, or they may be industry-led initiatives under a legal framework. Participating manufacturers commit to common goals and time schedules to improve the energy efficiency of devices. Examples are the voluntary agreements on the energy consumption of set-top boxes, which have been executed/signed in both the European Union and the United States.

The following table gives an overview of the main advantages and disadvantages of Voluntary Agreements.

Table 6: Main advantages and disadvantages of Voluntary Agreements

Voluntary Agreements	
Advantages	Disadvantages
• Collaborative solution with stakeholders • Provides continuous platform for dialogue • If manufacturers are obliged to provide supporting market data, resulting energy savings are quantifiable.	• Time consuming to establish • Does not cover whole market

2.4 Awards Program

Awards programs aim to encourage manufacturers to develop energy efficient devices. The award winners will benefit from the publicity and the associated consumer awareness. This measure is typically used to complement other policies. Examples are the Global Efficiency Medals, which are awarded by the SEAD Initiative (Super-Efficient Equipment and Appliance Deployment) in categories for lighting, motors, televisions and displays.

Table 7: Main advantages and disadvantages of Awards Programs

Awards Programs	
Advantages	Disadvantages
• Diverse stakeholders can contribute • Flexible in requirements and rewards	• Difficult to quantify resulting energy savings • May be only moderate incentive for manufacturers to improve devices • Improvements of selected devices only

2.5 Consumer Awareness Campaigns

Consumer awareness campaigns aim at creating a market pull for more efficient devices. They can be launched as stand-alone campaigns or together with other policy strategies. After becoming aware of an issue, the consumer needs to be enabled to act accordingly. Therefore this measure is typically complemented with others, e.g., a Labelling or Product Information Database. In addition to being organized by government authorities, such campaigns can be organized by other stakeholders such as utilities, or energy or service providers. An example of this measure is the consumer awareness campaign on modems, routers and set-top boxes of the Swiss Federal Office of Energy (SFOE). The pros and cons of Awareness Campaigns are listed below.

Table 8: Main advantages and disadvantages of Consumer Awareness Campaigns

Consumer Awareness Campaigns	
Advantages	Disadvantages
• Can be implemented rather quickly • Relatively/often low cost • Created market pull for energy saving products	• Usually needs to be complemented by other measures • Difficult to measure effect • Possibly moderate effect, if energy aware choice impacts service or features • May need sustained efforts to maintain consumer interest and effect

2.6 Product Information Database

Similar to Labels, Product Information Databases can enable consumers to make informed purchase decisions. Databases typically provide a comparison of the most energy efficient models in various product categories. An example is the TopTen online database (www.topten.info), which is now available for 16 countries.

Product Databases have the following advantages and disadvantages:

Table 9: Main advantages and disadvantages of Product Databases

Product Database	
Advantages	Disadvantages
• Creates market pull for energy efficient products • Tailored to specific device category • Encourages manufacturers to go beyond existing benchmark levels	• Complex and time consuming to maintain • Difficult to quantify energy savings

3 Policy Options for the Energy Efficiency of the IoT

3.1 General Considerations

In developing policy proposals, the special characteristics of IoT markets and technologies have to be taken into account:

1) The IoT market volume is forecast to grow rapidly.
2) The existing technologies are not yet mature and stable, but are evolving constantly at a high pace.
3) IoT is not a homogeneous applications area, but is comprised of many and very diverse product categories.

Due to these characteristics, the preferred policies will be able to be implemented quickly and will be independent of specific technological solutions. Otherwise a large-scale uptake of poor efficiency devices is likely, because they are typically of lower cost. Further, there is the risk of wasted policy-making efforts, if new technologies quickly replace those under consideration.

Therefore the proposed policies should be

- generic
- adaptable to technological changes
- focussed on high-impact areas (i.e. high-volume product categories), and
- based on existing policy frameworks, wherever possible

