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EuP Preparatory Studies
Lot 26: Networked Standby Losses

Final Report Task 7
Improvement Potential

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Disclaimer

The findings presented in this document are results of the research conducted by the IZM consortium and are not to be perceived as the opinion of the European Commission.

Contents

7   Task 7: Improvement Potential

The general objective of this task report is the identification of eco-design options for improving energy consumption related to networked standby, as well as their monetary consequences in terms of additional costs and revenues from energy savings. The improvement options are basically drawn from well established and best available technology, as introduced in Tasks 4 and 6. This existing best practice indicates achievable development targets with a mid-term time horizon for transfer to other products and manufacturers.

In this report we will argue that the main improvement potential derives from the implementation of an integrated power management. There are actually no real singular improvement options. It is always the combination of measures that will result in improvement. The improvement options for many individual product groups are in effect not entirely new. Mobiles, computers, and imaging equipment are featuring well implemented power management schemes. Product tests however indicate that the implementation of given power management options is not achieved in the market. For other product groups particularly consumer electronics, streaming clients and some networking equipment advanced power management seems to be still something new.

The implementation of the improvement options will require great efforts in conjunction with standardization and the development of integrated hardware and software solutions that support the energy saving objective. We are also arguing that improvement is a collaborative effort along the value chain starting with the component and software suppliers, followed by the equipment manufacturers, and finally ending with the access network and application service providers. Policy making needs to find a way to address this value chain.

Against that background the quantification of the improvement potential is inherently difficult. There are many assumptions and variables involved. Our approach is nevertheless straightforward: We are going to compare for selected examples business-as-usual scenarios (BAU scenario) against scenarios considering improvement options (ECO scenario). Again, it is not possible within the framework of this horizontal study to evaluate single improvement options for their potential for all product types covered, nor would the recipients of this study benefit from such an exercise. Hence the selection of the examples (representative of other networks and products) and the formulation of the worst case approach (if this improvement is possible for a product group, then others should be able to reach similar levels) is the backbone of the pragmatic approach. The same consideration applies to the financial benefit and burdens assessment (LLCC).

Despite these challenges with the assessment of the improvement potential there is good news as well. As a matter of fact, we have no problem with defining advanced best available technology. There are very strong product segments, which have developed power

management due to necessity. The main driver is the mobile devices industry. Being limited in energy supply, form factor, and thermal specifications, the designers of mobile products developed a vast technical portfolio and became proficient in reducing energy consumption. This is the benchmark. It indicates without doubt the improvement potential of an integrated power management.

7.1　　Options

7.1.1　　Implementation of power management

The basic concept for improving the energy efficiency of products that require network availability (networked standby) is the step-by-step reduction of functionality and respective power consumption while maintaining certain resume-time-to-application levels. Such approach secures convenience in the use of the equipment as well as required quality-of-service. The final objective is to reach a minimum level in energy consumption while maintaining the remote reactivation capability via a network connection for a specific level of network availability (high, medium, or low network availability) depending on the application.

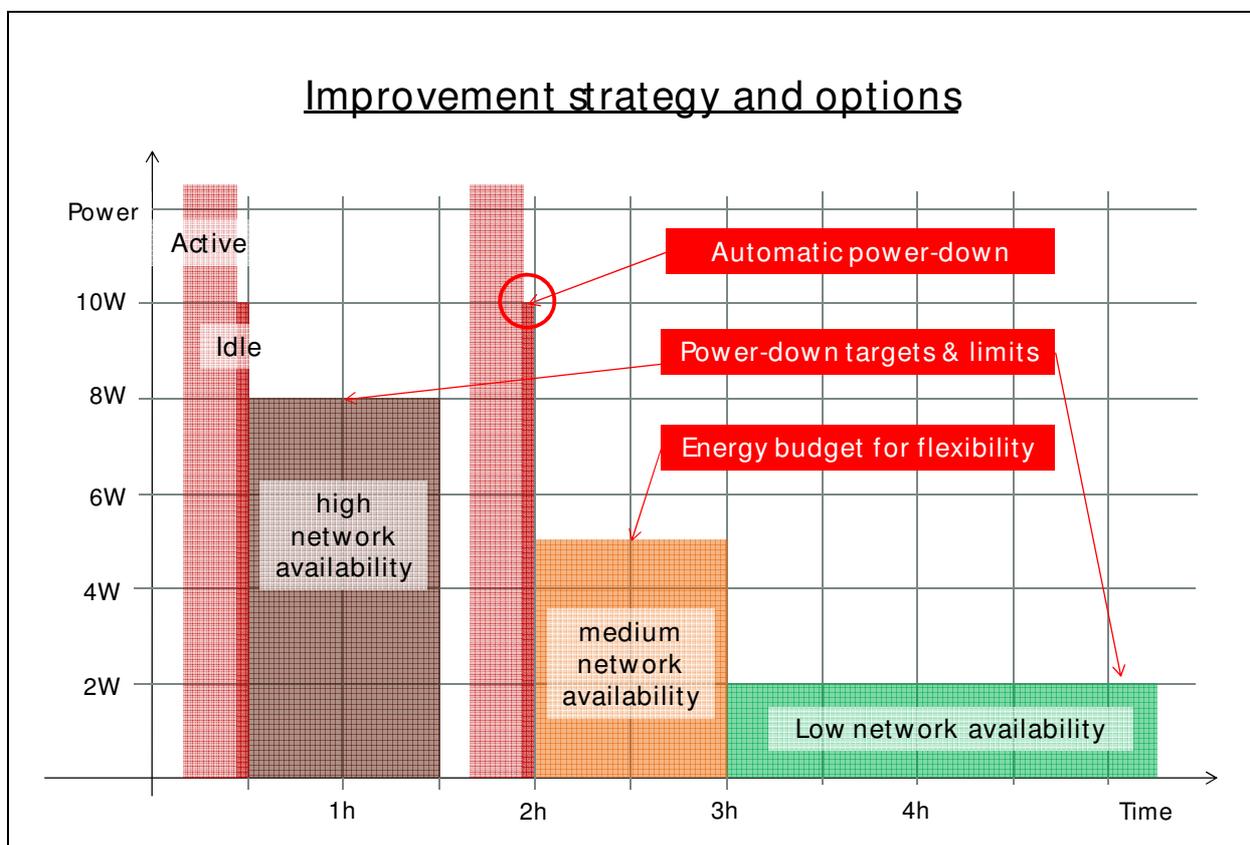Figure 1: Improvement strategy and options (scale not representative)

This improvement strategy reflects directly the second-tier eco-design requirements of the Commission Regulation (EC) No 1275/2008 implementing "Eco-design requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment". In the Annex II, § 2d, power management has been outlined as a basic

concept including automatic power down of equipment when the equipment is not actively used. This generic eco-design requirement takes effect in the year 2012. The ENER Lot 26 study in a way provides specifications for such required power management, but now for a differing functional scope including the network availability.

EC 1275/2008, Annex II, § 2d "Power Management"

When equipment is not providing the main function, or when other energy-using product(s) are not dependent on its functions, equipment shall, unless inappropriate for the intended use, offer a power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into:

— standby mode, or

— off mode, or

— another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode

when the equipment is connected to the mains power source. The power management function shall be activated before delivery.

The improvement options in this report are reflecting existing power management schemes deriving from the mobile, computer, and imaging equipment industry as well as a couple of other best practice examples.

There is a "chicken or the egg" causality dilemma involved at this point.[1] Many options that we discuss are not only useful for products with networked standby capability. These options are generally applicable for improving energy efficiency of products. We have already discussed in Tasks 4 and 6 that there are some product groups with well established (standardized) power management routines and other product groups that are missing this level of standardization and therefore widespread advanced power management capabilities. So requiring advanced power management in the networked product states could also lead to significant savings in the non-networked states, even though they are not in the scope of the study.

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[1] Hans-Paul Siderius commented on this the following way: "This is not a dilemma … It can be better characterized by a "win-win situation": several options are not only beneficial for reducing power consumption in networked standby but also in other modes". (comment received on 2011-01-05)

There is a second dilemma, which also addresses the complexity of power management. This dilemma has to do with "weighing convenience versus energy consumption". The following examples explain some of these aspects in more detail.

Example 1: A very straightforward option for networked standby would be a power management that powers down the equipment without long delay from active/idle into a low network availability mode (aka LowP4 in our technical analysis). The critical aspect of such an option is not how this could be done. The critical aspect is that the user might lose a lot of convenience (fast resume time) due to a missing step in-between idle and the low network availability mode. A cascaded power down using an intermediate step such as medium network availability mode (LowP2) for a limited time before eventually going into the most energy efficient (but less convenient) low power mode seems to be a more acceptable and therefore practical option.

This example shows an option in the style of ACPI power management. Personal computers shift from idle-mode into S3 sleep-mode after certain delay and eventually down into S5 off-mode (or S4 hibernate). The sleep-mode in the case of the PC is a very useful instrument to save energy while maintaining a high level of convenience for the user. This cascaded power management increases not only energy efficiency. It also increases the acceptance of power management measures by the user. This understanding is critical for the successful implementation of an automatic power management.

