Making Smart Products and Systems Efficient

Vida Rozite, International Energy Agency
Hans-Paul Siderius, Netherlands Enterprise Agency

ABSTRACT

Trends indicate increasing uptake of network-connected products and systems. If energy efficiency is not a consideration in the design stage of networks and products there is a risk that electricity demand will grow at a rapid rate. Based on research by the IEA, we provide an overview of current policy measures worldwide to create the drivers for the development and implementation of low power enabling technologies and efficient networks and products. Second, the analysis of this overview shows that approaches and requirements vary by region, and are fragmented. The risk is that less efficient products end up in regions with no or weak policy interventions and that there is not enough market volume for standardized solutions. Another risk is that focusing on improving efficiency in part of the network will shift energy consumption to other, unregulated parts. Therefore we give suggestions for policy measures and policy mechanisms that take into account the impact on and improve the wider system efficiency of networks, including issues to be addressed by standardization. International coordination through e.g. the IEA or SEAD will play an important role to ensure that opportunities for harmonized approaches are utilized.

Network Trends, Energy Implications and Technical Solutions for Efficiency

Introduction

In 2013, a relatively small portion of the global population relied on more than 14 billion network-enabled devices in homes and offices (Cisco 2013). As more people use a wider range of devices for increasingly diverse purposes, the total is expected to skyrocket to 50 billion network-enabled devices by 2020 (OECD 2012). Left unchecked, corresponding energy demand in a base case would soar to 1140 TWh per year by 2025, a vast majority of it consumed when devices are “ready and waiting” but not performing their main function (Bio Intelligence Service 2013). A situation that is reminiscent of the regular standby problem that emerged in the late 1980s – but also in some ways a cardinally different challenge. The new challenge of “network standby” is not only to limit the electricity used by devices that are not being used but are waiting for signals to power on but to actually get these devices to power down in the first place without detrimental impacts on their ability to deliver useful network-enabled services.

This paper starts out by outlining key drivers and trends that that are contributing to a spread of information communication functions in a broad range of devices and that are expected to result in a growing market demand for network-enabled devices. This serves as a backdrop for understanding the energy implications and the projected growth of the electricity demand associated with massive deployment of network-enabled devices. After a presentation of the energy savings potential, the paper briefly indicates technical solutions to promote energy efficiency. The paper then presents the policies on network standby that have been implemented in various countries and moves on to discuss gaps in current policies, scope for strengthening supporting technical foundations and implications of the lack of international coordination. This is followed by suggestions on how international collaboration could be strengthened. While network standby may be the new frontier of energy efficiency policies, it is by no means the end of the story. As our societies become increasingly digitalized the rate at which new areas or devices requiring energy efficiency attention is expected to escalate. To start laying the ground for strategies to future proof policy making in this area we explore the need for moving towards more systemic approaches and highlight strategies and actions that could contribute to such an effort.

Everyone and Everything is Becoming Connected

Online technologies such as broadband connectivity, wireless mobility, cloud computing, e-commerce, social media and sensors are quickly transforming the world. Trends indicate increasing uptake of network connected products and systems (IEA/4E 2014 forthcoming). If energy efficiency is not a consideration in the design stage there is a risk that electricity demand will grow at a rapid rate.

From 1990 to 2010, the number of Internet users increased from 3 million to 2 billion (WEC and INSEAD 2011); by mid-2012, the number had already increased to 2.73 billion (ITU 2013). Regional growth rates between 2000 and 2012 have been astonishing, exceeding 3 600% in Africa and 2 600% in the Middle East (Internet World stats 2012). Yet most regions still show substantial growth potential and worldwide access is still less than 40%. Globally, there were already two network-enable devices per capita in 2012; projections indicate that the ratio will rise to nearly 3:1 by 2017 (Cisco 2013). In a longer term perspective, network-enabled devices are forecasted to increase five-fold by 2020 (World Economic Forum and INSEAD 2012) and industry experts project an uptake of 50 billion network-enabled devices by 2020, reaching towards 500 billion over the coming decades (OECD 2012).

Energy Implications

ICT-based solutions can contribute to energy efficiency, for example, via smart metering and energy monitoring systems, home automation, dematerialization of products, intelligent logistics systems, and automated industrial control. However, the increased demand for network-enabled devices and increased network connectivity is not mainly driven by energy efficiency opportunities, but rather by desires for new features, increased comfort, enhanced control, security and entertainment. While ICT-enabled solutions can potentially contribute to all aspects our daily lives, there is an energy cost. Much of this cost is largely hidden since it is a very distributed demand spread over billions of devices.

