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Lot 26: Networked Standby Losses

Final Report Task 2
Economic and Market Analysis

Contractor: Fraunhofer Institute for Reliability and Microintegration, IZM

Department Environmental and Reliability Engineering

Dr.-Ing. Nils F. Nissen

Gustav-Meyer-Allee 25, 13355 Berlin, Germany

Contact: Tel.: +49-30-46403-132

Fax: +49-30-46403-131

Email: nils.nissen@izm.fraunhofer.de

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Fraunhofer IZM

bio Intelligence Service

Authors:

Dr. Nils F. Nissen, Fraunhofer IZM

Dr. Lutz Stobbe, Fraunhofer IZM

Kurt Muehmel, Bio Intelligence Service

Shailendra Mudgal, Bio Intelligence Service

Additional Contributions:

Karsten Schischke, Fraunhofer IZM

Sascha Scheiber, Fraunhofer IZM

Dr. Andreas Middendorf, Technische Universität Berlin and Fraunhofer IZM

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.

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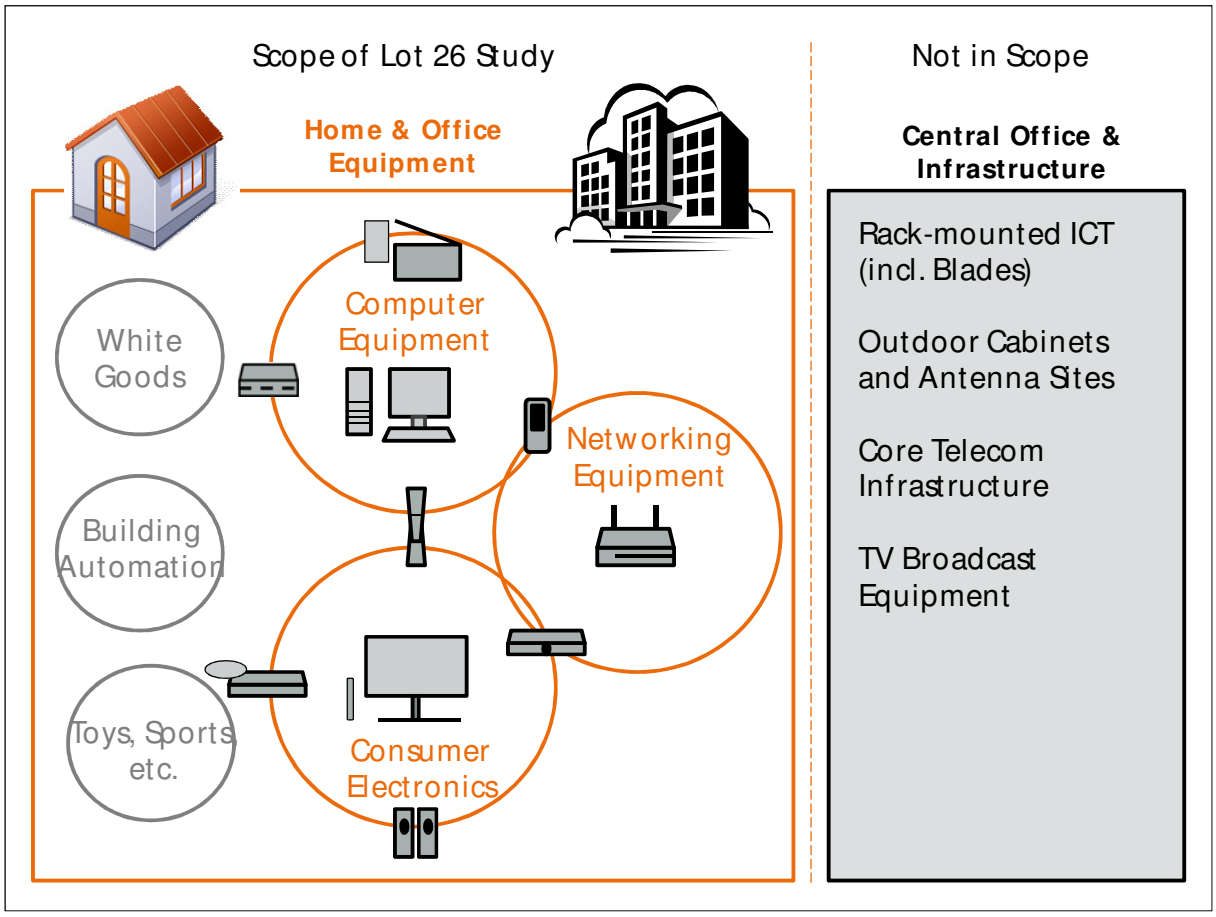
2 Task 2: Economic and Market Analysis

2.1 Generic economic analysis

The general objective of Task 2 is to place the technical scope that has been defined in the first task within the total of the European Union's economy. This means that it is now necessary to select and parameterize a representative product scope for the purpose of calculating the order of magnitude of networked standby power consumption. In this task we create the basic quantity structure for this assessment. We will obtain data for the installed base of products for a given geographical scope and time frame. The study's geographical scope is EU-27. The study's time frame is fixed by the reference year 2010 and extends to the year 2020. A longer reaching forecast is not feasible due to the dynamics of the market and technology development.