Example 2: The trend analysis showed that more and more complex consumer electronics (TVs, Media Server) are entering the market. With more complex hardware these products more often require boot times considered inconvenient for the user. They introduce a power management "feature" that provides convenience but not necessarily better energy performance. These options in new products are called "Fast Play" or "Quick Start" options, which have the task of reducing the considerably long booting times of about 20 to 30 seconds to an acceptable resume time of about 10 seconds. In order to achieve that, they keep many functional components in idle. Such features, let's call them convenience modes, could be misunderstood as low power sleep mode, and may even be accessible in the setup menu in the power management section. But the energy consumption is not 2 to 5 Watts as it is the case of S3 sleep mode. The respective power consumption is 10, 20, 30 or even 40 Watts depending on the equipment type and configuration.[2] The problem with this example is

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[2] Comment by German Federal Environmental Agency: "Since this interpretation may be questioned, the consultants should indicate their argumentation. Assuming that the quick-start mode of Complex TVs and Media Server are considered Standby as defined in (EC) 1275/2008, do the data given in chapter 6.3.6 indicate that the devices are not compliant: A complex TV – reflecting the market - consumes 20 W for Fast-Reactivation-Mode? This could lead to a considerable violation, at least when

also that although most of these new CE products feature the capability for remote wake-up via network connection, not all products are capable of it and would not qualify for network standby.

So while fast play or quick start may coincide with network availability (in which case new requirements could apply), such user enabled convenience features do not depend on an active network. If no network is active and no network service is offered, then a product in fast play configuration could be argued to fall under the existing standby regulation, since "faster reactivation" is not a function recognized as an exemption from 1275/2008 standby. Regardless of that, the power management requirement of 1275/2008 could apply from 2012.

Conclusion: The well established power management scheme of the personal computer industry (ACPI) with the best practice of mobile equipment in particular is the benchmark for all other product groups. Product groups which do not have such means available are strongly recommended to start or re-establish respective standardization activities.

7.1.2   Power-down routine, target modes, and energy budgets

With the introduction of the "Network Availability" concept we have recognized certain product specific requirements in terms of user-demanded functionality (usability) and respective resume time to application. The following network availability conditions have been defined:

- HiNA - High network availability (resume time to application: milliseconds)

- MeNA - Medium network availability (resume time to application: <10 seconds)

- LoNA - Low network availability (resume time to application: >10 seconds)

This concept includes the understanding that different resume times to application require different levels of energy for maintaining necessary components in an (re)active state. The faster the reactivation has to be, the more functional components are active, and the higher the resulting energy level of the equipment will be. The technical analysis also indicated that the functionality and the complexity of a specific product need to be considered, because of the power demand of certain functional components. A home gateway with an integrated WLAN module (activated) requires somewhat more energy than a comparable product without this wireless interface.

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the second stage of (EC) 1275/2008 enters into force! If "quick start" is neither considered falling under (EC 1275/2008) nor networked standby the risk of a loop hole exists. "

The improvement options outlined in this report are reflecting this network availability concept and the related understanding of product-specific energy demand. The basic improvement approach however works horizontally for all products. It is the implementation of a smart power management.

In the following paragraph we are going to explain the instruments and terminology we use in conjunction with the improvement options. There are two main terms:

- Power-down routine: Basic power management structure (e.g. delay times, modes)

- Power-down targets: Final network availability level to be reached (e.g. LowP1 or LowP4 incl. suggested average power consumption or energy budgets)

The power-down routine is initiated manually or automatically (default delay time setting) and starts from an "idle" condition. In idle condition the equipment is activated with all essential logic, memory, and power supply ready to process signals or data. This includes the network components and interfaces as well. The equipment maintains network integrity communication but there is no signal transmission or active traffic in the idle state.[3] The average power consumption of home and office equipment in "active" varies largely from about 15 Watts for a home gateway (modem/router) to about 150 Watts for a PC and up to 1500 Watts for a larger laser-copier/printer. In "idle" the power consumption is still considerable raging from about 5-10 Watts for the home gateway, about 50 Watts for the PC and over 100 Watts for the laser-copier/printer.

The reduction of this significant energy consumption is the main objective of the power management. Energy is saved by cutting the "idle" duration. Consecutively functionality is reduced to a minimum. Assuming an automatic power management, the power-down routine is initiated by means of a default delay time set-up. The selection of the default delay time needs to consider the energy consumption necessary for the reactivation of the equipment. An overly short default delay time might compensate the energy saving from the low power mode in case of an instant reactivation. However, a few minutes delay is usually sufficient and achieves energy savings, even if frequent reactivation occurs.

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[3] Comment by Bruce Nordman: There is the mention in Task 7 (7/10) and elsewhere that when a device is idle "there is not signal transmission or active traffic". Networked devices have a considerable amount of routine network traffic for various applications, and so some of this will occur when a system is merely idle. Some of this is generated by the device itself, and some of it is traffic from elsewhere that must be monitored and sometimes responded to. This is a feature of modern networks and not something likely to change.

With the initiation of the power-down routine the equipment is designed to makes a transition into a specified low power mode. This low power mode (LowP) is a networked standby mode reflecting a specific level of network availability (see Task 5). The power-down routine might end there, if this mode is the defined power-down target. If not, the power-down routine continues until the power-down target is reached.[4]

The Power-down target is a necessary power management instrument, indicating the final networked standby mode of the power-down sequence. The power-down target is therefore a mode with specified average power consumption (Watt hours per hour). The mode provides a defined level of minimum network availability without specifying the functionality. This means that low level duty cycles are possible, if the average power consumption (Wh/h) is maintained over time.

Power-down targets in conjunction with networked standby are:

- High network availability mode (LowP1)

- Low network availability mode (LowP4)

With respect to improvement options we consider only these two power-down targets.

High network availability mode (LowP1) is the power-down target basically for stand-alone (non-rack) networking equipment. This includes typical customer premises equipment (CPE) such as home gateways featuring wide area network (WAN) access modems (e.g. different types of DSL modem, DOCSIS modem, FTTH modem, cellular-wireless UMTS or LTE modem) and local area network interfaces (e.g. different types of LAN, WLAN, USB, HDMI, etc.). LowP1 is also applicable to non-rack networking equipment without modem such as LAN-switch or WLAN-repeater. Another product segment could be non-rack servers. The network service of this type of equipment could be time-critical. In this case however the

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[4] Comment by German Federal Environmental Agency: "This concept needs further explanation. It will be crucial to define an appropriate time for individual appliances to be in individual modes. How and using which parameters will this duration be determined? Could the consultants suggest a procedure?

Regulation (EC) 1275/2008 requires appliances (placed on the market after 7th January 2013) to power down „after the shortest possible period of time appropriate for the intended use of the equipment". It is obvious that the word "appropriate" allows for interpretation.

The concept of "energy budgets" suggested by the ENER26 consultants might contribute to a meaningful implementation of (EC) 1275/2008. Thus, we would appreciate if the consultants would suggest policy options in the light of the current standby-regulation.

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product should not get necessarily a permanent power consumption limit. Embedded in a power-down routine LowP1 could be designed as an energy budget similar to LowP2. With respect to power consumption level of LowP1 the best available technology would suggest a range of 5 to 8 Watts. The results of Tasks 4 and 6 clearly show that high network availability on the LAN-side can be design with about 2Watts. The critical point is the average idle power consumption and power-down capability (in conjunction with the WAN link) of the modem. DSL modems require about 2 Watt, DOCSIS modems considerably more with 4 Watt.

Low network availability mode (LowP4) is the basic power-down target for all other home and office equipment including stand-alone data and media server. This consequent targeting of lowest power networked standby takes of course a long resume time to application into consideration. We argue that there is no "network service" in the typical home and small office use environment, which require a permanent immediate (milliseconds) or fast (<10sec.) reactivation. Even with remote VPN wake-up request it cannot be argued that a general fast reactivation is essential. However, we recognize the request for a more elaborate power management routine in order to support usability, convenience and overall system efficiency. At this point we introduce the medium network availability mode (LowP2), an intermediate step improving service quality and convenience for the customer.

Medium network availability mode (LowP2) is not considered a power-down target. This mode functions as a flexible instrument for achieving usability and energy efficiency. How does it work? Whereas the power-down targets (LowP1 and LowP4) are defined by limit values for average power consumption (Wh/h) the LowP2 is defined as an **energy budget**. The energy budget (Watt hours) is a flexible limitation, which allows a higher power consumption over a shorter period of time or a lower power consumption over a longer period of time. As an example you can utilize a 5 Wh energy budget by designing a mode which runs ½ hour at 10 Wh/h or 2 hours at 2.5 Wh/h. After the energy budget is used the power management needs to ensure that the equipment transfers automatically into the power-down target LowP4. The energy budget is functioning as a flexible limitation. The energy budget is designed to overcome medium-length periods of inactivity.
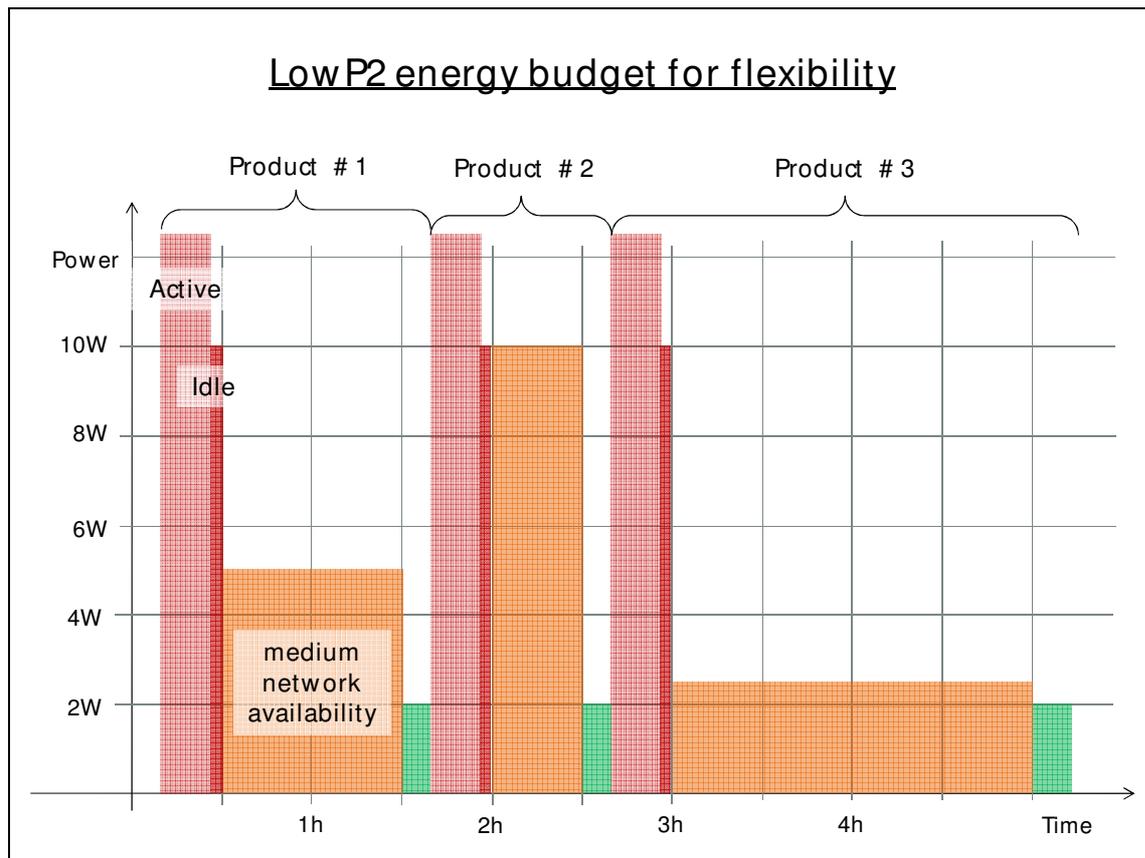
Figure 2: Energy budget for LowP2