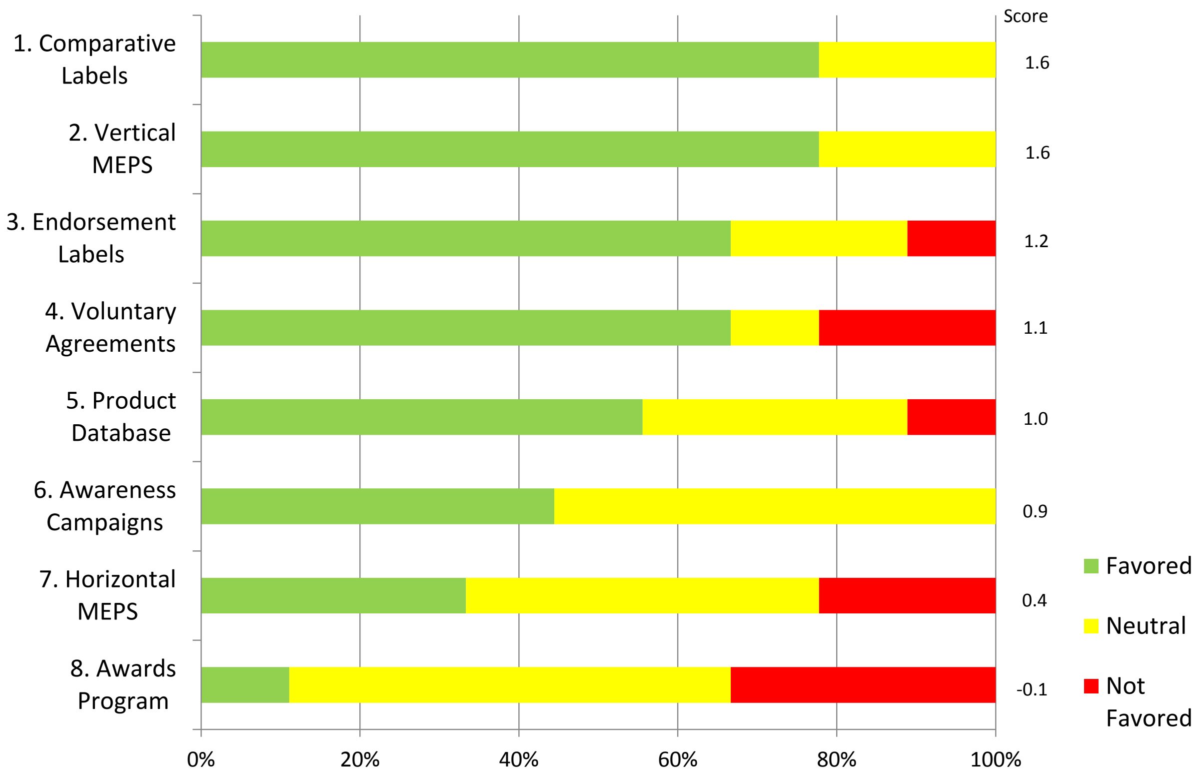
Extensive consideration was given to these desired and preferred characteristics in developing the policy proposals.

3.2 Policy Preferences

In preparation of the policy proposal analysis, a survey of policy preferences was completed with IEA 4E EDNA member countries. Nine member countries responded when asked whether a policy option was favoured . The results for generic policy options are depicted in Figure 3. The green bars show those in favour of a policy, the red ones show those against a policy, and yellow shows neutral votes. The ranking of the policies has been calculated based on a scoring scheme, which gives each “favoured” vote +1 point, each “not favoured” vote -1 point, and a “neutral” vote 0 points.

This scoring scheme leads to two favoured policies, which are Comparative Labels and Vertical MEPS. Endorsement Labels, Voluntary Agreements, Product Databases and Awareness Campaigns are in the midfield, whereas Horizontal MEPS and Awards Programs are the least preferred options. These results are, however, only a snapshot of the general policy preferences. As discussed in the previous chapter, all policy options have advantages and drawbacks, and need to be assessed in conjunction with the characteristics of the investigated applications.

Figure 3: Policy preferences of IEA 4E EDNA member countries



In the following sections, policy proposals for the investigated IoT application areas are presented in the order of the policy preference ranking.

3.3 Comparative Labels

As mentioned previously, Comparative Labels may be problematic for network standby, since this may be only a small portion of the overall energy consumption. Thus specific labels for network standby could give the wrong message about total energy consumption. Therefore Comparative Labels for network standby should be used only for high-volume device categories, for which the overall energy consumption is largely due to network standby. Additionally, significant savings in energy and/or cost must be achievable for the consumer to make product labelling meaningful. Further, there must be a spread in energy consumption over the products available on the market. Where these criteria are not fulfilled Endorsement Labels could be used as an alternative policy.