Figure 2-1: Product categorization for quantity structure



In order to create the quantity structure adequately we have to find a balance in the selection of representative product groups between the technical diversity and economical importance of the existing real-life product scope and future developments. The technical diversity is affecting the product's power consumption parameters, field of application, and typical use patterns. The economic impact is indicated by the total number of products at a certain point of time in the market (product stock in EU-27 at a specific reference year). Furthermore we have to consider to some extent the average lifetime of a product because this indicates changing parameters.

Figure 2-1 above (page 4) shows the selected product categories for the quantity structure. The quantity structure is focusing on mass market standalone (non-rack) networking equipment, computer equipment, and consumer electronic products that are typically applied in private homes and enterprise offices. Altogether the following 21 individual product groups have been selected for the environmental assessment.

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

Networked standby applies to a wider product scope. This includes e.g. white goods, toys, sports equipment and networked building automation equipment.[1]

The market data for the selected product scope have been obtained from open sources. The stock assumptions have been to some extent already discussed with industry stakeholders. Nevertheless, further input concerning market data is highly appreciated. As a matter of fact market statistics are usually not fully comprehensive and adequate for the purpose of this study. Our own assumptions are necessary particularly with respect to the required forecasts. In general it is difficult to verify available market data. In order to check the plausibility of the stock data we correlate the number of products with the number of households and offices. In this way we check the installed base of products against the resulting penetration rate.

Table 2-1: Basic economic data

EU-27	Unit	2010	2015	2020
Households*		**Reference**	Estimates	Estimates
Number of Households	in Million	**202**	203	205
Total Population	in Million	**500**	504	508
Offices**				
Office Work Spaces	in Million	**75**	80	85
Labor Force	in Million	**225**	227	230
Electricity Price***				
Average for Households	€/100 kWh	**16,73**	18,76	20,45
Average for Industry	€/100 kWh	**10,29**	11,54	12,58
*EUROSTAT (Data in Fokus 31/2009): Population and social conditions; Households forecast based on population projections (EUROPOP2008) and constant factor 2,48 (persons per household)				
**EUROSTAT Labor Market Statistics; Assumption that 33% (2010), 35% (2015), and 37% (2020) of total labor force is working in office work places.				
***EUROSTAT (Data in Fokus 25/2009): Environment and energy; Electricity price forecast has been estimated on a 2% increase per year				

Table 2-1 provide an overview of the basic economic data for the study. The data include the number of households (and respective population) as well as the number of office work spaces (and respective work force) within the European Union. These figures have been obtained from various EUROSTAT publications. Another basic economic data set is related to the environmental impact assessment and its primary focus on annual electricity demand. The economic assessment will relate the electricity consumption (kWh) to a cost factor

[1] In order to keep the coming analysis manageable, not all possible product groups covered by the scope of the project are analysed in detail. The product groups which have been analysed have been selected so as to represent a broad range of products while covering approximately 75% of the total scope.

(€/100 kWh). The assessment of EU production, import and export figures, annual sales, and apparent consumption has no value for the study and are therefore exempted from the analysis.

2.2 Market and stock data

2.2.1 Home Computer

Table 2-2: Stock assumptions for categories Home Computer

EU-27 Households (in Mio)	**Reference**	Estimates	Estimates	**202 M**	203 M	205 M
Home Computer	**Installed Units (Stock in Million)**			**Household Penetration Rate (%)**		
Year	**2010**	2015	2020	**2010**	2015	2020
Desktop PC	**131**	142	143	**65**	70	70
Notebook PC	**63**	91	123	**31**	45	60
Computer Display	**141**	152	164	**70**	75	80
NAS Storage Device	**20**	41	61	**10**	20	30
IJ-Printer/MFD	**76**	80	84	**38**	39	41
EP-Printer/MFD	**5**	6	7	**2**	3	3

Desktop PC:

- Definition: A computer where the main unit is intended to be located in a permanent location, often on a desk or on the floor. Desktops are not designed for portability and utilize an external computer display, keyboard, and mouse.[2] This product group also contains Integrated Desktop Computer, a desktop system in which the computer and computer display function as a single unit which receives its ac power through a single cable.[3]
- Stock assumption has been based on [TREN Lot 3, 2007][4] and [ICTEE, 2008].[5] The calculated penetration rate of 65% taken as a cross reference is 15% lower than for displays. This installed base seems feasible if we take into account that a larger number of notebook users also facilitate an additional larger flat panel display and that there is not a 1:1 ratio of desktop PC to computer display. Forecast has been based on the assumption that the household penetration will moderately increase until 2015. The market indicates already a wide diversity of products in a range between small servers, workstations or gamer PC on the high performance end and notebooks, sub-notebooks, thin clients on the lower performance end.