7.1.3   Manual and automatic power-down

Power management including the automatic transition into cascaded low power states are known from the computer and imaging equipment industry. Such automatic power management routines work quite well, because computers and imaging equipment are utilized by means of frequent user interaction (input commands). The user's inactivity (no input) results in an idle state and starts a timer. After a certain delay time the equipment transfers from idle into the cascaded low power routine.

An automatic power management routine is more difficult to implement for passively used equipment such as TV or AV media player. The consumer electronics (CE) have less frequent input commands. One typical application is the audio or video display of Radio/TV broadcasts. Once set this can run indefinite. Automatic power-down is therefore a challenge. It would require an active detection of the user's presence and an adequate feedback loop from the user before a power-down routine starts. There are products getting into the market that feature "presence sensors" in conjunction with other automatic power management options. Nevertheless, it seems necessary that "passively used" products (e.g. consumer electronics) need special attention with respect to manually and automatically initiated power

management. This includes the "fast play" issue. The improvement options will reflect these aspects.

7.1.4   Power management needs support along the value chain

We like to emphasize again that networked standby modes are in the first place instruments for saving energy. This objective is only achieved, if the industry collaborates along the whole value chain including upstream component suppliers and downstream service provider.

Standardization of power management schemes in all product categories: In order to achieve energy efficiency without losing convenience and functionality networked standby has to be designed properly on a hardware and software level. The ACPI example of the personal computer industry shows that good results are achieved when standards for interfaces and power management routines are developed in a collaborative effort. This includes the collaboration of all major component manufacturers (chip maker) and software houses along the supply chain of OEMs. If system chips, dedicated processors, network interfaces, and other electronic components are not supporting the low power strategy of the system, the equipment manufacturer has little room for improvement.

Infrastructure and service provider interaction: There is another support effort necessary. That effort has to be made by the access network provider. Customer premises equipment is limited in its energy efficiency efforts by the wide area network link. It is known for instance that ADSL (G.992.3) and ADSL2+ (G.992.5) recommendations define a power management feature including power trim steps in L2 (reduced power) and transition into L3 (idle). These features can be initiated on the central office (CO) or remote unit. Due to the several seconds transition time (L2) and the potential of losing data and connectivity (L3) most network provider are not using this power management feature. Their experience with unhappy VoIP (Voice over IP) customers cannot be denied. That does not mean however that the idea is wrong. The provider of the access network is influencing (with the technology, network topology, node configuration, and system setup) the energy consumption of the customer's equipment. If there is no traffic in the loop, the system should support low power modes.

The actual internet and TV service provider located downstream in the value chain are also influencing the energy efficient utilization of the customer's equipment. The known example from the TV/STB sector is the update of the Electronic Program Guide (EPG). This download requires energy for network availability and for the slow download due to the bandwidth limitations. There are obviously better ways to update the EPG, but that's not the subject of this study. However, the service provider should develop and support more energy efficient options for EPG and other system updates.

Interoperability and copyright issues: Power management in the PC industry works fine because this is quite an open system. PCs need to collaborate with other devices. This

"interoperability" and "networking" necessity is just starting gaining ground in the CE industry due to the transition from analogue to digital media. With this transition signal and data processing got more complex and network options increased. The CE industry is in the process of migrating from firmware solutions to more open software solutions. This development creates certain dangers. Important issues are "media copyrights" and "on-demand services". It has been argued that firmware solutions provide more security. Why is that a power management issue? It is difficult to standardize interoperability and power management against the background of hundreds of firmware solutions. Our point is that standardization is an important improvement option but requires feasible development time.

Conclusion: In this section we argued that energy efficient network availability and respective power management is system-dependent and requires a collaborative effort along the value chain including the hardware and software suppliers as well as the network infrastructure and application service provider.

7.1.5   Option 1: Manual and automated activation of standby/off

Option:	Manual and automated activation of standby/off (soft-off <1W)
Scope:	All equipment
Reasoning:	It is necessary to provide the user with a direct option for saving energy, even if it means that he/she is losing functionality (e.g. network availability).
Specification:	Hardware: • Standby/off button (soft switch) • Sensor pad on the equipment Software aspects include: • Appropriate shutdown routine • Required user interaction such as instruction for file saving, etc. via respective top-level-menu • Optional timer settings
Problems:	In the past additional costs, stability of handling, and optical design considerations have been the arguments for not implementing a soft-off button.
Example:	Best practice example is the soft-off switch and menu-based shutdown routine of mobiles, personal computers, imaging equipment, and some home gateways.

7.1.6   Option 2: Manual activation of power-down routine

Option:	Manual activation of the power-down routine (power management)
Scope:	All equipment
Reasoning:	The user should have the option to initiate directly and anytime a power-down routine for saving energy but without losing a certain level of network availability (see power down-targets). This option provides the user with a direct capability for starting the power management. This is a new option for more passively used products such as TVs or AV systems.
Specification:	Hardware: • Power-save button on the remote control or equipment (additional switch to the standby/off-button) • Direct input via keypad or touch screen panel Software: • Top-level-menu: This indicates that user interaction (input/activation) is provided on the highest level in the menu (top-level) • Shipment setting must allow instant use of this option
Problems:	Harmonization of the software menu (top-level) including terminology, sequence, icons, activation feedback (display), colouring, etc.[5]
Example:	Best practice example is the menu-based power management options of mobiles, personal computers, and imaging equipment.

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[5] Comment by Bruce Nordman: For electronics, the user interface is a topic researched extensively several years ago (see: http://www.energy.ca.gov/reports/2003-10-31_500-03-012F_APP.PDF), and the results of that work are embodied in an international standard. This can provide the basis of any policy in this area. For example, colour meaning is clearly important for power control, and is covered by this research and standard. For electronics products with a network connection, having the device power down to a sleep mode (that retains connectivity) is much more likely to be acceptable to the user than to an off mode which does not. For devices other than electronics, there is a need for attention to user interfaces, and this likely will show the need for further standards development.

7.1.7   Option 3: Automatic activation of power-down routine

Option:	Automatic activation of the power-down routine based on a specified default delay time of 15 minutes maximum for the idle mode duration.
Scope:	All equipment
Reasoning:	The best power management provides a smart system (the user might be the weakest link in the chain). In times of inactivity (no traffic, data and signal processing, etc.) the equipment should save energy by powering down automatically. The power-down routine varies according to the network availability specification of individual equipment.
Specification:	The power-down is typically initiated out of an idle mode. The option includes: • Shipment setting with automatic power down activated. • 15 minutes maximum default delay time for shifting from idle to first low power mode. More ambitions settings 5 or 10 minutes recommended (if resume time to application is fast). However, exemptions are also possible, if overall energy efficiency is prohibited by too ambitious settings. The selection of an appropriate default delay time needs to consider the average energy demand (watt hours) for the reactivation of the system out of a particular low power mode. • Power management menu on the top of the setup-hierarchy. Provide simple and easy access, clear instructions for the user.
Problem:	Products such as game consoles and media player feature "Pause" modes. We suggest that such "Pause" mode is considered an idle state. Development of conformity testing and measurement procedures necessary. For products that are typically tested according to a TEC methodology (Energy Star) such as IE, PCs should consider modification of test method. The TEC is in general a good approach for measuring typical energy consumption and should be considered also for other product groups. Suggested time to implementation 3 years.
Example:	Best practice examples are mobiles, personal computers, and imaging equipment.

