EuP
Lot 26
Networked Standby Losses

TREN/D3/91-2007/Lot 26

Preparatory Studies for Eco-design Requirements of EuP

Study funded by the European Commission

EuP Preparatory Studies
Lot 26: Networked Standby Losses

Final Report Task 5
Definition of Base Cases

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Berlin, Paris 21st June 2011

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5.1 Introduction

According to the MEEuP methodology, the objective of Task 5 is the environmental impact analysis of selected base cases applying the MEEuP EcoReport assessment tool. In the case of ENER Lot 26 Networked Standby this task requires modification in order to serve the horizontal purpose (wide product spectrum) of this particular study. The modification concerns Subtasks 5.1 and 5.2 – the product specific inputs and environmental impact assessment. With respect to the individual product inputs we selected and aggregated representative product groups that are typically used in European households (home) and business environments (office). The economical and use data for the eco-assessment derive from Tasks 2 (market analysis) and Task 3 (user behaviour). These technical input data have been analyzed in Task 4 (technical analysis). The power consumption values for the selected product groups derived generally from open sources such as technical reviews (test magazines), product declarations, Energy Star and technical product specifications. Some assumptions are drawn from the results of the technical questionnaire and stakeholder interviews that preceded this analysis. Nevertheless, for the purpose of this study and due to the broad product spectrum it was necessary to average most values.

The methodical approach for the required environmental impact assessment was developed on the basis of the technical analysis in Task 4. This analysis indicated that network availability and respective resume-time-to-application is a reference factor for distinguishing different levels of networked standby. In the first subtask we explain the intention, concept and structure of our Networked Standby Assessment Model which reflects the network availability concept. In the second subtask we present the input assumptions and assessment results for selected product group. We publish them in separate documents for more easy reading. In reaction to the comments received on the Draft Report (published in September 2010) we adjusted again some assessment scenarios.

This slightly modified approach is more pragmatic. It provides on the one hand a better basis for the evaluation of environmental impacts, but results on the other hand in a somewhat less realistic EU-total assessment (averaged economy level). The requested “real life” EU-total impact assessment (third subtask) will be constructed from a combination of the four different scenarios. The assessment of life cycle costs (LCC) is limited to the monetary value of electricity consumption with respect to the annual use phase scenarios. In the final subtask we will summarize and discuss the results of the impact assessment. It is the intention of this final analysis to identify the causal mechanisms between network availability, energy consumption and power management on the economy wide level.

5.2 Networked Standby Assessment Model

5.2.1 Modified Environmental Assessment Concept

The environmental assessment of networked standby is a challenging task. The primary objective of this assessment is to quantify the environmental significance of networked standby with respect to energy consumption within the European Union. The study is based on the assumption that network standby is a development which leads to a considerable increase in overall energy consumption within the next years. Let’s review the underlying problem.

Technical progress allows the remote wake-up of a product over a maintained network link or connection for the purpose of resuming an application (networked service) offered by the product. The environmental problem lies in the fact that this networked service is typically provided not out of a low power mode such as standby/off (according to the EC 1275/2008) but out of a higher power mode such as idle. According to our problem assumption this suboptimal design will lead to significantly increasing energy consumption (see Figure 1 below).

But the reality is not that simple. The technical analysis showed that networked standby is not only part of a problem but also part of a solution. Over the past 15 years the personal computer and imaging equipment (computer peripheral) industry developed with the Advanced Configuration and Power Interface (ACPI) an open standard for the implementation of power management. ACPI specifies interoperability of hardware and operating system allowing the design of cascaded low power (sleep) modes. The correlation between power level and resume-time-to-application deriving from ACPI has strongly influenced the network availability concept of our study.

The existing solutions for advanced power management in the field of Personal Computers (PC) and Imaging Equipment (IE) are positive benchmarks that need proper consideration in the environmental assessment. We therefore consider in parallel to the problem assumption a solution assumption as well (see again Figure 1 below). This assumption is based on the idea that products offering networked services feature an advanced power management including low power networked standby modes in order to reduce higher energy consumption (e.g. due to prolonged idle mode). This concept does not only apply to products which add network capability such as it is currently the case with more and more consumer electronics (CE) products. The concept also applies to always-online products such as telephones, networking equipment, and small services. For these products networked standby mode could be a means to improve their energy efficiency. The three different levels of network availability (high, medium, and low) reflect this general consideration.

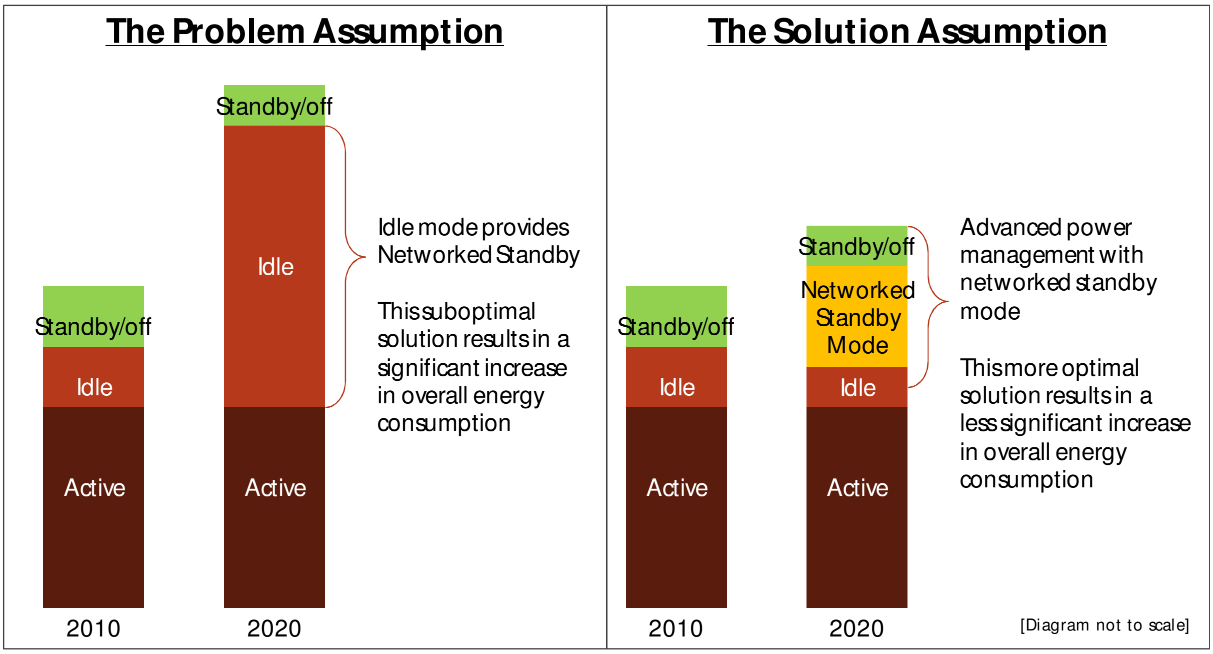

Figure 1: Assumptions reflected by the environmental assessment

Against that background the methodical approach to the environmental assessment consists of a reference situation (2010) and different development scenarios (2020). The assessment of the reference year 2010 alone would have limited value for the evaluation of the environmental impact. Again, we have the justified assumption that energy consumption related to networked standby will significantly increase with respect to individual equipments (product level) as well as with respect to the combined product stock (economy level).

In order to prove this environmental assessment assumption we have developed an assessment model that supports a comparable analysis of networked standby aspects on the technical, user and economical level. The basic assessment approach is a product level comparison of annual energy consumption. This typical energy consumption has been based on daily use patterns (see Task 3) and includes distinctions of different power modes. The different modes correlate to some extent with different levels of network availability (respective networked standby power consumption). This product level assessment will be then multiplied with the product stock assumption (see Task 2) in order to assess the economy level impact.

We have selected product groups from the home and office environment in order to be representative with respect to both – the product variety and overall market. In other words, the selection also reflects the two basic levels of our assessment:

- **The product level (unit)** is serving the purpose of calculating the annual power consumption impact of the four different network availability scenarios on the unit level. In this case we can allocate a certain level of network availability to a prolonged duration of a certain mode. The resulting typical energy consumption (TEC) indicates if higher or lower network availability changes the overall unit's energy consumption significantly or not. The product level assessment also indicates the current status of power management and respective power consumption levels.