Based on these considerations, possible policies for the prioritised IoT categories are:

- *Network standby energy rating label for home security cameras, smart home gateways and network-connected audio devices*
  All three product categories are of high volume and most of the time these devices are in network standby mode. Whether the variation in network standby power of the available products is large enough must be analysed in more detail.

- *Include network standby energy information on the existing Comparative Label for smart LED lamps*
  As an extension of the existing labelling schemes for lamps (e.g. EU regulation for energy labelling of electrical lamps and luminaires), which addresses the lumen efficiency and the total energy consumption, information regarding the network standby could be included.

3.4 Vertical MEPS

Considering the need for a quick implementation of policies to keep up with technology developments, Vertical MEPS should focus on well-defined, high-impact product categories.

The following Vertical MEPS policies are proposed for the prioritised IoT categories:

- *Vertical MEPS for network standby of home security cameras, smart home gateways, smart LED lamps and network-connected audio products.*
  These categories are forecast to have a high growth. Further, a spread of network standby power values has been observed within these product categories, which may be partly due to a poor implementation of available energy efficient technologies [1]. MEPS could help push the worst performers out of the market. If possible, the proposed policies could be implemented by amending existing regulations (e.g. by including home security cameras in the EU Ecodesign regulation for household equipment).
- *Tightening of Vertical MEPS for external power supplies*
  Measurements have shown [1] that the efficiency of external power supplies at low loads (i.e. device network standby mode typically uses less than 1 W) is often very low (< 40%). This implies that the network standby power of mains-connected IoT devices may be dominated by the poor efficiency of power supplies. Despite being low, the measured efficiencies are typically in compliance with existing regulations, that define a minimum efficiency based on the average of the efficiencies at 25%, 50%, 75% and 100% of the rated output power. Therefore, an opportunity to reduce network standby power of mains-connected IoT devices would be to tighten the efficiency regulations for external power supplies at low loads by adding, for example, a 10% load point. This could be achieved by amending existing regulations, e.g. the EU Ecodesign requirements, for external power supplies.

3.5 Endorsement and Warning Labels

Endorsement and Warning Labels may also be problematic for network standby. Endorsement Labels for network standby are preferred for high-volume device categories, for which the overall energy consumption is largely due to network standby.

Endorsement and Warning Labels for the prioritised IoT categories could include:

- *Network standby Endorsement Label for home security cameras, smart home gateways, smart LED lamps and network-connected audio products*
  These product categories are of high volume and most of the time these devices are in network standby.
- *Network standby Warning Label for home security cameras, smart home gateways, smart LED lamps and network-connected audio products*

3.6 Voluntary Agreements

Since Voluntary Agreements are based on a collaborative approach with industry stakeholders, their development tends to take considerable time. Therefore Voluntary Agreements should focus on high-impact product categories or even entire application areas.

Voluntary Agreements options include:

- *Voluntary Agreements for Smart Home network standby*
  An agreement could cover voluntary targets for the network standby of edge devices based on best available technologies and best practices regarding use of power-saving features of available standards. Industry associations in the areas of Smart Lighting, Home Automation and Smart Appliances could be involved.
- *Voluntary Agreements on the support of low-power communication standards in wireless routers and access points*
  Such agreements could encourage manufacturers of routers and access points to support low-power communication standards for Smart Home applications such as Wi-Fi Halo (Low-Power Wi-Fi), Bluetooth Smart, Z-Wave, or ZigBee protocols. This would eliminate the need for additional gateways for many Smart Home applications and promote inherently low-power standards for Smart Home communication. Depending on the country, this policy could possibly be implemented through the amendment of existing agreements (e.g. the EU Code of Conduct on Energy Consumption of Broadband Equipment).
- *Voluntary Agreements on the network standby of home security cameras*
  Measurements for home security cameras have shown a comparatively high network standby power. These devices typically record video continuously, even when in network standby mode, i.e. when no motion is detected. The most recent minutes are always stored in a local buffer. If motion is detected, the camera starts a live stream and also provides the buffered minutes before the trigger. This mode of operation may explain the high network standby power. A possible way to reduce the consumption could thus be to minimize the number of frames per second for the buffered video in the out-of-box configuration. Such and possible other measures could be covered by a Voluntary Agreement with camera manufacturers and security monitoring and service providers.

3.7 Product Information Database

The prioritised IoT application areas comprise many and very heterogeneous product categories, and novel applications and products are emerging frequently. Product Databases should focus on a few well-defined and high-volume product categories to ensure reasonable efforts for the development and maintenance.