7.1.8   Option 4: Individual power management settings

Option:	The equipment should provide the means for an individual power management set-up by the user. The individual set-up options have to be more ambitions than the power-down requirement. Setup deactivation of functions and ports.
Scope:	All equipment
Reasoning:	The user should have the alternative for more ambitious power management routines such as shorter default delay time settings, specific deactivation of functions or ports (e.g. WLAN and other interfaces), and timer-based night routines.
Specification:	Top-level menu setting for more ambitious power management: • Deactivation of functions or ports (e.g. ensure that user understands impact on network availability). Possibly smart deactivation could be offered (auto-detect links, deactivate all other interfaces). • Timer-based night routines (e.g. soft-off at night with timer, automatic activation of certain network availability during daytime) • Installation / first initialization set-up Eco-rating of power management options: • Menu (slide) button: Green – best, Yellow – sufficient, Red – critical • Provide average power consumption value as information in the menu
Problem:	Address the issue of "Fast Play" or "Quick Start", and reactivation of game consoles.[6]
Example:	Best practice examples are mobiles, personal computers, and imaging equipment.

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[6] Nintendo comment: Reactivation time is not an appropriate indicator for network availability cause it can highly differ depending on the game that is currently played. In this case, Nintendo support the proposal made in the Lot ENTR 3 preliminary study.

7.1.9　　Option 5: Power-down target for networking equipment

Option:	Power-down target for networking equipment is LowP1, a mode that supports high network availability. The power down routine starts from an idle state and is triggered manually or automatically with default delay time.
Scope:	Stand-alone networking equipment (non-rack), consider mission critical server as well.
Reasoning:	Although networking equipment requires the highest network availability there are phases during the day and particularly at night when no traffic occurs. In order to save energy during these periods networking equipment should reduce functionality (power) to a minimum without losing high network availability.
Specification:	Technical considerations: • Default delay time setting for idle mode duration: 15 minutes max. • Specifications for Idle and LowP1 (product-specific) • Design product with LAN components according to IEEE 802.3az (Energy Efficient Ethernet) • Deactivate unused ports / wireless interfaces • Adaptive clock speed, adaptive link rates (longer intervals) • Consider out-of-band signalling • Focus on power supply design • But support Proxying for system efficiency[7]
Problem:	Networking equipments are potential hosts for plug-in devices such as Zero Clients and Streaming Clients. The network connection may also supply power. Power-over-Ethernet and Power-over-USB devices have to be addressed in conjunction with design of power management (of the host).

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[7] Comment by Bruce Nordmann: Options 5 and 6 propose low-power modes for network equipment which is not a good idea. In addition, Proxying (Ecma-393) is not "interoperability with links"; rather it is about the protocols going to devices at the edge of the network, not about the link. In any case, it is not clear that proxying should require any more power on network equipment. Apple wireless access points added proxying capability in 2009 through adding software, not hardware.

7.1.10   Option 6: LowP1 average power consumption limit

Option:	The high network availability mode LowP1 should not exceed an average power consumption of 8 Wh/h.
Scope:	Stand-alone networking equipment with modem (non-rack)

Consider other networking equipment and mission critical server (non-rack) |
| Reasoning: | We consider 8 Wh/h as sufficient average power consumption for providing high network availability. This value is based on a minimum functionality for maintaining high network availability (signal detection and processing) at the modem, local wired and wireless interfaces. We expect that power saving measures need to be implemented in order to achieve this level. |
| Specification: | The level of power consumption is influenced by the overall product configuration and various technical aspects including:

• Number, types an standard of access network modem (e.g. DSL standards, DOCSIS standards, FTTX standards, Wireless)

• Number, types an standard of local network interfaces (e.g. LAN, WLAN, USB, HDMI)

• Power supply design (e.g. switching frequency)

• IEEE 802.3az (Energy Efficient Ethernet) implementation

• Distance of network connections (network topology)

• Interoperability with links (Proxying) |
| Problem: | Products with integrated modems / USB modems

Product with more than 4 active LAN or 4 telephone interfaces |
| Example: | |

7.1.11   Option 7: Power-down routine for all other products

Option:	The power-down routine for all other products consists of the power-down target LowP4 with an intermediate step LowP2 (optional) for convenient use. The power-down routine starts from an idle state and is triggered manually or automatically with default delay time (15 minutes maximum).
Scope:	All products (excl. networking equipment covered above)
Reasoning:	A "one-step" power management would be an auto-power-down routine from active/idle into standby/off. This approach loses efficiency and convenience. Following the well established power management approach of the computer industry we suggest a multi-step power-down routine with the final target LowP4. The LowP2 provides medium network availability with fast resume time to application (with a goal below 10 seconds, but up to 15 seconds may also apply). An energy budget is considered a flexible instrument (conformity testing needs to be addressed).
Specification:	LowP2: • Power-down from idle (pause) mode after 15 minutes maximum[8]

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[8] Comment by DigitalEuope: Idle times need to be set based on the industry and product, and the 15 minute delay times used in the PC industry may not be appropriate for other products. A fundamental portion of this calculation is what is the energy required to enter and exit the power-down routine. This transition energy will give you the minimum amount of time the equipment must stay in the low power mode to justify the transition energy (divide by the average power of the low power mode). If the idle time is too short, then the overall energy may raise because transition energy dominates the low power state energy. Given equipment with high energy transitions (e.g. printers) should be allowed to optimize this idle timeout.

Comment by Sony Computer Entertainment: 2 hours by default with current PS3. We can not say 15 minutes is appropriate as default settings for products, game. We would like to handle game consoles in New Lot3 and set appropriate time for APD in consideration of merchantability of game."Sony suggests that the automatic power down time should be 1h instead of 15min, which is too low and not realistic.

Comment by Nintendo: Auto power mode in 15 minutes is too low for the pause mode, which is considered as an idle mode. In addition, switching on and off the console can cause soldering points

	• Medium network availability with about 10 seconds reactivation
	• Typically suspend to RAM
	LowP4:
	• Power-down from LowP2 or if applicable from idle
	• Low network availability with more than 10 seconds reactivation
	• Typically suspend to disk, or full reboot after reactivation
	• Low level duty cycle possible
Problem:	Product with no hard disk drive or large flash memory: CE industry argues that suspend to disk is not feasible due to limited lifetime of non-volatile memory, reliability, form factor and sound (moving parts). In our view this would only apply for very extreme scenarios, see Task 6 report. [9]
Example:	Best practice examples are mobiles and personal computers.

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to fracture. For these reasons, Nintendo believe that a longer time period prior to APD is necessary. It would be preferable for game consoles to be regulated by a product-specific measure.

[9] Comment by Sony Computer Entertainment: "PS3 support WOL condition but power consumption limit and actual value are worlds apart. We can not accept it as we need to fundamentally overhaul architecture to comply with the limit, and the cost for it would be just about the cost of establishing new platform. (Also the limit value is quite hard to meet, we don't think it is not the value that every product category can meet.) We would like to handle game consoles in New Lot3 and make the requirements relevant to its merchantability."

7.1.12   Option 8: LowP2 energy budget

Option:	Medium network availability mode LowP2 energy budget of 5 Watt hours
Scope:	All products (excl. networking equipment)
Reasoning:	The energy budget of 5 Wh for LowP2 is based on computer sleep mode S3 with WoL. This energy budget should allow fast reactivation over a period of about one hour. Depending on the actual set-up higher average power consumption is possible but over shorter time duration and vice versa. Assuming that reactivation occurs within this time high user convenience is maintained.
Specification:	LowP2: • Power-down from idle (pause) mode after 15 minutes maximum • Medium network availability with about 10 seconds reactivation • Power budget 5Wh (Note: The actual average power determines default delay time for the transition into LowP4.) • Typically suspend to RAM
Problem:	See option 7
Example:	See option 7

7.1.13   Option 9: LowP4 average power consumption limit

Option:	Low network availability mode LowP4 should not exceed an average power consumption of 2 Wh/h.
Scope:	All products (excl. networking equipment)
Reasoning:	We consider 2 Wh/h as sufficient average power consumption for providing low network availability. This value is based on a minimum functionality for maintaining signal detection at a local network wired or wireless interface. We expect that power saving measures need to be implemented in order to achieve this level.
Specification:	LowP4: • Power-down form LowP2 or if applicable from idle • Low network availability with more than 10 seconds reactivation • Average power consumption of 2Wh/h (no time limit) • Typically suspend to disk mechanism • Low level duty cycle possible (peaks above 2 W permitted)
Problem:	See option 7
Example:	See option 7

7.2 Impacts

7.2.1 Overall Improvement Scenario

In order to assess the improvement potential an improvement scenario 2020 (ECO 2020) was created including the following mode assumptions:

Active: Same duration and power consumption as in selected base scenario for 2020

Idle: Adjusted, 10 minutes idle per 1 hour active mode (rounded to a quarter hour), power consumption same as in base scenario for 2020

LowP1: High network availability standby mode, 8 Wh/h

LowP2: Medium network availability mode, 2 x 5 Wh per day energy budget (this assumption indicates two full phase of medium network availability per day)

LowP3: NoNA, not considered in the scenario

LowP4: Low network availability mode, 2 Wh/h continuously for the remaining use phase per day

LowP5: NoNA, not considered in the scenario

The following ten product cases have been modified in the 2020 improvement scenario (ECO 2020). The other products have been not considered yet or already have multi-level power management.

1. Home Gateway

2. Home Desktop PC

3. Home Notebook PC

4. Home NAS

5. Game Console

6. Complex TV

7. Complex STB

8. Complex Player/Recorder

9. Office Desktop PC

10. Office Notebook PC

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The Figure 3 shows the results of the improvement scenario 2020 in comparison to the business as usual scenario 2010 and 2020. In the improvement scenario 2020 the overall energy consumption decreases substantially from 204 TWh (BAU 2020) to 164 TWh (ECO 2020). This is an overall improvement by about 40 TWh. The main impact comes from a significant reduction of idle duration and the utilization of the energy budget in medium network availability mode LowP2 as a transition phase down to LowP4. The LowP4 (low network availability standby) increased to some extent through shifting energy consumption from other low power modes.