- **The economy level (stock)** aggregates the individual product impacts. The purpose is to indicate the scale of the impact for the totally installed base of products in the European Union. The aim is to get an estimate on the overall energy impact based on highly averaged market utilization assumptions.

We will introduce four network availability scenarios for each selected product groups. These development scenarios reflect four different utilization options (use patterns) with respect to Network Availability.[1]

5.2.2 Network Availability Scenarios

The environmental assessment of the networked standby is based on the following four different Network Availability Scenarios:

- High Network Availability (HiNA)
- Medium Network Availability (MeNA)
- Low Network Availability (LoNA)
- No Network Availability (NoNA)

With these four scenarios we can now uniformly describe and assess different utilization cases (network availability levels) within and across different product groups. The Network Availability Scenarios are one layer of the abstraction and simplification process in order to generate the required Base Cases. These scenarios and their underlying assumptions will be applied to the individual equipment units (products level) and to the EU-27 product stock (economy level). As such, the Network Availability Concept describes "networked standby characteristics" of individual product groups as well as broader trends on the economy level.

Each network availability scenario is in reality a combination various modes. High network availability for instance could be indicated by prolonged idle mode phase. Some products, such as current networking equipment, might maintain active/idle mode without shifting to a lower power mode. There might by options however for further reducing idle mode power

[1] See network availability concept in Task 1.

consumption while maintain high network availability. This is the concept of LowP1 as will be explained further below. Other products have already active power management implemented in order to save energy. Notebooks (PC) and most printers (IE) will eventually shift into a lower power mode and through that into low level of network availability.

This example shows that a simple allocation of a different level of network availability to a certain mode is not realistic. In the first draft of this report, we had therefore combined the network availability concept with the daily use pattern. We basically mixed individual product level scenarios and averaged economy level scenarios. The idea was to show a tendency but not fully allocate a certain level of network availability to a certain mode. This approach has lead to criticism and confusion by some stakeholders.

In this new report we modified the scenarios of each product group. We made a more stringent allocation of the different network availability levels to specific power modes and their daily duration. The principle is this. Each product example has fixed active/idle use (daily time duration). The remaining time per day is the potential duration in which the product could be in high, medium, low or no network availability.

5.2.2.1 High Network Availability (HiNA)

Specification of HiNA:

- Remote access and reactivation is available 24h/d (always available).
- Immediate resume time to application (in milliseconds).
- Supported by remaining in idle mode or LowP1
- Typical products are networking equipment such as customer premises equipment (e.g. modems, home gateways, telephone, complex set-top-boxes, home server)

High network availability characterizes mainly networking equipment with point-to-multipoint communication. Regarding the application of high network availability in the market today, we should consider some conditions such as the time expectations (feedback loop such as a ringtone of a telephone), randomness (unexpected, at any time of the day), and network complexity (long distance, multiple nodes, security level and respective protocols). Moreover networking equipment becomes increasingly more functional by integrating large memory (e.g. HDD, SSD). A further trend is that server and set-top-box type products integrate routing capability (e.g. WLAN).

5.2.2.2 Medium Network Availability (MeNA)

Specification of MeNA:

- Remote access and reactivation is available 24h/d (always available).
- Resume time to application varies between periods of immediate (in milliseconds) and fast reaction (<<10 seconds).
- Supported by Wake-on-LAN-type sleep modes (LowP2).
- Typical products are server-type equipment with large data/media storage capacity (e.g. small server, desktop and notebook PCs, complex media player/recorder). Client-type products do also utilize MeNA for higher convenience in the use phase (e.g. printers or media player with “fast play” or “quick start” function).

Medium network availability characterizes products and applications for which remote access and reactivation is (less) random, can be planned and where delays can be taken into consideration by the initiator of the trigger signal. In such cases, a simple acknowledgement of the device’s successful reception of the signal can be sufficient to allay technical and psychological expectations for quick reaction. Fast reactivation (MeNA) improves convenience of use and is today an important instrument in advanced power management schemes of the PC and IE industry.

5.2.2.3 Low Network Availability (LoNA)

Specification of LoNA:

- Remote access and reactivation is available 24h/d (always available).
- Resume time to application varies between periods of fast (<<10 seconds) and longer reaction (>>10 seconds).
- Supported by Wake-on-LAN-type hibernate and off modes (LowP4).
- Products featuring low network availability are typically client-type and to some extent of server-type products (at the presented time this scenario is limited to PC and IE).

Low Network Availability characterizes the general capability of the product to reactivate and resume an application. The resume-time-to-application is of less concern for the user.

5.2.2.4 No network availability (NoNA)

Specification of NoNA:

- Remote access and reactivation is not available 24h/d

- Periods of network availability and unavailability can occur due to timer settings and other measures.

The concept of NoNA has been introduced in order to show product and user behavior that still prevails today but which is likely to change in the future as the trend towards higher levels of network availability continue.

5.2.3 Relationship between network availability and power modes

As the network availability scenarios describe a tendency, there is in reality not a direct mapping from a network availability scenario to a given power mode. However, power modes determine the network availability of a product.

In order to cover the wide product spectrum of this study and provide flexibility for the development scenarios we distinguish not only active and idle modes but a total of five low power modes (LowP). Regarding these modes we make the following basic assumptions:

- Active: This is the mode where the system executes the main applications or services. In the development scenarios we keep the duration of active mode constant in order to simplify the scenarios for the evaluation of networked standby.
- Idle: This is the mode where the system is fully operational and ready to execute the main applications or services immediately (in milliseconds). This mode is utilized to indicate high network availability at the current stage.
- LowP 1: This is a low power mode where the system can execute the main networking services immediately (in milliseconds) but reduce functionality in order to save energy. *Note: This is a fictional mode that provides idle functionality with about half the energy consumption. This mode will be utilized in later improvement scenarios.*
- LowP 2: This is a low power mode equivalent to sleep with WOL (ACPI G1/S3$_{WOL}$) or active standby that provides a resume time to application of <<10 seconds (typically 2-5 sec.). This mode is utilized to indicate medium network availability.
- LowP 3: This is a low power mode that provides no remote access and reactivation. It is equivalent to sleep (ACPI G1/S3) or passive standby (EC 1275/2008, passive as provided in IEC 62087). This mode is utilized to indicate no network availability.
- LowP 4: This is a low power mode that provides a resume time to application of >>10 seconds (typically 25+ sec.). It is equivalent to hibernate or soft-off with WOL (ACPI G1/S4$_{WOL}$ or G2/S5$_{WOL}$) or active standby low (IEC 62087). This mode is utilized to indicate low network availability.

- LowP 5: This is a low power mode equivalent to soft-off (ACPI G2/S5) or off-mode (EC 1275/2008) that provides no remote access and reactivation. This mode is utilized to indicate no network availability.

For the assessments the four availability scenarios correspond to six potential power modes indicated in Figure 2.

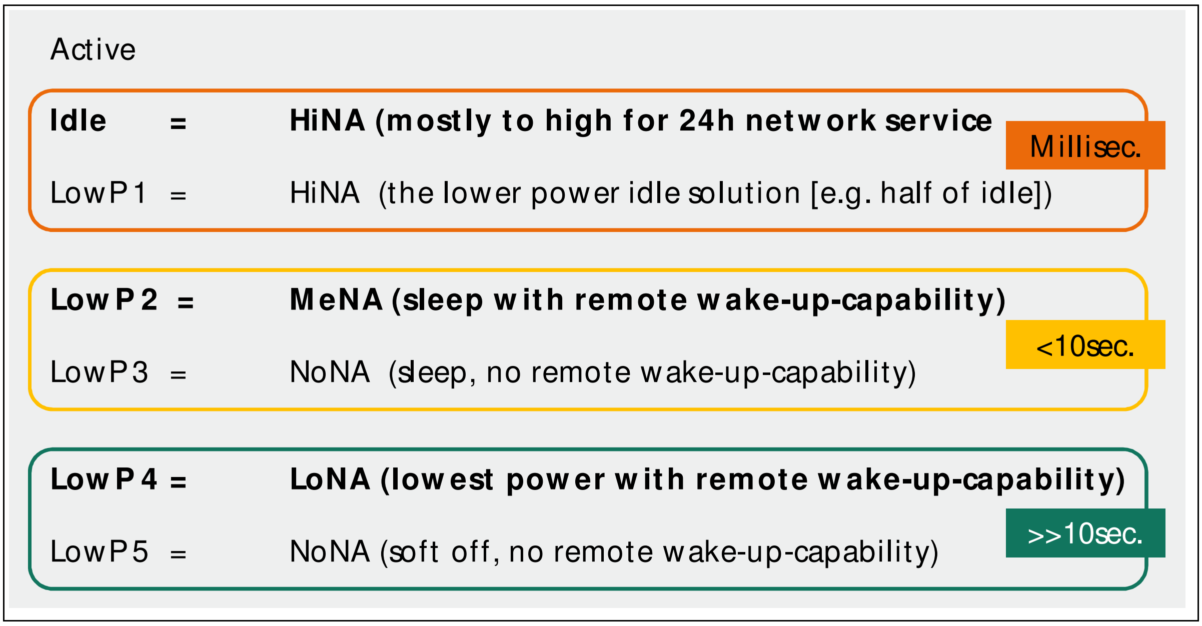

Figure 2: Overview of network availability concept and its relationship with power modes.