Based on these considerations, the following Product Information Databases are proposed for the prioritised IoT categories:

- *Product Information Databases for home security Cameras and smart LED bulbs*

If a Product Database already exists (such as for LED Lighting in several countries) the network standby information could be added as additional information. Otherwise a new product database could be established, which includes the network standby energy.

3.8 Awareness Campaigns

Although it is expected that IoT devices will proliferate considerably in the next 10 years, they are currently not established and known well enough to justify a specific Awareness Campaign. This may change however in a few years.

Therefore the following approach is proposed regarding Awareness Campaigns in the current situation:

- *Include IoT examples in general network standby awareness campaigns*
  Examples such as Smart Lighting, which is already quite popular with consumers, could be included in awareness campaigns in addition to the well-known examples (e.g.TV sets). This measure needs to be complemented by other policies however, such as Product Labelling or Product Information Databases, to enable the consumer to choose energy efficient products.

3.9 Horizontal MEPS

As discussed in section 2.1, Horizontal MEPS don't consider specific device characteristics. Therefore the defined performance limits are typically a compromise between best possible values and broad product coverage. Given the rapid evolution of the IoT market and the many and diverse product categories, it may be a good trade-off to use Clustered MEPS.

A possible approach for the prioritised IoT application areas is:

- *Clustered MEPS for network standby power of Smart Home edge devices*
  The investigated Smart Home edge devices (with exception of home security cameras) are not very demanding regarding communication requirements (range, bandwidth, latency). These requirements can be easily covered with several available low-power communication technologies of similar network standby power [1]. Therefore this application area could be covered with Clustered MEPS to ensure that the best available technologies are used and correctly implemented.

3.10 Awards Program

Awards Programs should focus on well-defined, high-impact product categories

Possible options for Award Programs include:

- *SEAD Medal for Smart Lamps*
  Network standby could be included in the award criteria, in addition luminous efficacy, light quality and lifetime.
- *Special award for energy efficiency at the IoT / M2M Innovation World Cup (http://www.innovationworldcup.com/iot-m2m/)*
  The existing awards categories (e.g. Smart Home, Smart City, Security or Healthcare) could be complemented by a special network standby energy efficiency award.

3.11 Summary

Table 10 provides an overview of the policy options. Based on the general considerations discussed in section 3.1, policies covering a broad range of product categories would be desirable to keep pace with rapid technological developments. Three measures fulfilling this requirement were identified:

- Clustered MEPS for network standby power of Smart Home edge devices
- Voluntary Agreement on Smart Home network standby
- Include IoT examples in general network standby awareness campaigns

Table 10: Overview of policy proposals for investigated IoT applications

	Vertical MEPS (for single product category)	Horizontal MEPS	Clustered MEPS	Comparative Label	Endorsement/Warning Label	Voluntary Agreement	Awards Program	Awareness Campaign	Product Database
Home Security Cameras	x			x	x	x			x
Smart Home Gateways	x			x	x				
Smart LED Lamps	x			x	x		x	x	x
Network-Connected Audio	x			x	x				
Smart Home Systems			x			x			
External AC/DC Power Supplies	x								
Wireless Routers / Access Points						x			
All IoT devices							x		

If the scope is narrowed, four prioritised IoT application areas lend themselves to more specific policies: Smart LED lamps, home security cameras, smart home gateways, and network-connected audio products. All these devices are expected to have high growth and represent each a rather homogeneous product category. Therefore several policy options can be considered:

- Comparative Labelling for network standby energy of home security cameras, smart home gateways, and network-connected audio devices
- Include network standby energy information on Comparative Labels for smart LED lamps
- Vertical MEPS for network standby power of home security cameras, smart home gateways, smart LED bulbs, and network-connected audio devices
- Endorsement and Warning labels for network standby of home security cameras, smart home gateways, smart LED lamps, and network-connected audio products
- Voluntary Agreement on network standby of home security cameras
- Product Information Databases for home security cameras and smart LED bulbs

Two additional areas were identified that may have a significant impact on the network standby energy consumption of the prioritised IoT applications: External power supplies and wireless routers and access points. The associated proposed policy options are:

- Tightening the Vertical MEPS for the efficiency of external power supplies at low loads

- Voluntary Agreements on the support of low-power standards in wireless routers and access points

For more specific policy recommendations, a further analysis of policy making and existing regulations of the IEA 4E EDNA member countries is needed.

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