The comparison of the reference year scenario (BAU 2010) with the improvement scenario (ECO 2020) also indicates an overall improvement by 8.1 TWh. This result indicates a general positive development through the adoption of power management including low power targets, even though device numbers and functionality offered increase.
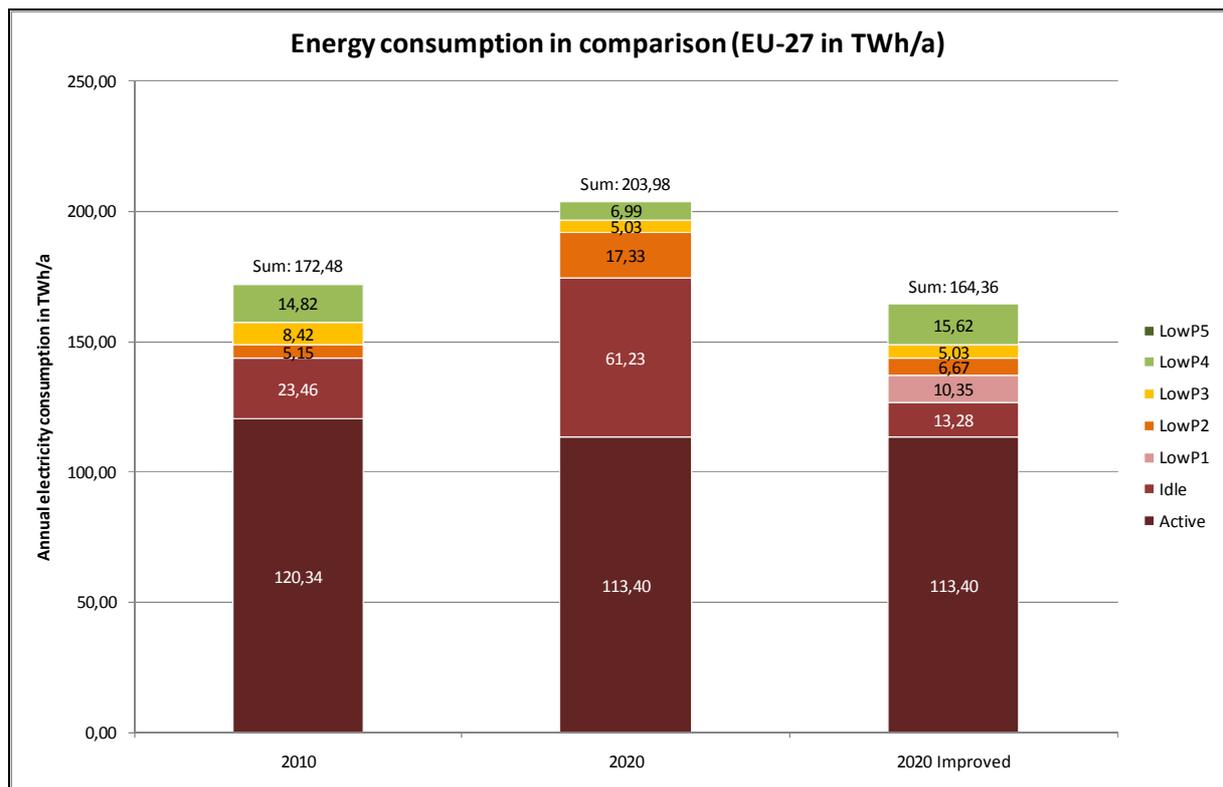
Figure 3: Improvement scenario 2020 in comparison to business as usual scenario 2020

Figure 4 below is indicating the improvement in direct comparison of BAU 2020 with ECO 2020 (all modes) with ranking of impact by products. Due to our assumption that simple products (e.g. Simple TV, Simple STB, and Simple Player/Recorder) do not change the use patterns, it is not surprising that some of these products are still high in the ranking. Interesting to notice however is the positive development with respect to the Complex TV, the Home and Office Desktop PC, and particularly the Game Consoles.

The home gateway is in the ranking of products in third place. It needs to be noticed that the annual energy consumption of this group remains the same in both scenarios (BAU and ECO). This is due to our general improvement assumption of 20% already in the BAU 2020 (compared to 2010 performance levels). The idle mode power consumption (as an average 2020 level) and LowP1 power consumption are practically the same with 8W in both 2020 scenarios. This coincidence does not mean that the proposed improvement option (power-down target LowP1 for networking equipment) will not have a positive impact in the future. It rather indicates two aspects. Firstly, home gateways with higher idle mode power consumption (>8W) will still show improvement. Secondly, lower levels or more advanced power management might be considered for this product group.
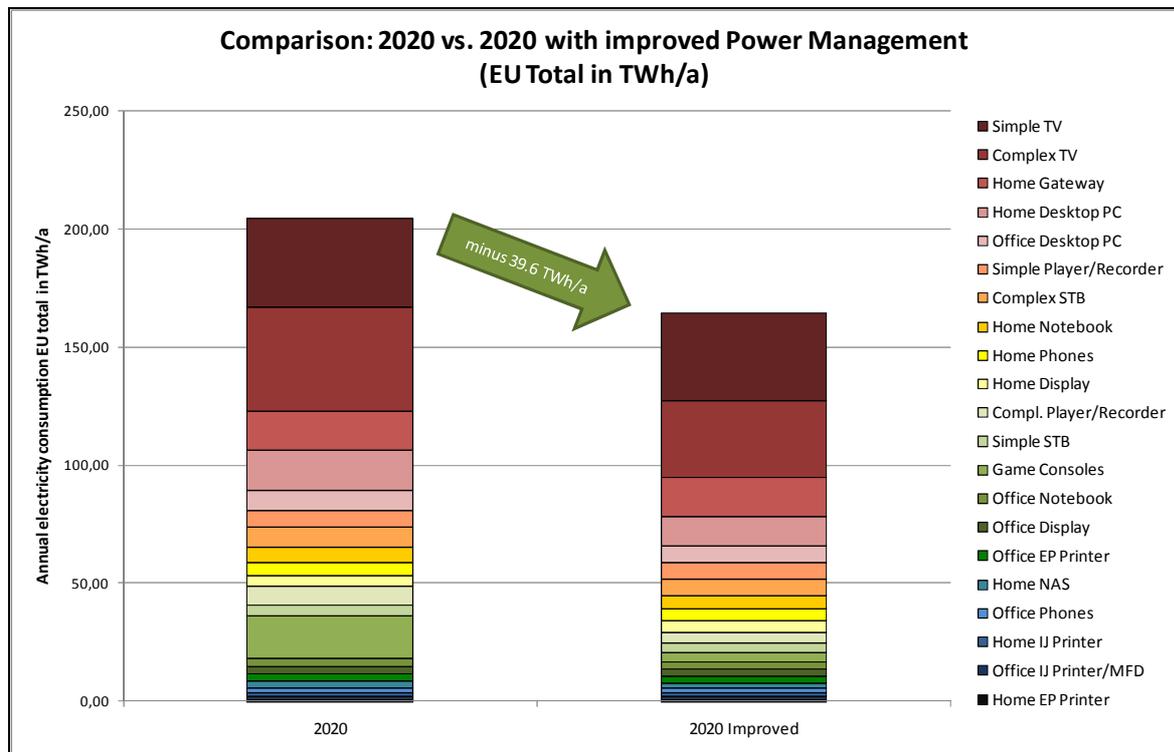

Figure 4: Comparison of BAU 2020 with ECO 2020 with ranking of impact by products