There are many variables to consider in such an assessment including:

- Various types of products (Note: The study tries covering as many product groups as possible. But there are obvious limitations to the full spectrum of possible products.)[2]
- Product utilization environments and individual use patterns (Note: The study tries to cover mass product applications in home and office.)
- Different types of Network Services and Quality of Service requirements (Note: The power management options can be limited by the linked equipment. One example is the interaction between DSL Modem and the DSLAM of the network provider.)

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[2] One example is game consoles. Following the draft report, one manufacturer indicated that his products are not adequately represented in the study. Under the given framework, this study is actually covering quite a broad product range.

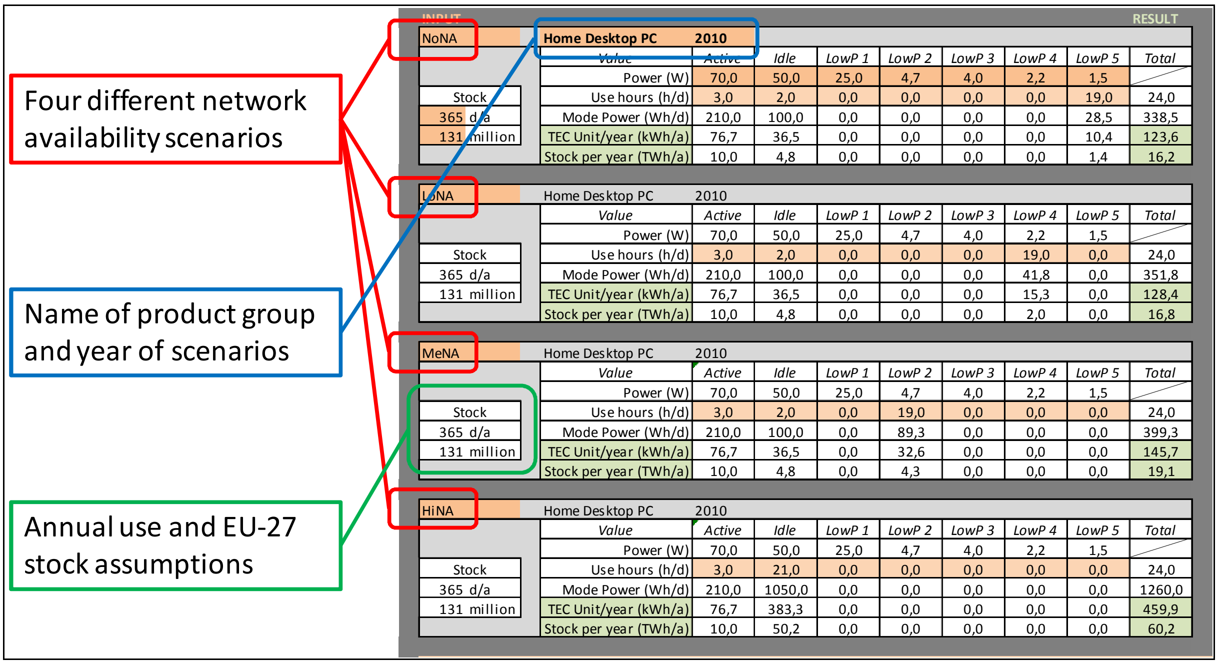
- Main components and the network configuration of the respective product (Note: The average power consumption per mode depends on the selected components, circuitry design, and software support.)
- Available power management options and mode configurations (Note: There large differences in the standardization of power management schemes between different product sectors [see below].)
- Technical progress in the next years with respect to all power modes (Note: It is feasible to assume that advanced component technology and system integration will generally improve the energy performance of most products. The increase in functionality will be compensated be these component level improvements.)
- Product stock development (installed base in EU-27) and new products (Note: multifunctional devices, convergence of functionality, standard network technologies)

In the following text, we describe each input aspect of the assessment model and the calculation sheets created for this purpose. Since the environmental impacts are limited to energy consumption in the use phase the MEEuP EcoReport is only used for interpreting the totals at the end of this task report.

5.2.4 Description of Assessment Spreadsheets

5.2.4.1 Basic input data

Before we provide the data input for the individual product group assessments it is necessary to shortly explain the spreadsheets we created for this purpose.



NoNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	0,0	0,0	0,0	19,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	0,0	0,0	0,0	28,5	338,5
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	0,0	0,0	0,0	10,4	123,6
	Stock per year (TWh/a)	10,0	4,8	0,0	0,0	0,0	0,0	1,4	16,2

LoNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	0,0	0,0	19,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	0,0	0,0	41,8	0,0	351,8
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	0,0	0,0	15,3	0,0	128,4
	Stock per year (TWh/a)	10,0	4,8	0,0	0,0	0,0	2,0	0,0	16,8

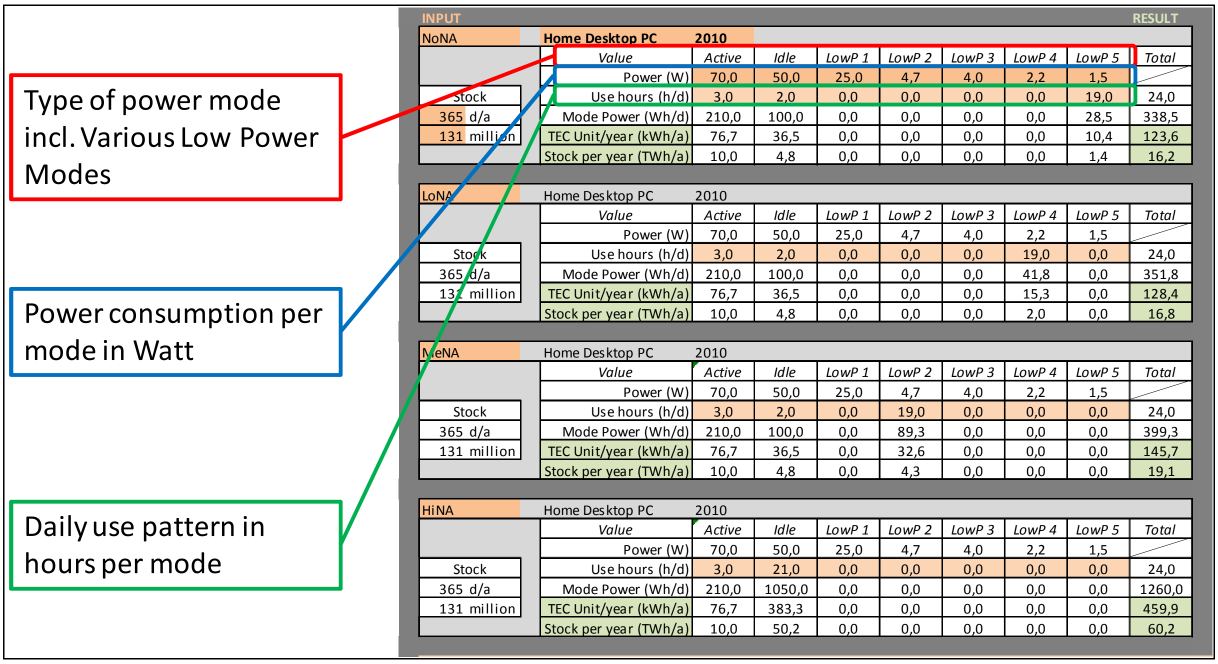
MeNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	19,0	0,0	0,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	89,3	0,0	0,0	0,0	399,3
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	32,6	0,0	0,0	0,0	145,7
	Stock per year (TWh/a)	10,0	4,8	0,0	4,3	0,0	0,0	0,0	19,1

HiNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	21,0	0,0	0,0	0,0	0,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	1050,0	0,0	0,0	0,0	0,0	0,0	1260,0
131 million	TEC Unit/year (kWh/a)	76,7	383,3	0,0	0,0	0,0	0,0	0,0	459,9
	Stock per year (TWh/a)	10,0	50,2	0,0	0,0	0,0	0,0	0,0	60,2

Figure 3: Assessment spreadsheets showing different scenarios in spreadsheets

Figure 3 above shows the assessment spreadsheet on the example of home desktop PCs (framed in blue). There are four tables for the reference year 2010, one for each Network Availability Scenario (framed in red). In the table, you find the basic assumptions for the annual use and the EU-27 Stock (framed in green).