[2] Definition according to Energy Star Program Requirements for Computers (Version 5.0)
[3] Definition according to Energy Star Program Requirements for Computers (Version 5.0)
[4] [TREN Lot 3, 2007]: EuP Study on Computers and Monitors, 2007; http://www.ecocomputer.org
[5] [ICTEE 2008]: Impacts of Information and Communication Technologies on Energy Efficiency, 2008; ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/sustainable-growth/ict4ee-final-report_en.pdf

Notebook PC:

- Definition: A computer designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an ac power source. Notebooks must utilize an integrated computer display and be capable of operation off of an integrated battery or other portable power source. In addition, most notebooks use an external power supply and have an integrated keyboard and pointing device. Notebook computers are typically designed to provide similar functionality to desktops, including operation of software similar in functionality as that used in desktops.[6]
- Stock has been again based on [TREN Lot 3, 2007][7] and [ICTEE, 2008].[8] Notebook PCs are a more rapidly growing market segment with higher diversity performance and price. This trend could lead to a much faster increase of the installed base. However, for the purpose of this study we consider a more conservative development.

Computer Display:

- Definition: A display screen and its associated electronics encased in a single housing, or within the computer housing (e.g., notebook or integrated desktop computer), that is capable of displaying output information from a computer via one or more inputs, such as a VGA, DVI, Display Port, and/or IEEE 1394.[9]
- Stock assumption has been based on [TREN Lot 3, 2007][10] and [ICTEE, 2008][11]. The current penetration rate of almost 80% seems realistic taking the fact into account, that 65% of households use the Internet. Forecast reflects further dissemination of Desktop PC, other computing equipment and the trend to utilize more than one display. Household penetration rate is reaching about 100% by 2020. Further increase might be slowed by faster dissemination of Notebooks, Thin clients and the use of larger TV-displays.

[6] Definition according to Energy Star Program Requirements for Computers (Version 5.0)
[7] [TREN Lot 3, 2007]: EuP Study on Computers and Monitors, 2007; http://www.ecocomputer.org
[8] [ICTEE 2008]: Impacts of Information and Communication Technologies on Energy Efficiency, 2008; ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/sustainable-growth/ict4ee-final-report_en.pdf
[9] Definition according to Energy Star Program Requirements for Computers (Version 5.0)
[10] [TREN Lot 3, 2007]: EuP Study on Computers and Monitors, 2007; http://www.ecocomputer.org
[11] [ICTEE 2008]: Impacts of Information and Communication Technologies on Energy Efficiency, 2008; ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/sustainable-growth/ict4ee-final-report_en.pdf

Network Attached Storage (NAS):

- Definition: A NAS unit is a computer connected to a network that only provides file-based data storage services to other devices on the network. NAS systems contain one or more hard disks, often arranged into logical, redundant storage containers or RAID arrays.[12]
- Actual market data have not been available from public sources. Stock and forecast estimates have been based on simple assumption regarding current and future household penetration rate.

IJ-Printer/MFD:

- Definition: This product category combines single function printer, copier or multifunctional devices with Ink-Jet (IJ) marking technology. Product and technology definitions according to Energy Star Program Requirements for Imaging Equipment.
- Stock data have been again slightly modified from [TREN Lot 4, 2007][13] and [ICTEE, 2008] in order to distinguish between home and office use. The installed base seems again a little bit low. Comparing the combined number of Desktop PCs and Notebook PCs (290 units in 2010) with the combined number of EP- and IJ-Printer/MFDs (81 units in 2010) a factor 3.5 results and a 40% household penetration rate respectively. The data should be checked by industry stakeholder.

EP-Printer/MFD:

- Definition: This product category combines single function printer, copier or multifunctional devices with Electro Photography (EP) marking technology. Product and technology definitions according to Energy Star Program Requirements for Imaging Equipment.
- Stock data have been slightly modified from [TREN Lot 4, 2007][14] and [ICTEE, 2008] in order to distinguish between home and office use. According to these figures the installed base and penetration rate seem quite low. The data should be checked by industry stakeholders.

2.2.2 Home Gateway + Network

Home gateway and network products include many different technologies which serve the same functional purpose. For example, gateways may provide a network connectivity via a

12 Wikipedia: Network-attached storage; http://en.wikipedia.org/wiki/Network-attached_storage
13 [TREN Lot 4, 2008]: EuP Study on Imaging Equipment, 2007; http://www.ecoimaging.org
14 [TREN Lot 4, 2008]: EuP Study on Imaging Equipment, 2007; http://www.ecoimaging.org

number of different transmission technologies (e.g. DSL, cable, optical or wireless). As such, we have grouped these different technologies into two broad product groups, Home Phones and Home Gateways, as shown in Table 2-3. These groups aggregate the sub-totals of the specific technologies (shown in grey in the table).