7.2.2 Improvement potential of individual product groups

The previous discussion of results already indicated the different impacts of the improvement options on individual products. Figure 5 below shows a comparison of BAU 2020 and ECO 2020 without active mode. This figure provides a more detailed overview on the energy saving with respect to all products. According to our scenarios, the most considerable improvement potential comes from complex products (e.g. Complex TV, Complex Player/recorder, Complex STB) and Desktop PCs, and Game Consoles.
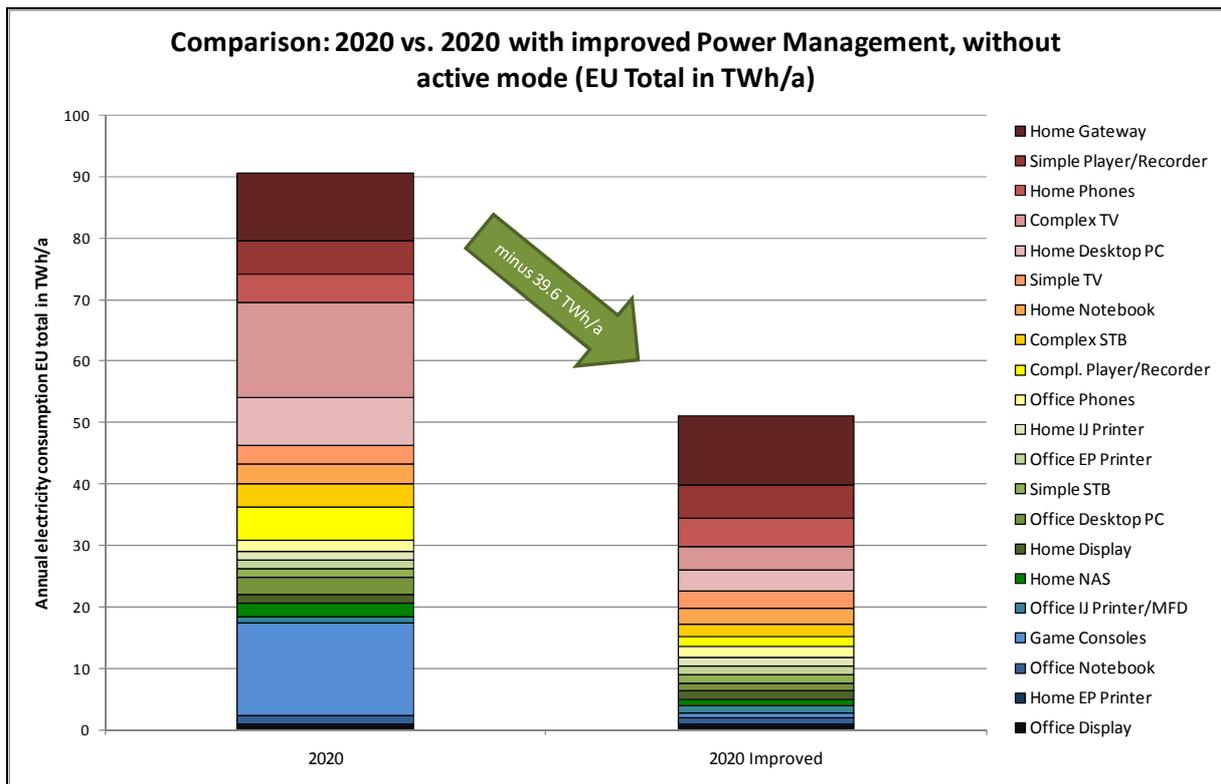
Figure 5: Comparison of BAU 2020 and ECO 2020 without active mode (incl. Ranking)

The following Figure 6: Comparison of product according to improvement potential provides a ranking of product groups with the largest improvement potential.
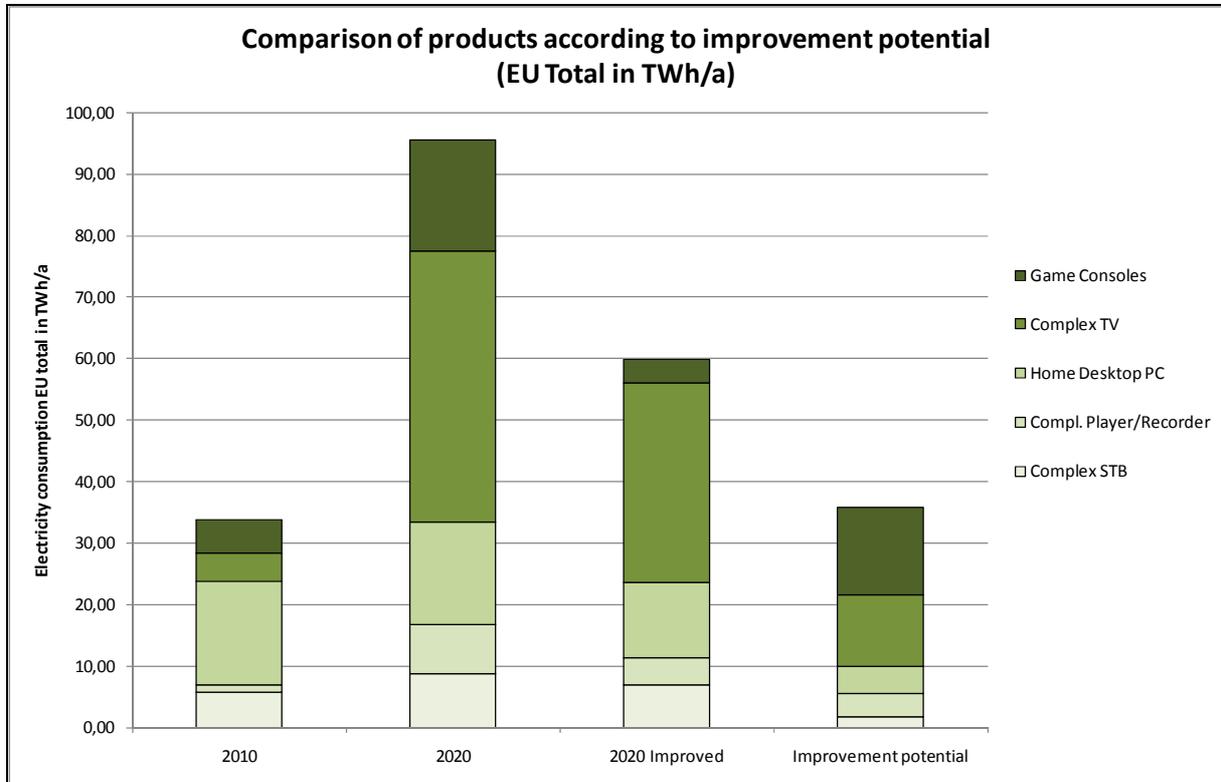
Figure 6: Comparison of product according to improvement potential

Game Consoles and Complex TV show an improvement potential of more than 10 TWh each. Both scenarios reflect a critical business-as-usual scenario (BAU) with 12h idle per day. The consideration was that these products do not feature a dedicated power management including low power modes with fast resume time to application. For details on Game Consoles see Figure 7 and for Complex TV see Figure 8.