In 2013, the global electricity demand of ICT exceeded 1560 TWh corresponding to approximately 8% of total current final global electricity use (IEA/4E 2014 forthcoming)[1]. This is a conservative assessment, recent market developments, infrastructure developments, and expansion of services, growing online population and growth in traffic volumes indicate that the current ICT energy demand could be in the region 1/3 higher. All trends indicate that this demand will continue to grow at a rapid rate.

In terms of sub-sets of ICT energy demand, network and data centre electricity demand surpassed 640 TWh in 2013 (IEA/4E 2014 forthcoming). Of greater cause for concern is the

[1] IEA estimates including electricity demand of network enabled end-use devices, user premise network equipment, networks, data centers and other ICT.

growing energy demand of billions of network-enabled devices, edge devices and customer premises network equipment (CPE), scattered in offices and homes around the world. While the individual energy consumption of each device may not seem high, cumulatively these devices currently constitute more than 40% of ICT energy demand (IEA/4E 2014 forthcoming). Global electricity consumption of network-enabled devices reached 615 TWh in 2013, overtaking the current electricity consumption of Germany (Bio Intelligence Service 2013). On the end-use level, uptake of these devices in households and businesses will drive up electricity bills. On the global scale, it will lead to increased electricity demand and the corresponding need for more energy infrastructure.

To ensure quality of service, many network-enabled devices are on 24 hours, 7 days a week, leading to a situation where up to 2/3 of electricity (in some cases even in the region of 80%) is consumed when products are not delivering their primary function but merely waiting for instructions or responding to routine data messages (IEA/4E 2014 forthcoming). Currently, the estimate for global electricity wasted in this way by network-enabled devices is 400 TWh (Bio Intelligence Service 2013). This savings potential corresponds to the annual electricity delivered to consumers by 133 Rosenfelds[2]. The capacity required to power network-enabled devices in the 2025 base case would correspond to approximately 380 Rosenfelds, i.e. 739 TWh/yr, more than the current total final electricity consumption of Canada, Denmark, Finland, and Norway combined (see figure 1). Considering recent projections indicating an even faster rate of market development for network-enabled devices than anticipated, the related energy demand could grow at an even faster speed than forecasted in the base case.

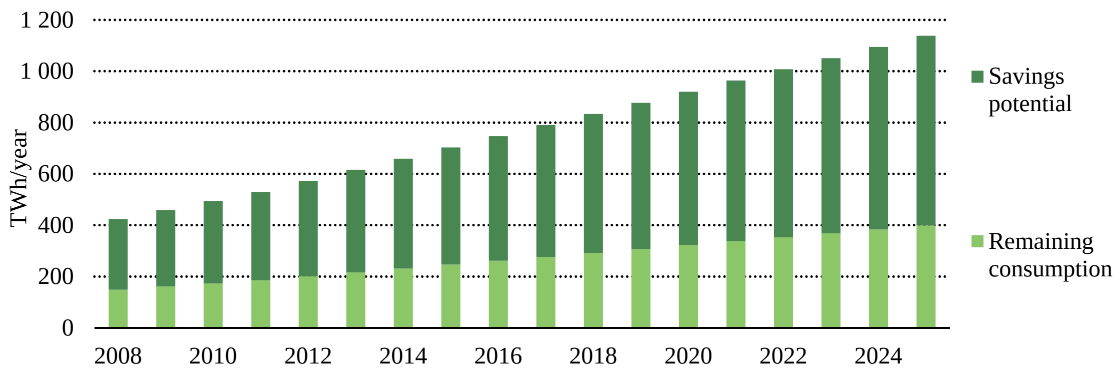

Figure 1. Current and projected global network-enabled device electricity consumption and savings potential. *Source*: Bio Intelligence Service (2013).[3]

Technical Solutions for Energy Efficient Networks

Communication networks (such as the Internet) and network-enabled devices have, for the most part, been developed with little regard to energy efficiency. The key considerations

[2] A Rosenfeld is a unit used to depict standard avoided power plant that have physical meaning and intuitive plausibility – it is based on a 500 MW existing coal plant operating at a 70% capacity factor with 7% transmission and distribution losses. Displacing such a plant for one year would save 3 TWh/year at the meter and reduce emissions by 3 million metric tons of CO_2 per year.