Stock assumptions are explained for each of the technologies in the paragraphs below, while deeper analysis in later sections is done at the level of the aggregated groups, Home Phones and Home Gateways.

Table 2-3: Stock assumptions for categories Home Gateway / Phone

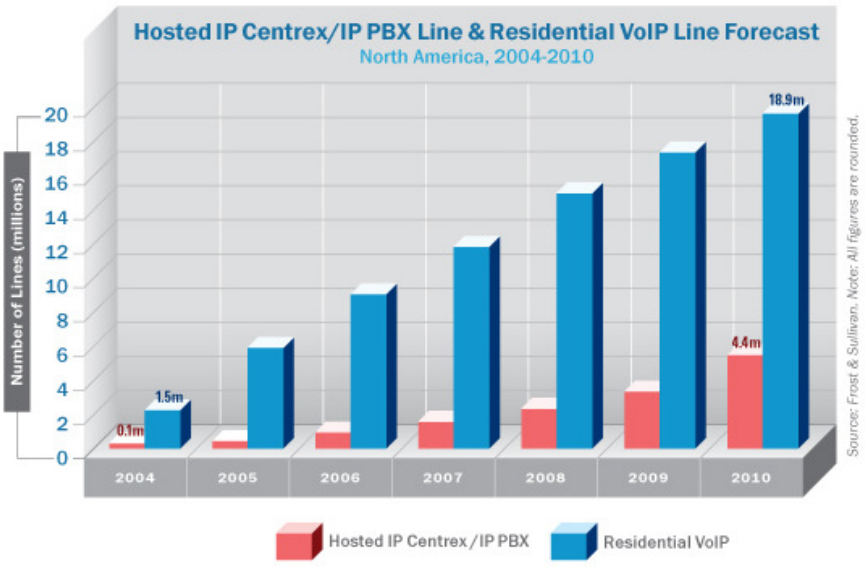
EU-27 Households (in Mio)	**Reference**	Estimates	Estimates	**202 M**	203 M	205 M
Home Gateway + Network	**Installed Units (Stock in Million)**			**Household Penetration Rate (%)**		
Year	**2010**	2015	2020	**2010**	2015	2020
Home Phones	**141**	177	205	**70**	87	100
Phone / DECT	**121**	126	123	**60**	65	60
VoIP-Phone	**20**	51	82	**10**	25	40
Home Gateway	**136**	179	225	**67**	88	110
DSL Gateway (ADSL, VDSL)	**66**	71	82	**33**	35	40
Cable-TV Gateway (DOCSIS	**61**	71	61	**30**	35	30
Optical Gateway (FTTH)	**7**	31	61	**3**	15	30
Wireless Gateway (WiMAX)	**2**	6	20	**1**	3	10

Telephone/Digital Enhanced Cordless Telecommunications (DECT):

- Definition: A commercially available electronic product with a base station and a handset whose purpose is to convert sound into electrical impulses for transmission. Most of these devices require an external power supply for power, are plugged into an ac power outlet for 24 hours a day, and do not have a power switch to turn them off. To qualify, the base station of the cordless phone or its power supply must be designed to plug into a wall outlet and there must not be a physical connection between the portable handset and the phone jack. Product and technology definitions according to Energy Start Program Requirements for Telephony.
- Stock based on [ICTEE, 2008]. Data given for 2010 and 2020, interpolated for 2015.

Voice over Internet Protocol (VoIP)-Telephone:

- Definition: A DECT telephone designed to make phone calls using VoIP.
- Stock and forecast are based on office penetration rate assumptions.



DSL Gateway:

- Definition: Customer Premises Equipment (CPE) for Internet access over phone line (ADSL, VDSL services). The product usually features various (local area) network interfaces.
- Stock: Installed base has been estimated based on EUROSTAT data regarding broadband access in the EU (status 07/2009)[15]. According to this source, the broadband access penetration rate (number of broadband lines per 100 populations) is 23.9. There are in total 94 million DSL access lines and 25 million broadband access lines (non-DSL). Of this last number 18 million are Cable modems and 7 million approximately optical fibre lines. This figure does not indicate the number of home gateways yet. Retail lines are the main wholesale access for new entrants with 71.4% of DSL lines. We make the assumption that 70% of the 94 million DSL lines are end user access point. This would mean that there are 66 million DSL gateways installed. Future development has been based on the assumption that DSL will maintain a main access technology and slightly increase in the next ten years. Optical technologies will however limit the increase in the long term. Based on these considerations we assume a maximum household penetration rate of 40% or 82 million units as installed base in 2010.