Figure 4 below shows the individual data inputs for the daily use including the type of mode, power consumption per mode in Watt, and use duration in hours.



NoNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	0,0	0,0	0,0	19,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	0,0	0,0	0,0	28,5	338,5
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	0,0	0,0	0,0	10,4	123,6
	Stock per year (TWh/a)	10,0	4,8	0,0	0,0	0,0	0,0	1,4	16,2

LoNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	0,0	0,0	19,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	0,0	0,0	41,8	0,0	351,8
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	0,0	0,0	15,3	0,0	128,4
	Stock per year (TWh/a)	10,0	4,8	0,0	0,0	0,0	2,0	0,0	16,8

MeNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	19,0	0,0	0,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	89,3	0,0	0,0	0,0	399,3
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	32,6	0,0	0,0	0,0	145,7
	Stock per year (TWh/a)	10,0	4,8	0,0	4,3	0,0	0,0	0,0	19,1

HiNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	21,0	0,0	0,0	0,0	0,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	1050,0	0,0	0,0	0,0	0,0	0,0	1260,0
131 million	TEC Unit/year (kWh/a)	76,7	383,3	0,0	0,0	0,0	0,0	0,0	459,9
	Stock per year (TWh/a)	10,0	50,2	0,0	0,0	0,0	0,0	0,0	60,2

Figure 4: Assessment spreadsheet with main data inputs

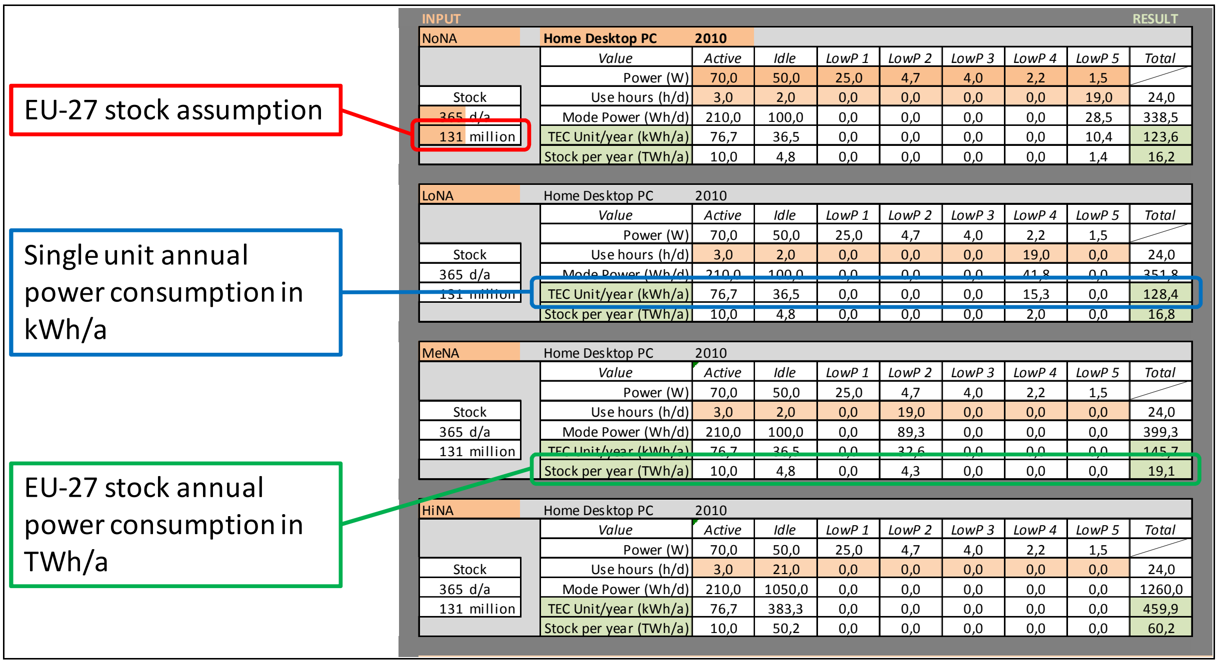
The assumed power consumption levels for each mode are based on averaged data for products that are currently in the market. In the development scenarios for the year 2020 we generally consider an improvement of single mode power consumption by about 20%.

Rationale for 20% general improvement assumption: The general 20% improvement assumption had been subject of discussion following the publication of the draft report. Some stakeholders were worried that this 20% improvement assumption is already a requirement. This is of cause not the case. Our intention was to be realistic. The past ten years show a dramatic improvement in power consumption due to the increasing efficiency of electronic components (e.g. Moore's Law), higher system integration and power management. Nevertheless we recognize that active mode power consumption may further increase due to the performance requirements of processors and displays.

Typical energy consumption of single products: In order to calculate the annual electricity consumption we made assumptions for daily use patterns by defining time durations (hr) per mode per day. If possible we consider existing power management requirements (standby/off) and practice (e.g. IE) in the assumptions.

5.2.4.2 Annual Electricity Consumption Assessment

The primary objective of the spreadsheet is the calculation of the annual electricity consumption. We calculate the annual electricity consumption of each product group both per single unit and per the EU-27 installed base (see Figure 5 below).



NoNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	0,0	0,0	0,0	19,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	0,0	0,0	0,0	28,5	338,5
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	0,0	0,0	0,0	10,4	123,6
	Stock per year (TWh/a)	10,0	4,8	0,0	0,0	0,0	0,0	1,4	16,2

LoNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	0,0	0,0	19,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	0,0	0,0	41,8	0,0	351,8
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	0,0	0,0	15,3	0,0	128,4
	Stock per year (TWh/a)	10,0	4,8	0,0	0,0	0,0	2,0	0,0	16,8

MeNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	2,0	0,0	19,0	0,0	0,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	100,0	0,0	89,3	0,0	0,0	0,0	399,3
131 million	TEC Unit/year (kWh/a)	76,7	36,5	0,0	32,6	0,0	0,0	0,0	145,7
	Stock per year (TWh/a)	10,0	4,8	0,0	4,3	0,0	0,0	0,0	19,1

HiNA	Home Desktop PC 2010								
	Value	Active	Idle	LowP 1	LowP 2	LowP 3	LowP 4	LowP 5	Total
	Power (W)	70,0	50,0	25,0	4,7	4,0	2,2	1,5	
Stock	Use hours (h/d)	3,0	21,0	0,0	0,0	0,0	0,0	0,0	24,0
365 d/a	Mode Power (Wh/d)	210,0	1050,0	0,0	0,0	0,0	0,0	0,0	1260,0
131 million	TEC Unit/year (kWh/a)	76,7	383,3	0,0	0,0	0,0	0,0	0,0	459,9
	Stock per year (TWh/a)	10,0	50,2	0,0	0,0	0,0	0,0	0,0	60,2

Figure 5: Assessment spreadsheet showing results

Annual typical energy consumption (TEC): The single unit annual energy consumption is given in kWh/a, and indicates a value that can be compared to the Typical Electricity Consumption (TEC) method of the Energy Star Program, for example. For some products we used the TEC values as an orientation for an appropriate correlation of the selected use pattern and power consumption level per mode.

The EU-27 annual energy consumption is given in TWh/a. This value is strongly influenced by the available stock data. We cross check the stock assumptions with the household and office penetration rates in order to verify their plausibility. We conclude that this method can only indicate the order of magnitude of networked standby related energy consumption.