[3] Domestically and professionally used network-enabled devices, connected to external or internal networks. Savings potential is estimated on the difference between the best available technology and the average device on the market. Projections start with 2012.

were to ensure reliability and capacity among a relatively small number of devices that were dedicated to transmitting and processing data. Although the number of devices has increased dramatically, the key considerations have not. However, technical solutions for energy efficient networks are available, see e.g. Energy Efficient Strategies (2010) and May-Ostendorp et al. (2013). We summarize the main solutions in this section.

The basic idea of improving energy efficiency of networks and network-enabled devices is to enable devices to power down or reduce energy requirements without losing their ability to provide the services that network connectivity enables; the main principles include:

- Reducing power consumption of components, including power required for network links.
- Implementing energy management by designing devices to automatically reduce the time they spend in high power modes and increase the time they spend in low power modes.
- Implementing power scaling by turning off unneeded functions and adjusting processing power to the actual tasks that need to be performed.

Power consumption of components differ and even if the differences per network connection may be not large, the large number of connections make the total significant. Energy management includes software and hardware modifications that either enable devices to power down while still maintaining a network connection (changing product state without the cooperation of the network) or to power down with the cooperation of the network. Proxying is an example of the first option where the network is lead to believe that the device is active where it is really asleep. This option is attractive because it does not require changes in communication protocols. The second option offers further possibilities for using network communication to optimize energy efficiency but requires development of protocols and functions only if the link and both ends of it are compliant. Other hardware and software solutions enable devices to scale power consumption to actual work carried out, thereby enabling then to utilize less energy when less data needs to be processed and transmitted. Examples include Energy Efficient Ethernet, light sleep, optimizing task scheduling, multi-core processors and power islands.

Mobile products are front-runners regarding energy efficiency of network-enabled devices: some provide network connectivity for as little as 0.5 mW. The main driver is limited battery capacity; such a strong market driver is not available for network-enabled products and networks in general. Therefore, policies are needed to create the drivers for the development and implementation of low power enabling technologies and solutions.

Policies for Energy Efficient Networks and Products

In the absence of strong market drivers, concerted global policy action is needed to curb escalating electricity demand from network standby. Governments need to act promptly to address network standby and avoid unnecessary energy waste. Governments worldwide are starting to address network standby consumption through multiple policy instruments, however, many factors hinder the development of network standby policy: methodologies for data collection and technology testing are still under development, available data sets are limited, national and international end-user surveys are insufficiently comprehensive to inform policy making.

Overview of Current Policies

For the most part, network standby is currently addressed through amendments to existing policy: EU amendments to the Ecodesign standby regulation, the inclusion of network-enabled devices in labelling and minimum energy performance requirements in Korea and the addition of network standby consideration to the ENERGY STAR program the United States. The ease and speed with which amendments can be introduced prevents some energy waste in the short term while longer-term solutions are developed, and may spur further energy efficiency measures throughout the value chain. Further advantages include that amendments do not require significant changes in the regulatory framework and that they build on existing processes which saves resources and provides industry with familiar procedures. There are some disadvantages though. By taking the amendment route, it may not be possible to take into account all issues of relevance to network standby. Also trying to fit complex, rapidly evolving technologies into an existing framework developed for stand-alone devices may produce sub-optimal outcomes. But amending existing policies to encompass network-enabled devices is a first and immediate step to reduce some network standby issues and stimulate developments in others. The following provides an overview of current policies.

EU policy. 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 specific device categories, e.g. complex set-top boxes, imaging equipment and broadband equipment. The European Code of Conduct for Broadband equipment engages major producers and European service providers to drive the industry to reduce power consumption of network devices. Furthermore, the European Commission is the first jurisdiction in the world to develop a policy specifically targeting network standby. In 2009, it commissioned an Ecodesign Directive preparatory study in consultation with industry organizations and other stakeholders (Nissen 2011). The study concluded in 2011 and recommended a horizontal approach to network standby policy by amending Regulation 1275/2008/EC on standby. Three categories of devices with different "network availability" (how quickly devices need to respond to network signals) are distinguished:

- Devices with high network availability (HiNA): router, switch, hub, modem, wireless access point, voice over Internet protocol (VoIP) phone or video phone.
- Devices with HiNA functionality: router, switch or wireless access point as side function.
- Devices with low network availability (LoNA) or "other network-enabled devices": all other network-enabled devices.