15 http://ec.europa.eu/information_society/eeurope/i2010/docs/interinstitutional/cocom_broadband_july09.pdf

Cable-TV Gateway:

- Definition: Customer Premises Equipment (CPE) for access to Cable-TV (modem) and for broadband access (Triple Play Services) via DOCSIS (Data over Cable Service Interface Specification). The product can feature various (local area) network interfaces.
- Stock: Installed base has been estimated based on "ASTRA Reach 2009" market report.[16] According to this report approximately 30% of households in Europe receive TV and Internet services via TV-Cable. Future development has been based on two assumptions. In the short term the number of the installed base will slightly increase (35% household penetration rate) due to good price to broadband ratio. In the midterm however the stock declines due to availability and more capable fibre-to-the-home and wireless broadband access solutions.

Optical Gateway:

- Definition: Customer Premises Equipment (CPE) or optical network termination for Internet access via Fire-to-the-Home (FTTH). The product usually features various (local area) network interfaces.
- Stock: In July 2009 a total of 120 million fixed broadband lines have been counted by EUROSTAT. According to the FTTH Council Europe only 1.75% of all fixed lines in Europe are currently Fibre-to-the-Home (+40% year-on-year). For this study we assume a slightly higher penetration rate of 3% for the reference year 2010. In the midterm we expect a strong increase of FTTH. Our forecast for 2015 and 2020 are based on household penetration rate assumptions.

Wireless Gateway:

- Definition: Broadband cellular mobile modems or routers which provide wireless access via cellular mobile communication technology such as UMTS, HSPA, LTE. These devices can be integrated into personal computers and notebooks or come as external cards or even larger standalone devices.
- There have been no market data available. Stock and forecast are assumptions.

[16] Internet download (2009-12-03): http://www.international-television.org/archive/astra_satellite_monitor_europe_2009.pdf

Figure 2-2: VoIP Line Forecast

2.2.3 Home Entertainment

Table 2-4: Stock assumptions for categories Home Entertainment

EU-27 Households (in Mio)	**Reference**	Estimates	Estimates	**202 M**	203 M	205 M
HOME Entertainment	**Installed Units (Stock in Million)**			**Household Penetration Rate (%)**		
Year	**2010**	2015	2020	**2010**	2015	2020
Simple TV	**384**	325	246	**190**	160	120
Simple STB	**151**	162	123	**75**	80	60
Complex TV (integrated DVB	**20**	81	164	**10**	40	80
Complex STB	**82**	82	123	**41**	41	60
Simple Player/Recorder	**233**	203	174	**115**	100	85
Game Console	**67**	83	64	**33**	41	31

Television:

- Definition: A commercially available electronic product designed primarily for the reception and display of audiovisual signals received from terrestrial, cable, satellite, Internet Protocol TV (IPTV), or other digital or analogue sources. A TV consists of a tuner/receiver and a display encased in a single enclosure. For the purpose of this study a distinction is made between Simple TVs (TVs that are used in conjunction with a Set-Top-Box) and Complex TVs (TVs that feature and utilize an integrated DVB tuner/receiver.
- Overall stock assumption has been based on [TREN Lot 5, 2007][17]. Data was given for years 2005, 2010 and 2020. An interpolation was used for the year 2015 between 2010 and 2020. We assume an average of two devices per household. The number of Complex TVs will grow continuously over the next years. At the same time the number of Simple TV and Simple STBs will decline.

Simple Set-Top Box (STB):

- Definition: A stand-alone device whose primary function is converting standard-definition (SD) or high-definition (HD), free-to-air digital broadcast signals to analogue broadcast signals suitable for analogue television or radio, has no “conditional access” function, and offers no recording function based on removable media in standard library format. Product and technology definitions according to EC Regulation 107/2009/EC.

[17] [TREN Lot 5, 2007]: EuP Study on Televisions, 2007; http://www.ecotelevision.org/

- Stock for the reference year 2010 based on [TREN Lot 0, 2007][18]. Data extrapolated from EU-25 to EU-27 based on 2005 population. According to TREN Lot 0 Simple STBs are expected to be obsolete by 2025. We are not following this assumption and rather assume that Simple STBs will remain in the market for considerable amount of time. Replacement will start after 2020 with mass utilization of IPTV.

Complex Set-Top Box / Media Centre:

- Definition: A set-top box that allows conditional access. A set-top box is a stand-alone device, using an integral or dedicated external power supply, for the reception of Standard Definition (SD) or High Definition (HD) digital broadcasting services via IP, cable, satellite, and/or terrestrial transmission and their conversion to analogues RF and/or line signals and/or with a digital output signal. Product and technology definitions according to [TREN Lot 18, 2008].