5.3 Product-specific Inputs and Environmental Impact Assessments

Note: The individual assessment of 21 selected product cases including all scenarios (input tables and impact assessments) are covered in separate documents in the annex to this report). The following table lists the selected product cases as well as the selected scenarios for the base cases.

Table 1: Selected Product Cases for Environmental Impact Assessment

Item No.	Product Category	Selected Scenarios 2010	Selected Scenarios 2020
1	*Home Desktop PC*	LoNA	MeNA
2	*Home Notebook*	LoNA	MeNA
3	*Home Display*	LoNA	MeNA
4	*Home NAS*	MeNA	MeNA
5	*Home IJ Printer*	LoNA	LoNA
6	*Home EP Printer*	LoNA	LoNA
7	*Home Phones*	HiNA	HiNA
8	*Home Gateway*	MeNA	HiNA
9	*Simple TV*	LoNA	LoNA
10	*Simple STB*	LoNA	LoNA
11	*Complex TV*	LoNA	MeNA
12	*Complex STB*	LoNA	MeNA
13	*Simple Player/Recorder*	LoNA	LoNA
14	*Compl. Player/Recorder*	LoNA	MeNA
15	*Game Consoles*	LoNA	MeNA
16	*Office Desktop PC*	LoNA	MeNA
17	*Office Notebook*	LoNA	MeNA
18	*Office Display*	LoNA	MeNA
19	*Office IJ Printer/MFD*	LoNA	MeNA
20	*Office EP Printer*	LoNA	MeNA
21	*Office Phones*	HiNA	HiNA

5.4 EU-Totals and Life Cycle Costs

5.4.1 Selection of an Economy-Wide Base Case

In this subtask we summarize and evaluate the aggregated results from the individual product cases for each of the network availability scenarios for the reference year 2010 and the prognosis year 2020. The following Figure 2 shows the selected product scenarios in an overview.

Table 2: Selected Product Scenarios for Environmental Impact Assessment

Item No.	Product Category	Selected Scenarios		Active		Idle		LowP1		LowP2		LowP3		LowP4		LowP5		Total		Total without Active	
		2010	2020	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020	2010	2020
1	*Home Desktop PC*	LoNA	MeNA	10,04	8,77	4,78	4,18	0,00	0,00	0,00	3,77	0,00	0,00	2,00	0,00	0,00	0,00	16,82	16,71	6,78	7,94
2	*Home Notebook*	LoNA	MeNA	2,07	3,23	0,92	1,44	0,00	0,00	0,00	1,88	0,00	0,00	0,66	0,00	0,00	0,00	3,64	6,55	1,58	3,31
3	*Home Display*	LoNA	MeNA	3,86	3,59	0,00	0,00	0,00	0,00	0,65	1,26	0,00	0,00	0,00	0,00	0,22	0,00	4,72	4,85	0,86	1,26
4	*Home NAS*	MeNA	MeNA	0,44	1,07	0,22	0,53	0,00	0,00	0,69	1,69	0,00	0,00	0,00	0,00	0,00	0,00	1,35	3,30	0,91	2,23
5	*Home IJ Printer*	LoNA	LoNA	0,09	0,08	0,42	0,38	0,00	0,00	0,44	0,39	0,00	0,00	0,79	0,70	0,00	0,00	1,75	1,55	1,66	1,47
6	*Home EP Printer*	LoNA	LoNA	0,09	0,10	0,08	0,09	0,00	0,00	0,07	0,08	0,00	0,00	0,24	0,27	0,00	0,00	0,49	0,55	0,40	0,45
7	*Home Phones*	HiNA	HiNA	0,46	0,54	3,96	4,61	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	4,43	5,15	3,96	4,61
8	*Home Gateway*	MeNA	HiNA	4,17	5,52	4,22	11,17	0,00	0,00	2,53	0,00	0,00	0,00	0,00	0,00	0,00	0,00	10,92	16,69	6,75	11,17
9	*Simple TV*	LoNA	LoNA	67,28	34,48	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	5,61	2,87	0,00	0,00	72,88	37,35	5,61	2,87
10	*Simple STB*	LoNA	LoNA	4,41	2,87	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,09	1,36	0,00	0,00	6,50	4,24	2,09	1,36
11	*Complex TV*	LoNA	MeNA	4,38	28,73	0,00	14,37	0,00	0,00	0,00	0,00	0,00	0,00	0,29	0,96	0,00	0,00	4,67	44,06	0,29	15,32
12	*Complex STB*	LoNA	MeNA	4,49	4,95	0,00	3,13	0,00	0,00	0,00	0,00	0,00	0,00	1,14	0,63	0,00	0,00	5,63	8,71	1,14	3,76
13	*Simple Player/Recorder*	LoNA	LoNA	2,55	1,52	0,68	0,41	0,00	0,00	0,00	0,00	8,42	5,03	0,00	0,00	0,00	0,00	11,65	6,96	9,10	5,44
14	*Compl. Player/Recorder*	LoNA	MeNA	0,77	2,51	0,22	0,72	0,00	0,00	0,00	4,79	0,00	0,00	0,22	0,00	0,00	0,00	1,20	8,02	0,44	5,51
15	*Game Consoles*	LoNA	MeNA	2,74	2,98	2,28	14,89	0,00	0,00	0,00	0,00	0,00	0,00	0,37	0,20	0,00	0,00	5,38	18,07	2,65	15,09
16	*Office Desktop PC*	LoNA	MeNA	6,05	5,64	2,16	2,02	0,00	0,00	0,00	0,95	0,00	0,00	0,48	0,00	0,00	0,00	8,68	8,61	2,64	2,96
17	*Office Notebook*	LoNA	MeNA	1,94	2,35	0,65	0,78	0,00	0,00	0,00	0,54	0,00	0,00	0,24	0,00	0,00	0,00	2,84	3,67	0,89	1,32
18	*Office Display*	LoNA	MeNA	2,16	2,45	0,00	0,00	0,00	0,00	0,19	0,44	0,00	0,00	0,00	0,00	0,06	0,00	2,42	2,89	0,26	0,44
19	*Office IJ Printer/MFD*	LoNA	MeNA	0,19	0,15	0,38	0,30	0,00	0,00	0,29	0,76	0,00	0,00	0,25	0,00	0,00	0,00	1,10	1,21	0,91	1,06
20	*Office EP Printer*	LoNA	MeNA	1,73	1,46	0,69	0,58	0,00	0,00	0,28	0,78	0,00	0,00	0,45	0,00	0,00	0,00	3,15	2,83	1,43	1,37
21	*Office Phones*	HiNA	HiNA	0,43	0,39	1,80	1,63	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	2,23	2,02	1,80	1,63
	total:			120,34	113,40	23,46	61,23	0,00	0,00	5,15	17,33	8,42	5,03	14,82	6,99	0,28	0,00	172,48	203,98	52,14	90,58

The Base Case consists of a comparison of the EU-total annual energy consumption of 21 selected product cases scenarios with the reference year 2010 and the prognosis year 2020. This is a sufficient number of products for the base case assessment and we estimate about 75% of the possible product scope for networked standby. The selected product case scenarios considered the general trend towards:

- Higher number of networked equipment (more complex products)
- Increase demand of network services (an increase in network availability in general)
- More power management utilization (Note: this aspect is shown later in the study)

The development scenario is due to the assessment model not necessarily a plausible real-life scenario. A real-life scenario would need to distinguish different network availability levels between individual products and product groups. In other words, the selected scenarios are not showing functional power management implementations. We explained at the beginning of this task report; for the assessment of networked standby we needed a more structured approach that breaks the complexity of the real-life situation. Nevertheless, some product groups such as imaging equipment (e.g. printers) and personal computers (e.g. notebooks) feature and implement sophisticated power management schemes. We covered the existing good practice to some extent in our scenarios.

5.4.1 Base Case Analysis

The Figure 6 below shows the aggregated EU-totals for the selected scenarios of all products.