Since the amendment (European Commission 2013) does not change the scope of Regulation 1275/2008/EC, it applies to all devices listed in Annex I of that regulation including household appliances, consumer electronics and ICT equipment for use in households and offices. The amendment stipulates two additional EU performance requirements:

- All devices are required to power down within 20 minutes of stopping their primary function. This must be the default when devices are placed in the market.
- All devices must be able to deactivate wireless network ports. When all network ports are deactivated i.e. the device is no longer network-enabled, then standby power consumption (if it exists) must be less than 0.5 W.

As it typical of EU regulations, the policy is phased in over several years with multiple tiers to reflect that implementation for some devices will be more complex and require additional time. In each case, the regulation becomes increasingly stringent.

Korean policy. Korea's e-Standby Program used a device-by-device approach to set network standby limits for 11 target electronic edge devices, based on a combination of power limits:

- Total energy consumption, including sleep mode, transition time and off mode for computers, printers, fax machines, copiers, multi-function devices; and
- Specified transition times and power limits for modes (or a set of modes).

An additional 11 devices have power limits for passive standby mode and idle mode. Korea has strategically linked these standby power limits to a corresponding labelling system. Devices that do not meet the standby power limits cannot be rated above level 2 on the scale of 1 to 5, with 1 being the most efficient (Jung 2013).

US. The US DOE recently drafted provisions to include set-top boxes and network equipment as devices covered in its Energy Efficiency Program for Consumer Devices (US DoE 2012), spurring industry to launch a voluntary agreement in 2013. The US Set-Top Box Energy Conservation Agreement is a voluntary agreement between US government, oversight bodies, service 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.[4]

ENERGY STAR. ENERGY STAR focuses on total energy consumption and takes network standby into account in terms of promoting network connection with the lowest power possible. Consideration is paid to offsetting active modes with standby modes and incentivizing lower power budgets for the device as a whole. Network connectivity specifications are typically based on total energy consumption: i.e. annual consumption, incorporating consumption in on mode (or idle in the case of personal computers), standby mode (for select devices) and off mode. Currently, devices for which ENERGY STAR sets out specifications to address network connectivity include audio/visual equipment, game consoles, televisions, set-top boxes, servers, computers, imaging equipment, digital television and displays. ENERGY STAR has been in dialogue with appliance manufacturers since January 2011 and is developing specifications for demand-response enabled devices (Radulovic, 2013). The US EPA has rewarded those ENERGY STAR-rated computer devices that maintain network connectivity in low power states, including allowances for Wake-on-LAN for Ethernet connectivity and incentive for proxying (according to the technical standard ECMA 393). This reward system has potential for energy savings by encouraging devices to enter sleep mode for longer periods.

[4] The full text of the agreement is available on NCTA's website www.ncta.com/sites/prod/files/VOLUNTARY-AGREEMENT-ENERGY-EFFICIENCY-OF-SET-TOP-BOXES.pdf

Switzerland. In May 2013, as part of the "Swiss Energy" initiative, the Swiss Federal Office of Energy (SFOE) launched a large consumer awareness campaign on optimising the energy performance of modems, routers and set-top boxes. The three largest service providers – Swisscom, UPC Cablecom and Sunrise – will target advice to consumers on how to reduce energy waste and use energy-saving features. Considering that there are 3 million modems and 2 million set-top boxes in Switzerland, the SFOE estimates that such optimization would cut the current consumption of 500 GWh to 320 GWh, a savings equivalent to the total electricity of 40,000 households. Pending positive results, the campaign will be developed and continued (Brüniger 2013).

Analysis: Gaps in Current Policies

Policy development is underway but approaches and types of requirements vary (see Table 2).

Table 2. Overview of approaches and types of requirements

EU	• directly regulates networked standby to get the least efficient devices off the market; also requires power management • addresses to improve overall efficiency of network-enabled devices as part of agreements (e.g. Codes of Conduct) with industry for specific products
Korea	• energy consumption limits, including networked standby, set on a device-by-device basis
US	• voluntary agreement with industry covering one product category (set-top boxes)
ENERGY STAR	• addresses network standby indirectly, as part of an endorsement label recognizing/incentivizing the most efficient devices on the market • has no specific power limits for network standby; network standby in low power modes is factored into total energy consumption • network-enabled consumption typically dealt with by adders i.e. additional allowances; these adders vary considerably among device categories
Switzerland	• consumer awareness raising with focus on some product categories via the engagement of service providers

According to the overview, policies show variation in:

- Voluntary or mandatory nature of the measures.
- The number of products covered by a measure: one by one or many (horizontal).
- Direct, specific limits for networked standby versus addressing networked standby indirectly as part of total energy consumption.
- Focus on manufacturers or consumers.