- Stock based on [TREN Lot 18, 2008][19]. The data was given for 2010, 2015 and 2020 in the report. In the long term we assume a different trend than the one assumed in Lot 18. We assume that complex STBs and so called Media Centre or Digital Media Receiver are merging. This new converging product group will have a high market penetration. A digital media receiver is a device that connects to a home network using either a wireless or wired connection. It includes a user interface that allows users to navigate through a digital media library, search for, and play back media files. The device is connected to a TV using standard cables.[20]

Simple Player/Recorder:

- Definition: A stand-alone device whose primary function decodes video to an output audio/video signal (from recorded or recordable media via a powered or integrated media interface such as an optical drive USB or HDD interface), has no tuner unless it records on a removable media in a standard library format, is mains powered, does not have a display for viewing, and is not designed for a broad range of home or office applications. Product and technology definitions according to ENTR Lot 3 Draft Task 1-5.

- Stock based on [Draft ENTR Lot 3, ongoing][21]. The data of the stock of the UK was given in the ENTR Lot 3 report, as shown in Figure 2-3 below. The UK market for electronics typically represents 18% of the total EU-27 for electronics. The EU totals have been calculated accordingly. It is questionable if this type of media will really

[18] [TREN Lot 0, 2007] EuP study on Simple Set Top Boxes, 2007.
[19] [TREN Lot 18, 2007] EuP study on Complex Set Top Boxes, 2008. www.ecocomplexstb.org
[20] Modified from http://en.wikipedia.org/wiki/Digital_media_receiver. Accessed 22 Jan 2010.
[21] [ENTR Lot 3, ongoing] EuP study on sound and imaging equipment www.ecomultimedia.org

decline in the predicted way. We therefore adjusted the figures to a slower decline by a correlation to the household penetration rate.

Game Console:

- Definition: A standalone computer-like device whose primary use is to play video games. Game consoles use a hardware architecture based in part on typical computer components (e.g., processors, system memory, video architecture, optical and/or hard drives, etc.). The primary input for game consoles are special hand held controllers rather than the mouse and keyboard used by more conventional computer types. Game consoles are also equipped with audio visual outputs for use with televisions as the primary display, rather than (or in addition to) an external or integrated display. These devices do not typically use a conventional PC operating system, but often perform a variety of multimedia functions such as: DVD/CD playback, digital picture viewing, and digital music playback. Handheld gaming devices, typically battery powered and intended for use with an integral display as the primary display, are not covered by this specification.[22]
- Stock and forecast has been based on ENTR Lot 3 report.
- As recognised in the ENTR Lot 3 report, there is a wide variation in the consumption levels of game consoles currently on the market due to the differences in processing power required to provide standard- or high-definition video output. Industry stakeholders have also commented that a distinction between two classes of game consoles (based on whether the device supports standard- or high-definition video output) would be useful. Please see Annex 15 of the Task 5 report for a full discussion of the assumptions made in this report.

[22] Check ENTR Lot 3 http://www.ecomultimedia.org

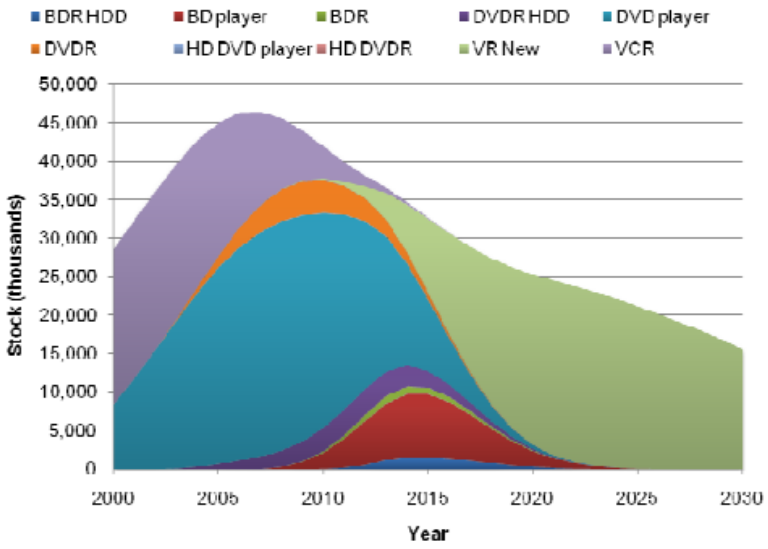


Figure 2-3: UK market for video/disk-player/recorder

2.2.4 Office Computer + Network

Table 2-5: Stock assumptions for categories Office Computer

EU-27 Office Workplace (in M	**Reference**	Estimates	Estimates	**75 M**	80 M	85 M
Office Computer + Network	**Installed Units (Stock in Million)**			**Office Penetration Rate (%)**		
Year	**2010**	2015	2020	**2010**	2015	2020
Desktop PC	**60**	64	70	**80**	70	60
Notebook PC	**45**	64	68	**60**	70	80
Computer Display	**60**	72	85	**80**	90	100
IJ-Printer/MFD	**32**	34	36	**64**	64	65
EP-Printer/MFD	**18**	19	19	**36**	36	35
Phone / DECT	**56**	40	13	**75**	50	15