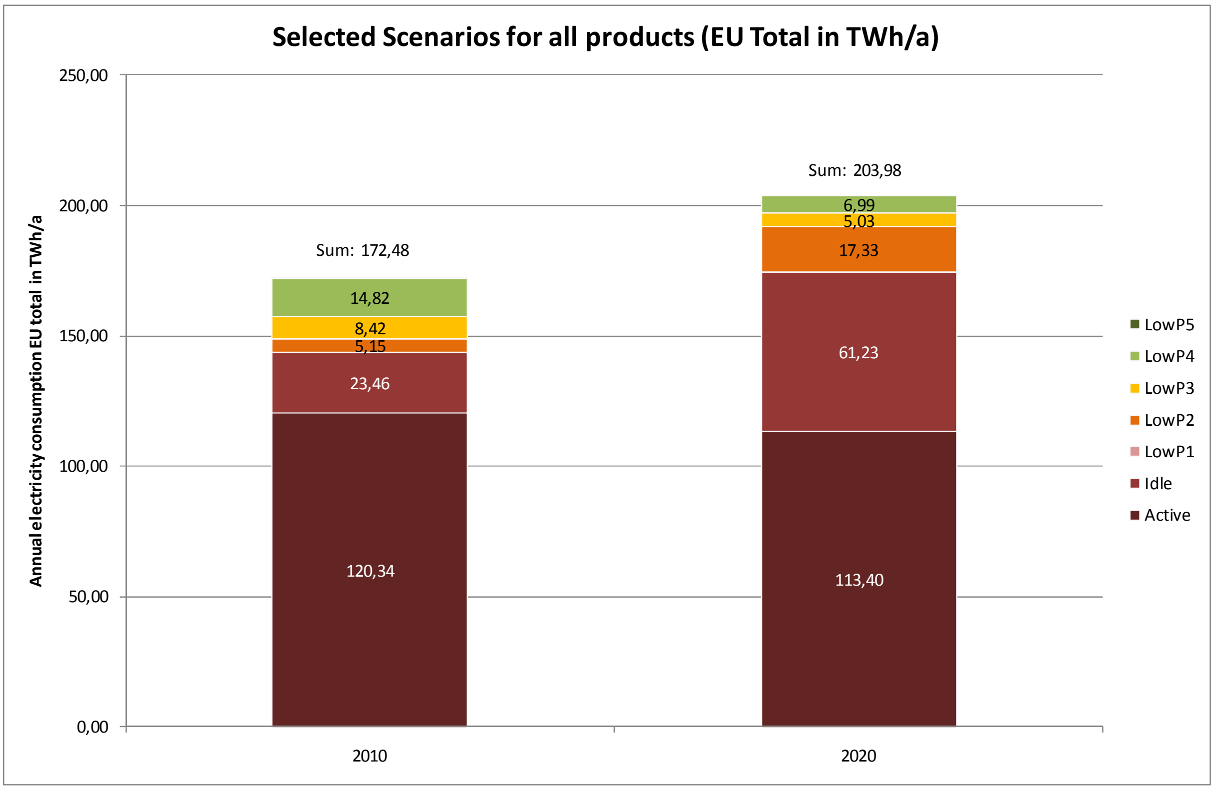


Figure 6: Aggregated Product Scenarios (EU-Totals)

The 2010 selected aggregated scenario reflects a situation where medium and high network availability is less often employed. Most products are put into a sleep or low power mode (standby/off) when not actively used. The overall annual power consumption is 172 TWh (terawatt hours). A total of 52 TWh is related to non-active use of which about 50% is related to existing low power modes.

The horizontal comparison of the 2010 scenarios with the 2020 scenarios shows an overall increase in total power consumption from 172 TWh in 2010 to 204 TWh in 2020. This considerable growth is a result of our basic assumption that the demand of network availability will increase. This is insofar an interesting result even under our much discussed assumption of a general 20% improvement with respect to the mode-specific power consumption in 2020. The 2020 scenario indicates the impact of idle mode which increases from 23 TWh in 2010 to 61 TWh in 2020. One reason for this increase is the shift to medium and high network availability in specific product groups which currently do not feature an appropriate power management (low power modes). Another reason is the increase stock of the complex (networked) product groups.

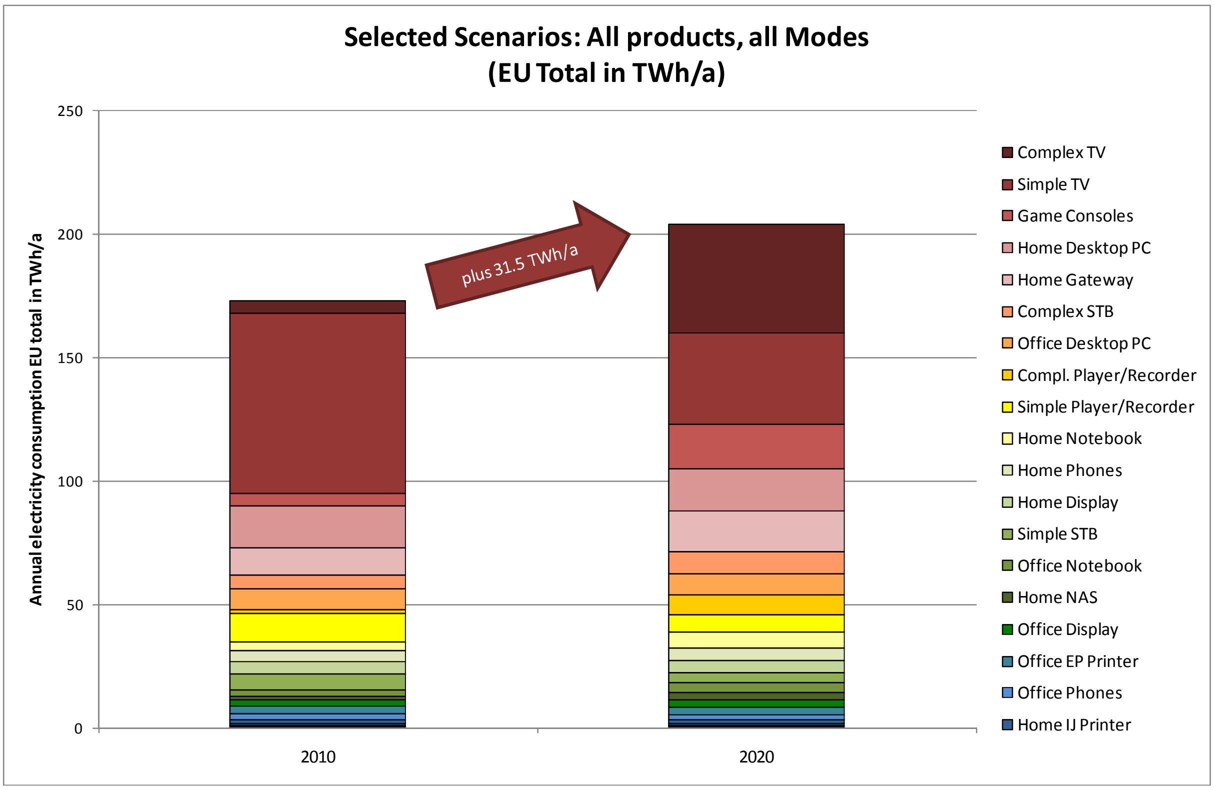


Figure 7: Selected scenarios summarizing energy consumption of all products

The Figure 6 above provides a detailed – product by product – distinction of total energy consumption. The annual energy consumption increases in total by 31.5 TWh. It is not surprising that TVs, Game Consoles[3], and PCs are the most energy intensive product groups. This is due to their high average active power consumption and considerable long daily utilization. The increasing number of home gateways, the only networking equipment for which stock figures have been available, is another growing product segment. Complex Set-Top-Boxes and Media Player/Recorder are another product segments that need attention.

[3] Industry stakeholders have indicated that it is important to distinguish between devices which are capable of high-definition gameplay and those which are not as the former tend to have much higher levels of energy consumption.

The following Figure 8 showing the same listing of the products energy consumption but without that active mode, is for the purpose of the networked standby environmental impact analysis better suited.