Although using different types of measures is a good thing – single silver bullets mostly do not exist – the current policy approach seems too scattered and thinly spread. Furthermore, for those jurisdictions that have mandatory power limits – the European Union and Korea – these power limits differ. Overall, the Korean requirements are more stringent and the timing is more ambitious. For example, a network-enabled drum washing machine in sold in Korea will need to power down to 2 W or less, while a corresponding washing machine sold on the European market will need to power down to 6 W or less from 2015 and to 2 W or less in 2019. In terms of power management, network-enabled devices sold in Europe will need to power down 20 minutes max after they stop performing their primary function, while scanners sold in Korea will need to power down after 15 minutes and home gateways after 10 minutes. These differences are a consequence of the horizontal approach in the EU which covers more products but can not tune the limits to individual products. There are also considerable differences in test procedures for the approaches used in Europe, US and Korea.

Where policies and implementation varies considerably between countries it is expected that there will be a higher risk that products that do not comply with legislation in one jurisdiction will be sold in countries lacking legislation or with weaker requirements i.e. inefficient products will dominate in markets where there are no or weak policy interventions. Another risk is that there is not enough market volume for standardized solutions that can be implemented at lowest costs.

Making Systems Efficient

Tackling network standby may be the next frontier, it is targeting only a part of the system and larger energy efficiency potentials can only be tapped by extending boundaries to encompass sub-systems or larger systems. As digital technologies become increasingly embedded into all devices and integrated into all aspects of our economies, more systemic approaches that both address energy consumption of specific types of functions and define efficient behavior across the network for hardware, software and communication protocols are warranted.

While significant energy efficiency improvements can be achieved in individual devices, or even in a particular part of the broader system, unlocking potential savings in some of these elements (i.e. the end-use device) requires introducing solutions in others (i.e. networking devices). A piecemeal approach that focuses on different parts of the system, one by one, may not deliver the full savings potential. In fact, it could be counterproductive: fixing one part of the system without considering system implications could result in shifting of electricity consumption to other parts of the system. In other instances – from a wider energy efficiency perspective – it can make sense to use more electricity in some parts of the system to enable larger savings in other parts. For example, a centralized system (i.e. home gateway or security system) that provides power management functions, such as enabling users to power down network-enabled devices, may need to be in active mode continuously or power down only to a limited extent but in return can contribute to decreasing the overall electricity consumption of the system (ECOS 2011). Conversely, if reducing the power levels of network equipment, such as modems or routers, causes a reduction of functionality, this can create bottlenecks that ultimately drive up energy consumption for end-use devices, which are forced to remain active for longer periods to compensate for networking delays.

For more integrated and sustained policy and technology development efforts towards ICT energy efficiency, a process is needed to assess how each part of the system contributes to overall energy consumption, and to introduce appropriate solutions that improve system-wide energy efficiency. A systemic approach to ICT energy efficiency calls for a comprehensive examination of all the elements within the network infrastructure, from the end-use device to the server or data centre, including the following:

- understanding the complexity and interdependency of multiple devices and equipment on a network;
- mapping the relationships between network-enabled devices and any real needs those devices have in terms of availability to receive and transmit information to each other;

- understanding how much electricity each element in the network uses over the full range of traffic loads and profiles.

In an even broader perspective, it makes sense to develop approaches that would enable assessing the net energy efficiency of whole systems i.e. assessing the energy requirements and the energy savings that such systems enable.

The priority for energy efficiency needs to be raised throughout the value chain of network-enabled devices: in software, network design, network architecture, communication protocol development, technical standardization processes, service providers, and device and component manufacturing. In the wider context of ICT and increasing digitalization of global economies, a strong case must be made for co-operation in tracking trends, assessing energy implications and energy savings opportunities, and identifying areas that warrant energy efficiency technology and policy attention. Integrating energy efficiency considerations in the earliest stages of network design will encourage the development of approaches to enable energy management and waste reduction across the whole network (Energy Efficient Strategies 2010).

From an energy efficiency policy making perspective this entails a shift of focus. Whereas energy efficiency policy has typically been directed at the manufacturers of devices, opportunities to create incentives for network designers and Internet (and media) service providers could prove to be a necessary complementary approach.