Desktop PC:

- Definition: A computer where the main unit is intended to be located in a permanent location, often on a desk or on the floor. Desktops are not designed for portability and utilize an external computer display, keyboard, and mouse.[23] This product group also contains Integrated Desktop Computer, a desktop system in which the computer and computer display function as a single unit which receives its ac power through a single cable.[24]

[23] Definition according to Energy Star Program Requirements for Computers (Version 5.0)
[24] Definition according to Energy Star Program Requirements for Computers (Version 5.0)

- Stock assumption has been based on [TREN Lot 3, 2007][25] and [ICTEE, 2008].[26] The forecast assumes a slow increase over time due to increasing number of office work places in the EU-27 (mostly in new member states). In terms of office penetration we assume a decline due to the increasing use of notebooks and thin clients.

Notebook PC:

- Definition: A computer designed specifically for portability and to be operated for extended periods of time either with or without a direct connection to an ac power source. Notebooks must utilize an integrated computer display and be capable of operation off of an integrated battery or other portable power source. In addition, most notebooks use an external power supply and have an integrated keyboard and pointing device. Notebook computers are typically designed to provide similar functionality to desktops, including operation of software similar in functionality as that used in desktops.[27]
- Stock data are considering only to some extent [TREN Lot 3, 2007]. The numbers provided by the older study are not fully plausible. We therefore considered a moderate office penetration rate of 60% for the reference year 2010 and further increase.

Computer Display:

- Definition: A display screen and its associated electronics encased in a single housing, or within the computer housing (e.g., notebook or integrated desktop computer), that is capable of displaying output information from a computer via one or more inputs, such as a VGA, DVI, Display Port, and/or IEEE 1394.[28]
- Stock assumption has been based on [TREN Lot 3, 2007][29] and [ICTEE, 2008].[30]

IJ-Printer/MFD:

- Definition: This product category combines single function printer, copier or multifunctional devices with Ink-Jet (IJ) marking technology. Product and technology definitions according to Energy Star Program Requirements for Imaging Equipment.

[25] [TREN Lot 3, 2007]: EuP Study on Computers and Monitors, 2007; http://www.ecocomputer.org
[26] [ICTEE 2008]: Impacts of Information and Communication Technologies on Energy Efficiency, 2008; ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/sustainable-growth/ict4ee-final-report_en.pdf
[27] Definition according to Energy Star Program Requirements for Computers (Version 5.0)
[28] Definition according to Energy Star Program Requirements for Computers (Version 5.0)
[29] [TREN Lot 3, 2007]: EuP Study on Computers and Monitors, 2007; http://www.ecocomputer.org
[30] [ICTEE 2008]: Impacts of Information and Communication Technologies on Energy Efficiency, 2008; ftp://ftp.cordis.europa.eu/pub/fp7/ict/docs/sustainable-growth/ict4ee-final-report_en.pdf

- Stock data have been again slightly modified from [TREN Lot 4, 2007][31] and [ICTEE, 2008] in order to distinguish between home and office use.

EP-Printer/MFD:

- Definition: This product category combines single function printer, copier or multifunctional devices with Electro Photography (EP) marking technology. Product and technology definitions according to Energy Star Program Requirements for Imaging Equipment.
- Stock data have been slightly modified from [TREN Lot 4, 2007][32] and [ICTEE, 2008] in order to distinguish between home and office use.

Telephone/Digital Enhanced Cordless Telecommunications (DECT):

- Definition: Non-IP telephones systems used in offices
- Stock and forecast are based on office penetration rate assumptions.

[31] [TREN Lot 4, 2008]: EuP Study on Imaging Equipment, 2007; http://www.ecoimaging.org
[32] [TREN Lot 4, 2008]: EuP Study on Imaging Equipment, 2007; http://www.ecoimaging.org

2.3 Market Trends

2.3.1 Introduction

The given objective for this paragraph is the description of market trends with respect to:

- The production structure and typical redesign cycles for the products in scope,
- General product design trends including functional features and configurations,
- Infrastructure and services offered in conjunction with the products (provider services)

In few of the broad product scope that needs to be covered in this “horizontal” study it is obviously difficult to cover all products in detail with respect to the required task. Our approach is to find a balanced between the required task (MEEuP) and the limitations of this study by generalizing market trends on the one hand and providing specific examples on the other hand.

In the following analysis we will start on the infrastructure and service level then work our way over to the product features and configurations and finally down to the component and technology level. The market trends related to our topic are the result of the complex interaction between a dynamic technical development on the one side and new services that can be created based on the available technology level on the other side. The technology development creates new products and services that are provided by the industry. But it is also the customers, who demand certain services based on their perception of technical options.