Home Desktop PCs, although assumed to have good power management already, still show an improvement potential. For details on Home Desktop PCs see Figure 9. Figure 10 and Figure 11 show the individual improvement potentials of Complex Player/Recorder and Complex Set-Top-Boxes.
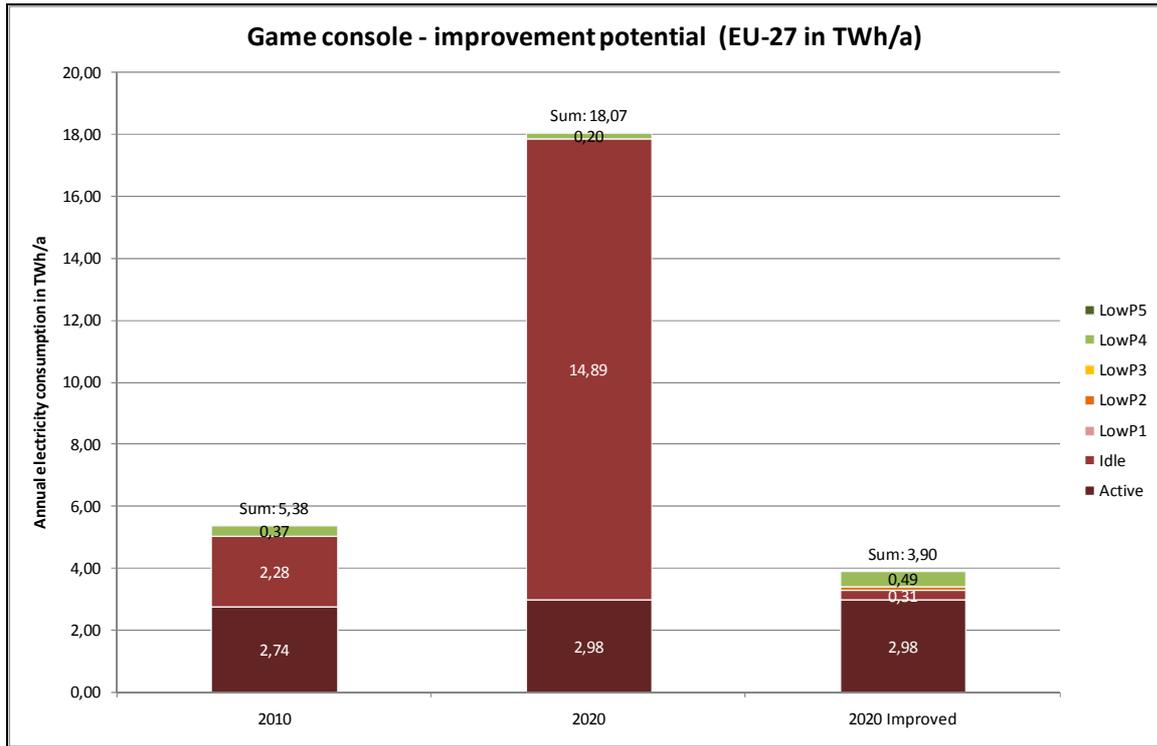
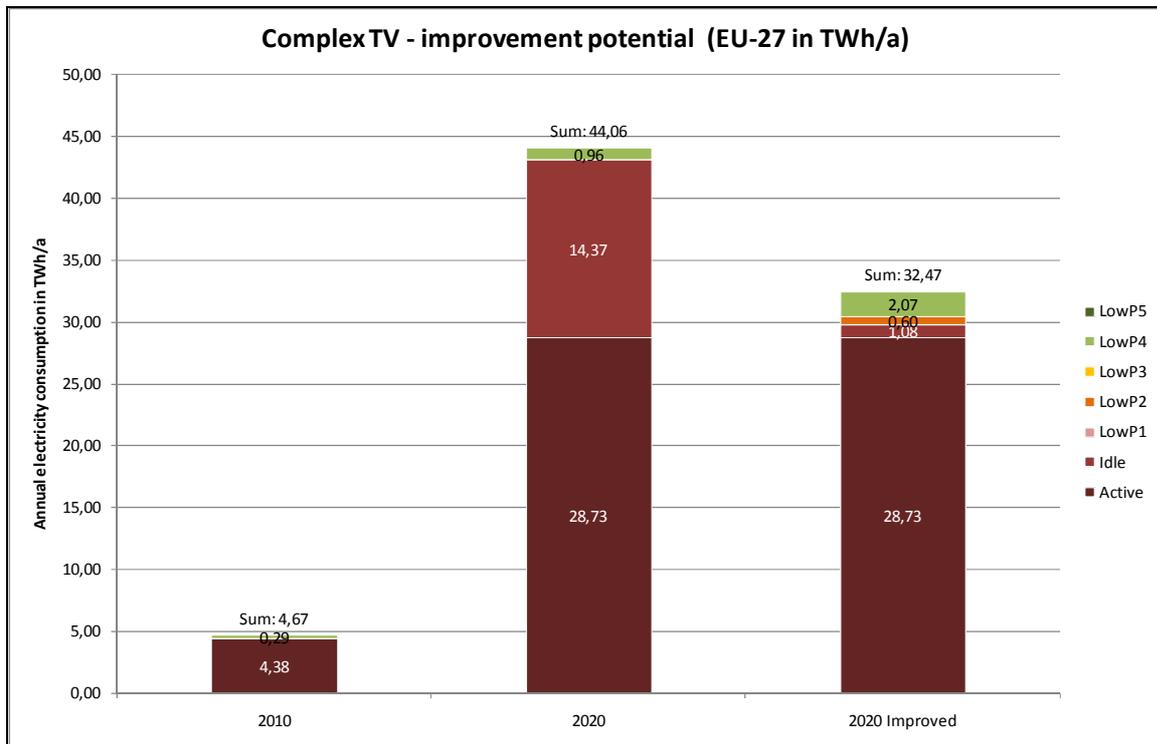Figure 7: Game Console improvement potential
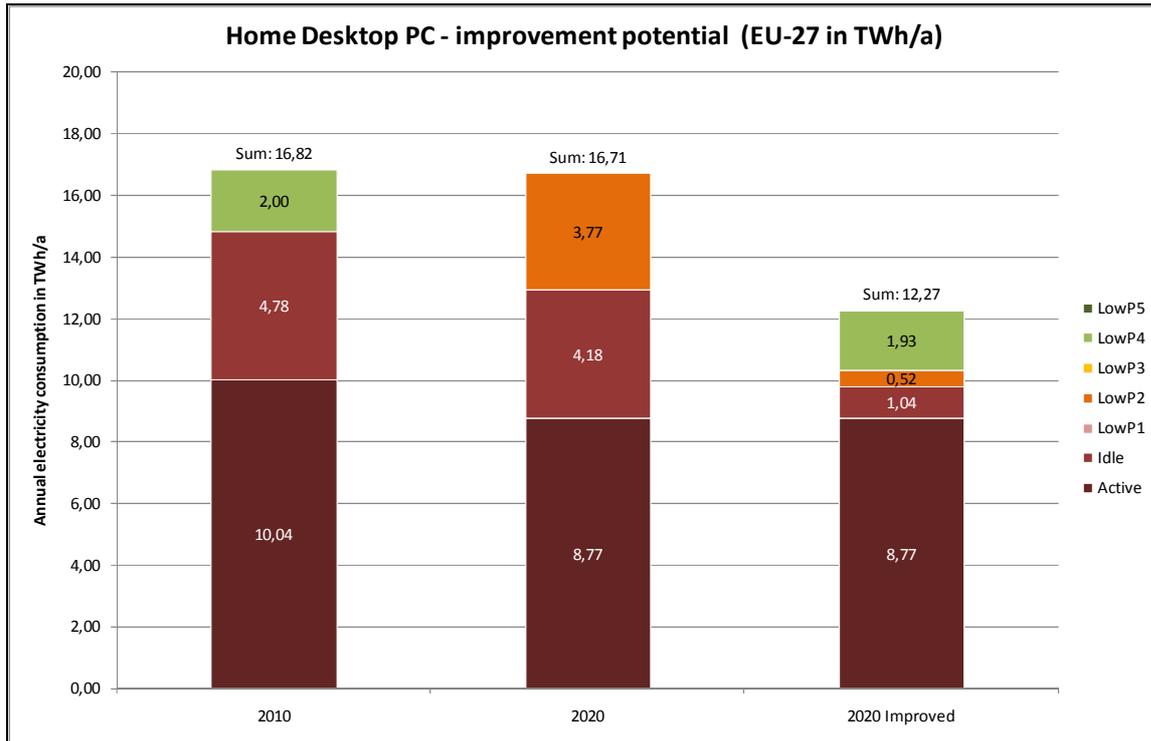

Figure 8: Complex TV improvement potential

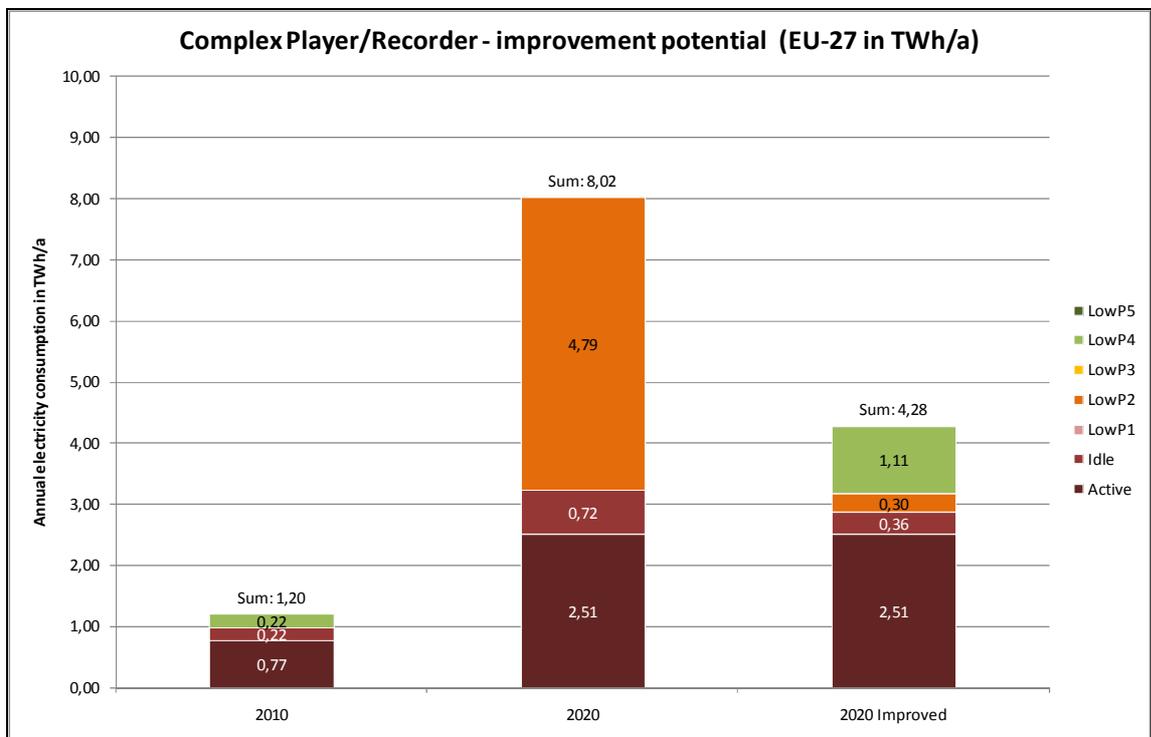Figure 9: Home Desktop PC improvement potential

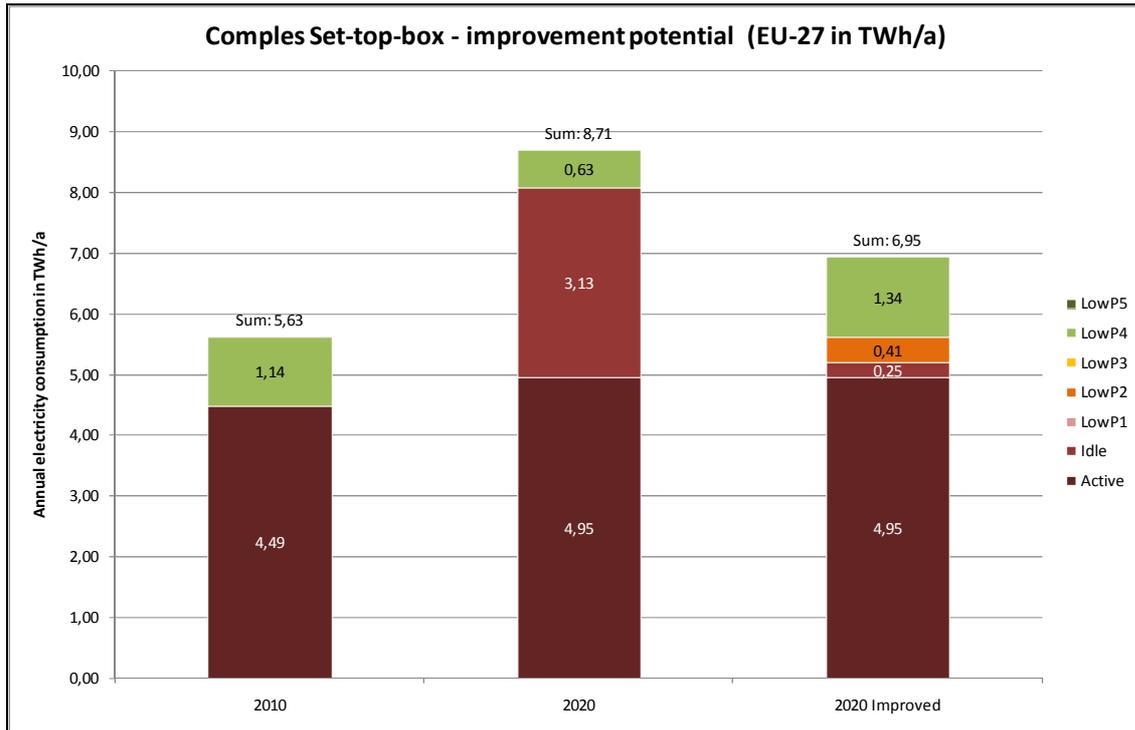Figure 10: Complex Play/Recorder improvement potential

Figure 11: Complex STB improvement potential

Note: We encourage all stakeholders to provide comments on the scenario assumptions and improvement options.