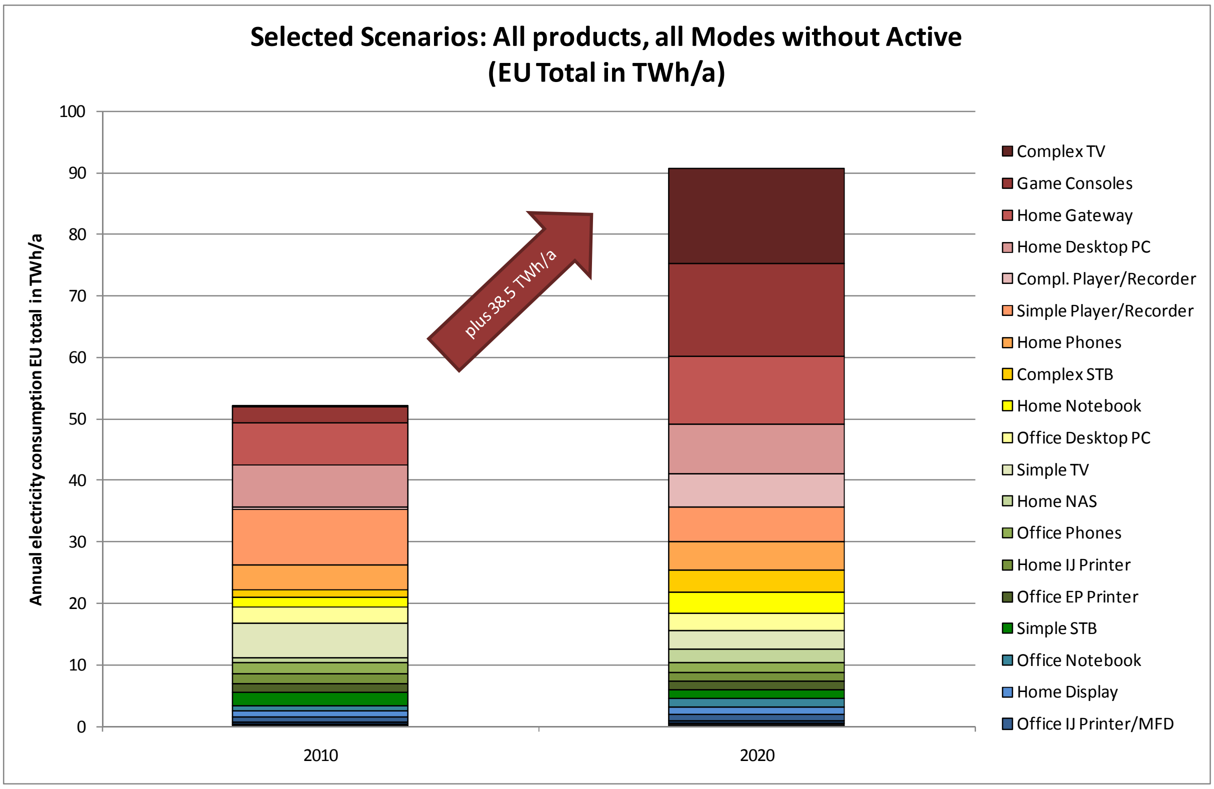


Figure 8: Selected scenarios summarizing all products without active mode

This diagram shows not only the significance of the non-active mode but also a somewhat different ranking of the product cases. The currently missing power management option of Complex TVs and Game Consoles are significant and indicate already an improvement potential. The home gateways, although our assumptions for active and idle are moderate, show an overall impact of more than 10 TWh. Interesting is the overall development. The energy consumption without active mode increases significantly from about 52 TWh in 2010 to over 90 TWh in 2020. We consider this difference not necessarily as the full spectrum of an improvement potential, but the calculation clearly indicates the room for improvement.

Note: For an individual analysis of the selected product case we encourage the reader to study the individual documents in the annexes. In addition to the stock level assessment, please also compare the changes in the single unit's annual energy consumption (TEC) in the different network availability scenarios. This might help to get a more realistic and detailed understanding of the causal relationships between power consumption per mode, daily use pattern, and the positive impact of an ambitious power management.

5.4.2 Energy Impact and Costs

The cost of electricity per kWh was covered in Task 2: The price of electricity in each of the EU-27 Member States is listed in Table 2-10, as well as an EU-27 average. To account for the trend of increasingly expensive electricity, this task will use 0.20 €/kWh[4] as the average EU-27 electricity price. Figure 9 below shows the aggregated electricity costs for all product groups according to the selected scenarios.

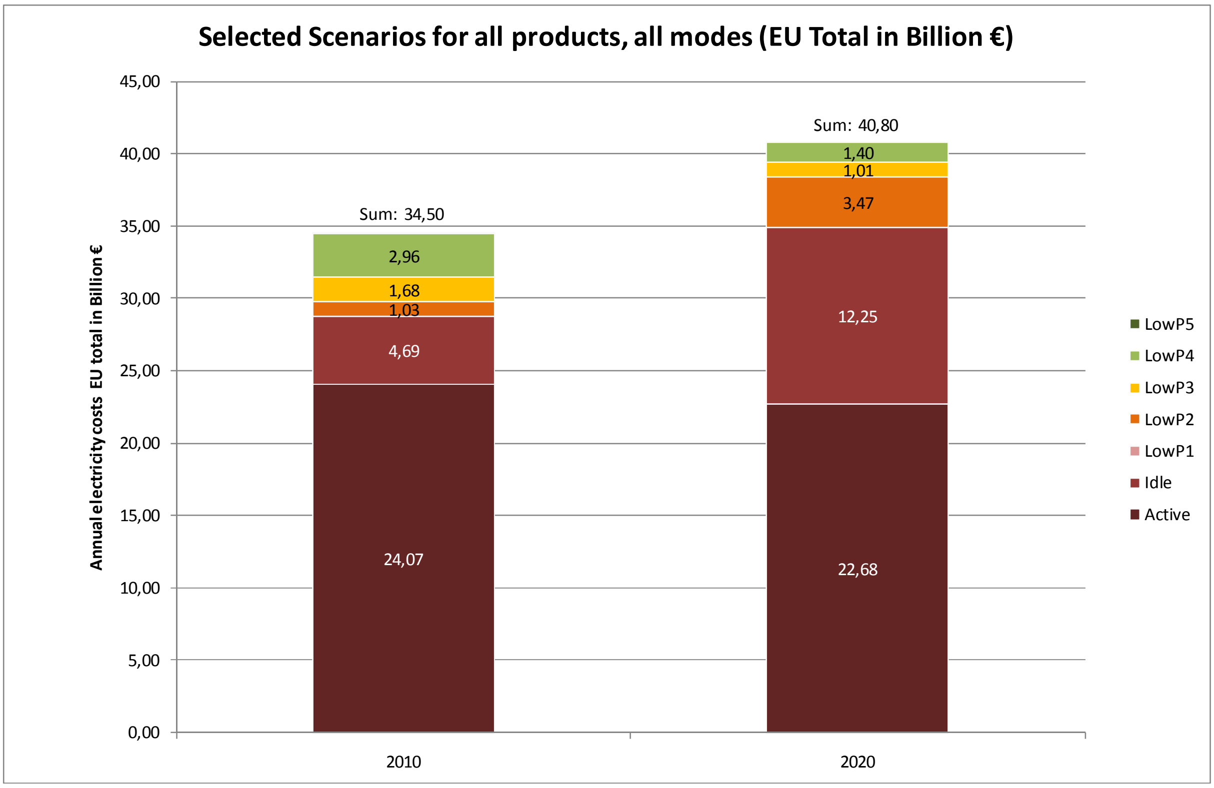


Figure 9: Electricity costs under the selected scenarios in all modes (in Billion EUR)

Considering only the selected scenarios and corresponding power modes for each of the base cases, we calculated that the 2010 scenario total electricity consumption is about 172 TWh. This is equivalent to:

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[4] 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 and in 2020 to 44.9 billion €/a.

- An electricity cost factor of 34.5 Billion EUR (LoNA 2010)
- Global Warming Potential (GWP100) of 80 Million Tons CO2eq.[5]

In comparison, the total electricity consumption of the 2020 scenario is 204 TWh, which is equivalent to:

- An electricity cost factor of 40.8 Billion EUR (MeNA 2020)
- Global Warming Potential (GWP100) of 95 Million Tons CO2eq

Given the dominance of active mode in these diagrams (representing approximately 24 Billion EUR and 23 Billion EUR in 2010 and 2020, respectively), the exclusion of that mode provides a more detailed look at the total costs incurred by each of the low-power modes. This is shown in Figure 10.