Conclusions and Suggestions for Future Policy Measures

The global nature of ICTs warrants global policy and technology cooperation across the entire value chain, implying engagement of all stakeholders. Governments and industry should work together to enable coordinated investment to develop test procedures and methodologies, as well as further research into the precise operations and energy requirements of network-enabled devices and networks.

Summary and Recommendations

Network standby is a major issue that is building momentum, with two possible outcomes. 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 realize significant opportunities for energy savings, even as device deployment grows. Considering the rapid rate of deployment of network-enabled devices, network standby should be a priority for energy efficiency policy makers. Actions are recommended in five areas indicated below.

Assess, analyze and align existing policy approaches for globally traded devices. The current proliferation of widely different policy approaches is counterproductive. Countries moving forward in policy development need not start from scratch: rather, they can capitalize on the considerable work done to develop energy efficiency policies and programs for network-enabled devices (most notably, by the European Commission and Korea, and by ENERGY STAR). Assessing which policies exist, analyzing their effectiveness and improving alignment will deliver broad short- and long-term benefits.

Pursue close interaction with industry. In a rapidly evolving environment, it is critical to create close relations 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. Considering the rate at which technology advances, the onus lies more on policy to keep pace: technology will not wait. Again, alignment of effort is vital: an over-proliferation of initiatives that aim to establish international dialogue with industry associations or with industries directly can lead to sub-optimal use of resources for all parties involved. The result is often unclear messaging and outcomes. 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 and 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 have a role to play in ensuring international standards developed are fit for policy making purposes. International standardization organizations (e.g. International Electrotechnical Commission, International Organization for Standardization and International Telecommunications Union) should seek to avoid overlap and duplication of effort by working jointly or collaboratively to the greatest extent appropriate and possible.

Encourage development of communication protocols that support energy efficiency. Governments should launch and/or promote programs and initiatives that incentivize and award device developers to that create communication protocols that enable energy savings (e.g. Energy Efficient Ethernet[5]). This can be done through certification schemes or labelling, for example, that recognize front runners, or by adjusting policy to reflect the top achievements in industry. Such incentives should, however, remain technology-neutral.

Prioritize data collection. At present, the use of disparate scopes and methodologies leads to incomparable data sets that undermine collaborative data collection efforts. While it is evident that different approaches and methodologies will be needed to collect different kinds of data, coherence across device types is vital. Developing a data collection and data management plan is a key first step, followed closely by international collaboration to reach consensus on data collection methodologies. This second step must incorporate dialogue with industry, particularly in relation to how industry can provide relevant energy data for devices and systems while protecting proprietary information. The third step is to initiate data collection projects, ideally in parallel with establishing a system or repository to enable international data sharing and data management. Such a repository must be sufficiently resourced to ensure sustainability.

Network standby is one aspect of the much broader field of networked systems. Over time, further international efforts and collaborations are warranted to ensure that energy efficiency aspects are integrated considerations throughout the development and deployment of related technologies, as they continue to evolve.

[5] Energy Efficient Ethernet is a standard developed by the The Institute of Electrical and Electronics Engineers (IEEE), through the IEEE 802.3az task force. The standard describes a communication protocol that enables for less power consumption during periods of low data activity. It can reduce device electricity demand by 50% or more.

Future Policy Measures for Making Smart Products and Systems Efficient

The urgent need for network standby policies is clear: but these must be part of a broader energy efficiency policy approach that, in a coordinated and integrated manner, targets other elements on the network and network-enabled systems as a whole. Further efforts are needed in exploring constellations of devices and their interaction to identify where the greatest impact could be made by policy interventions, as well as in developing innovative policy approaches that suit a dynamic, rapidly evolving and multifaceted technological environment. Ultimately, to develop and implement effective policy, further effort is needed to understand the precise functions and energy requirements of network-enabled devices and systems, and subsequently to develop comprehensive, complementary programs, international standards and test procedures.

Further work is also needed in establishing strong technical foundations for the effective implementation of policies and technical solutions. The development of these foundations requires increased international engagement between policy makers, standardization organizations and industry. Further international efforts and collaborations, e.g. through the IEA 4E implementing agreement or the Super Efficient Appliance Deployment (SEAD) initiative, are warranted to ensure that energy efficiency aspects are integrated throughout the development and implementation of networked systems and that opportunities for harmonized or aligned approaches are utilized.

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