7.3   Analysis of LLCC and BAT

7.3.1   Electricity costs of the improvement scenario

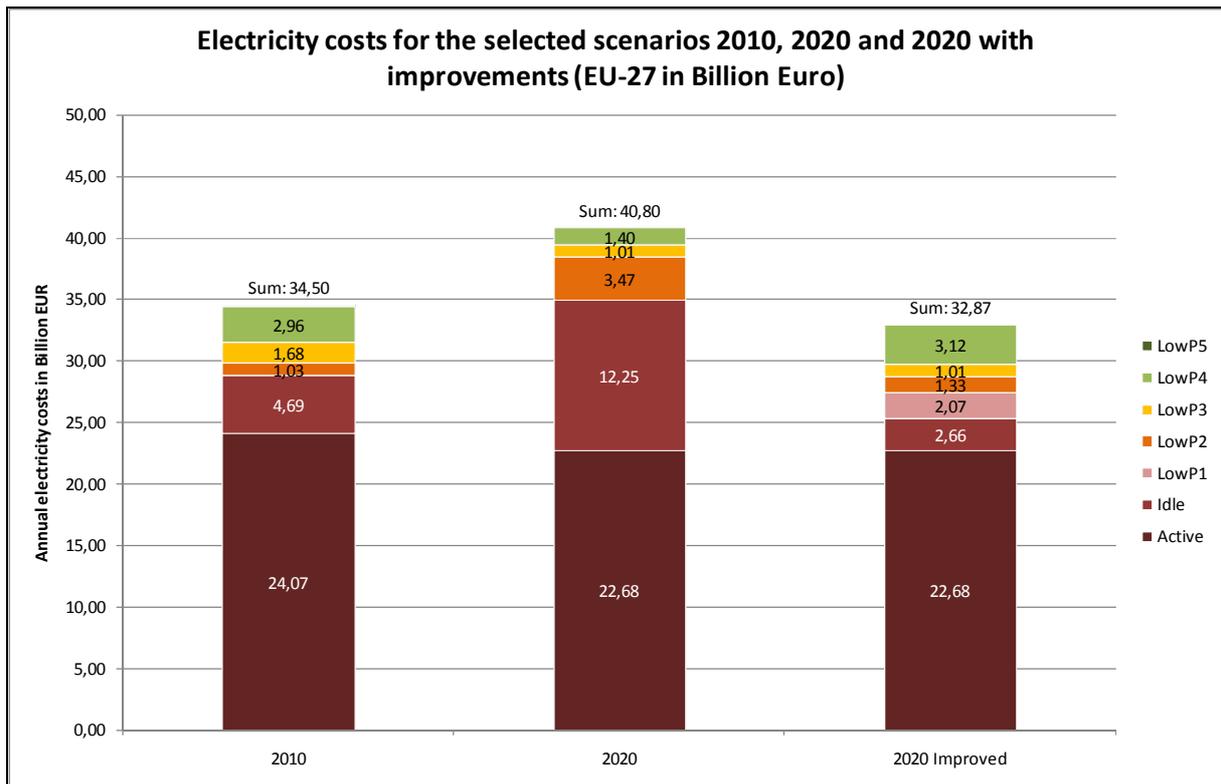The cost assessment mirrors the assessment of annual energy consumption in the individual scenarios (see Figure 12).[10]

Figure 12: Electricity costs for selected scenarios

7.3.2   Cost Benefits

In order to calculate least life cycle costs (LLCC) specific component prices would be necessary. Such data are not only difficult to obtain, the representative character of components and their integration in products is questionable. We are taking a different

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[10] Following the publication of the draft final report and respective comments, we changed our assumptions for the electricity costs: In 2010 the assumption is 0.17 €/kWh, in 2020 0.22 €/kWh. According to this new assumption the cost factor in 2010 changes to 29.3 billion €/a, in 2020 to 44.9 billion €/a and in the improved scenario 2020 36.2 billion €/a.

approach by calculating cost benefits. Cost benefits result from the comparison of annual energy consumption for certain power levels and daily utilization. Figure 13 below shows this approach. We have calculated the energy consumption of different power levels (from 2W to 26W) for a daily period of 12 hours (daily use) and multiplied by 0.2 EUR per resulting kWh. This value has been multiplied by 365 days (annual use) and mapped for an overall life time of 5 years.

If we assume that a home gateway is 12h per day at 12W idle the resulting cost after 5 years are 52.5 EUR. If we now assume that the same product utilizes a high network availability mode LowP1 with 8W the resulting energy costs are only 35 EUR. The cost benefit is therefore is 17.5 EUR. This amount of money could be invested into an energy saving LowP1 solution without increasing the life cycle costs for the customer.

This simplified approach provides us with an order of magnitude with respect to improvement costs. In reality we have to consider R&D investments, market price development and other risk factors. Nevertheless, the example calculation indicates a single product benefit.

Following expected feedback after publication of this draft report, we will provide on the example of the selected product case studies a matrix of resulting cost benefits from the improvement options.
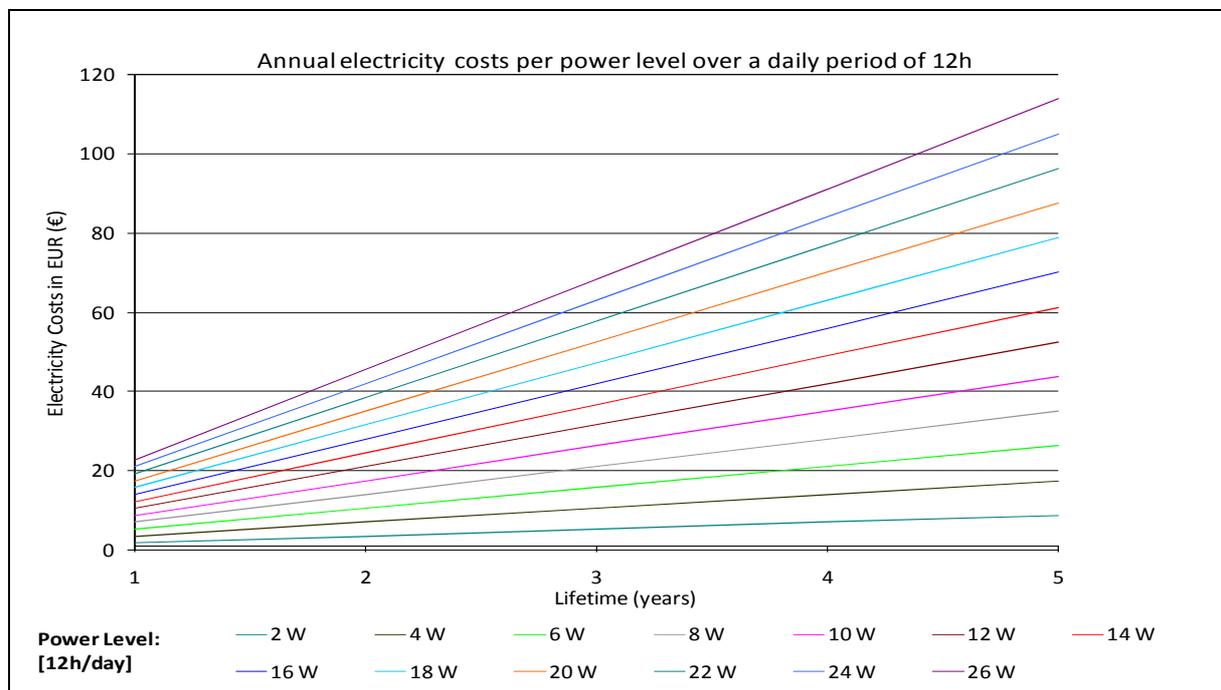

Figure 13: Annual electricity costs per power level for 12h/day use

Data for Figure 13 are given below.

Table 1: Annual electricity costs per power level for 12h/day use

Power	Lifetime in years / Electricity Costs in EUR				
12h/day	1	2	3	4	5
2 W	1,75	3,50	5,26	7,01	8,76
4 W	3,50	7,01	10,51	14,02	17,52
6 W	5,26	10,51	15,77	21,02	26,28
8 W	7,01	14,02	21,02	28,03	35,04
10 W	8,76	17,52	26,28	35,04	43,80
12 W	10,51	21,02	31,54	42,05	52,56
14 W	12,26	24,53	36,79	49,06	61,32
16 W	14,02	28,03	42,05	56,06	70,08
18 W	15,77	31,54	47,30	63,07	78,84
20 W	17,52	35,04	52,56	70,08	87,60
22 W	19,27	38,54	57,82	77,09	96,36
24 W	21,02	42,05	63,07	84,10	105,12
26 W	22,78	45,55	68,33	91,10	113,88

As a simplification the numbers in the table can also be used to extract the cost benefit directly, by using the power saving as the input on the left hand. A product saving an average of 4 W over 12 hours for three years would achieve a cost benefit of 10.51 €, for example.