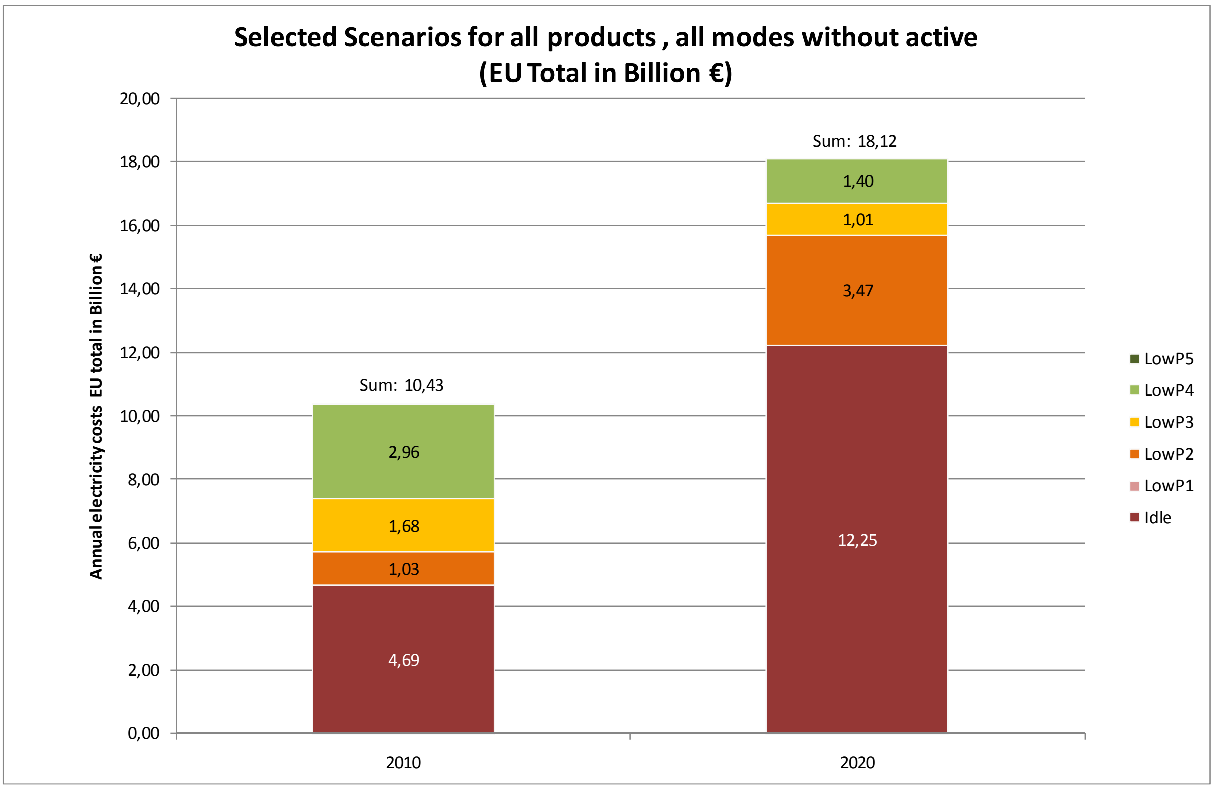

Figure 10: Electricity costs under the selected scenarios, without active mode (in Billion EUR)

As Figure 10 demonstrates, the impact of idle and the low mode in 2020 are significant not only in environmental terms, but also in financial terms as well, representing a cost of approximately 18 Billion EUR annually to citizens of the EU-27. The cost of this network

[5] Calculated based on MEEuP EcoReport 2005

availability, where the device is not actively used, is roughly equivalent to 35 EUR per inhabitant per year.[6]

5.4.3 Impact Assessment and Conclusions

At this point we like to summarize and discuss the results of the base case assessment. For the purpose of this impact assessment we selected 21 product groups. Based on a comparison with the reference study TREN Lot 6 "Standby and off-mode" losses we estimate that the selected product groups represent about 75% of the product scope that need to be considered horizontally with respect to networked standby.

For each product group we developed harmonized scenarios reflecting different levels of network availability. In the selected base case we assumed that the demand for network availability will increase between 2010 and 2020. The HiNA scenario of all product case would demonstrate a worst case situation. But this is very unrealistic. We therefore considered a moderate increase in network availability demand for the 2020 development scenario.

The single scenarios have been calculated based on a set of mode assumptions (power/use) reflecting averaged product configurations and use patterns. We calculated the single unit's annual energy consumption differentiating active and low power modes. We also calculated the annual energy impact for EU-27 total product stock. The distinction of various modes helped to analyze different levels of network availability (networked standby). Through this approach we tried to indicate that networked standby is a multi-mode issue.

The results of these scenarios and the aggregated base case indicated that the business-as-usual case of growing network availability requires more energy. High network availability is currently often related to prolonged idle mode. Low power modes with equal functionality do not exist in all product groups. Notebook computers and printers, however, are good examples which show that power management is able to support high product performance and network availability with acceptable energy consumption.

With respect to the selected base cases, the energy consumption of Idle and the other low power modes accounts together for about 90 TWh per year or about 44% of total annual energy consumption. This is a considerable amount of energy. The low power modes excluding idle mode remain in our selected scenario 30 TWh almost constant. This reflects some existing good power management practice. The considerable growth in idle mode on the other hand is a strong indicator for further improvement potential.

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[6] Based on a projected EU-27 population of approximately 514 Million in 2020. Source: Eurostat.

A part of idle mode is certainly caused by the user requirement for prolonged network availability, and if no convenient low power mode with a similar capability is offered, many more products would remain in idle in the future. Networking-type and server-type products such as home gateways, telephones, desktop computers, but also the growing number of media consumer electronic products are examples, which require a substantial amount of energy for network availability. If these products would remain active/idle all the time, then the environmental impact would drastically increase. Network availability needs to be addressed holistically and with respect to all power states.

In order to show a rough order of magnitude of the impact related to networked standby (and possible overhead to our 21 product cases) we can make the following calculation. If we assume that in 2020 each household in the EU-27 (205 million) runs an additional device with about 6W (networked standby) over 24h per day throughout the year (395 days) the resulting energy consumption would amount to 10.8 TWh. If we furthermore assume that each office (85 million) runs a similar device throughout the year another 4.5 TWh would be required. These figures alone indicate an additional 15 TWh per year overhead to our existing case studies.

The scenarios finally demonstrate that a discussion and improvement of energy consumption related to networked standby requires a distinction of networked availability levels (e.g. through QoS requirements for individual products) and to some extent a product by product approach. In order to improve energy efficiency with respect to networked standby a consistent utilization of functional low power modes is clearly an option. The availability of respective functional low power modes – modes that allow the wake-up over the network – is however the first precondition. We have seen that such options exist in some product sectors. Secondly, the employment of such functional low power modes has to be realized by an advanced power management scheme. With respect to the individual product cases it also becomes apparent that the overall product performance, which is characteristically reflected by the power demand of active and idle, will influence the power consumption levels in support of higher network availability.

Against that background we would like to conclude this assessment and formulate a first tentative differentiation for the further work. We consider a distinction of “high”, “medium”, and “low” network availability as very important and useful analytical tool. Particularly high network availability (idle) and to some extent medium network availability are product-specific issues with a large technological spectrum, individual network services and field of application. Products associated to high and medium network availability should be addressed, where possible, in a vertical way in order to improve efficiency.

A consequent powering-down to low network availability should also be considered for many products that maintain higher availability due to insufficient power management and interoperability. Low network availability, as an additional mass phenomenon, is less product-specific and could more directly be addressed in a horizontal way. In Task 4 we have investigated some of these product developments in conjunction with smart home and multimedia. Lower component costs and miniaturization basically allows creating network availability for many products. The important aspect for the utilization of such capability is the network service that a product provides (to the end user or service provider). With respect to eco-design it is necessary to find a balance between network availability and overall energy consumption.

The BAT analysis and the improvement options will strengthen the points of proper power management and of implementing (new) network availability states, which are not effectively constant idling. When idle mode is the only or the most convenient mode to satisfy the user requirements (be it real, instant network access or the faint possibility of a remote access at some undefined point) we are approaching the worst case scenario (HiNA) with a tremendous increase in energy consumption. Technologically, the same or a very similar product reaction should already be possible at much lower power levels.

The further steps of the study will show the improvement potentials in this area. However, an approach towards new products (that are currently not covered vertically) should be developed as well. This objective is in the clear interest of the study.