In addition to the interplay between supply and demand of new products, we must also consider that the addition of a new device to a network brings additional value not only to the individual device, but to the network as a whole. This effect, aptly titled the “network effect”, implies that the increasing number of networked devices is a self-reinforcing process and which will, *ceteris paribus*, tend towards accelerating (exponential) growth.

As such, it is relevant to look into the growth of the Internet traffic in a first step towards understanding the growth of networked devices. The first aspect we are investigating is the growing internet utilization and resulting IP-based and non-IP based data traffic. This trend indicates one important fact with respect to networked standby: The number of network services, networked products and their utilization is increasing rapidly. This general trend leads to the assumption, that products and infrastructures increasingly maintain constant network connections (active links) in order to provide network services on-demand 24 hours per day. The volume and segmentation of IP-based and non-IP-based data traffic is a good indicator of for the demand of a specific network availability level. By analysing the traffic with

respect to provider infrastructure (services) and user (demand), the direction of network communication – and through that the sleep/wake-up dynamics – can be assessed. Depending on the type and direction of traffic, the senders and receivers could implement networked standby functionality in order to save energy. The following paragraph provides some basic market data with respect to the growing internet traffic.

2.3.2 Growing Internet/IP Traffic

Cisco, a world leading network equipment provider, is tracking and forecasting global IP traffic through its Visual Networking Index (VNI)[33]. The VNI is updated every six months, and provides currently a forecast of IP traffic until 2013. The data within this section is extracted from the VNI. Traffic data is given in the unit of petabytes (PB) per year.[34]

[33] http://www.cisco.com/en/US/netsol/ns827/networking_solutions_sub_solution.html#~overview

[34] One petabyte is 1015 bytes. For comparison, one compact disc holds 7 x 108 bytes, and one petabyte of data would be the equivalent of roughly 1.5 million compact discs.

Table 2-6: European IP Traffic, 2008-2013

European IP Traffic, 2008-2013							
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**CAGR 2008-2013**
Consumer Internet Traffic (PB per year)							
Web/Email	5 148	6 720	8 616	10 992	14 184	16 176	26%
File Sharing	12 972	15 816	19 248	24 432	29 364	34 188	21%
Internet Gaming	192	336	384	456	636	708	30%
Internet Voice	516	636	732	816	768	720	7%
Internet Video Communications	108	168	300	612	876	1 320	65%
Internet Video to PC	2 112	5 280	9 540	15 960	23 796	33 288	74%
Internet Video to TV	144	396	1 008	3 132	4 980	6 924	117%
Ambient Video	396	732	2 136	4 956	7 332	10 248	92%
Total	**21 588**	**30 084**	**41 964**	**61 356**	**81 936**	**103 572**	**37%**
Consumer Non-Internet Traffic (PB per year)							
Cable MPEG-2 VoD	3 469	5 285	7 872	11 778	18 070	26 120	50%
Cable MPEG-4 VoD	26	48	73	110	186	281	61%
IPTV VoD	833	1 224	1 655	2 273	3 252	4 315	39%
Total	**4 328**	**6 556**	**9 600**	**14 160**	**21 508**	**30 716**	**48%**
Business IP Traffic (PB per year)							
IP WAN	2 710	3 758	5 181	6 904	8 997	11 683	34%
Internet	5 724	7 786	10 323	13 283	16 803	21 194	30%
Total	**8 433**	**11 544**	**15 504**	**20 187**	**25 800**	**32 877**	**31%**
Mobile Data and Internet Traffic (PB per year)							
Mobile Data and Internet	**132**	**336**	**852**	**2 076**	**4 548**	**8 448**	**130%**
Total (PB per year)							
European IP Traffic	**34 481**	**48 520**	**67 920**	**97 779**	**133 792**	**175 614**	**38%**

According to Cisco VNI the global IP traffic expected to increase by five times from 2008-2013, growing with a compound annual growth rate (CAGR) of 40% from 122 088 PB/yr in 2008 to 667 044 PB/yr in 2013. Table 2-6 above presents IP traffic forecasts on the sub-segment level for the EU[35]. Total European IP Traffic is increasing with a CAGR of 38% from 34 481 PB/yr in 2008 to 175 614 PB/yr in 2013. Of the total traffic 69% of the data traffic is related to the private end-user (consumer) and only 31% to business applications.

A significant portion of this growth will be due to Internet Video and TV services, which requires significant bandwidth for growing picture resolution (HD and 3D). A second major

[35] Data was aggregated from the "Western Europe" and "Central Eastern Europe" categories. This may not necessarily be the EU-27; however, the trends can be safely assumed to be representative of those of the EU-27.

increase will occur in the mobile data transmission, although the actual traffic rates are considerably lower in comparison to the wired services. The following Figure 2-4 present the data of Table 2-6 in visual form.

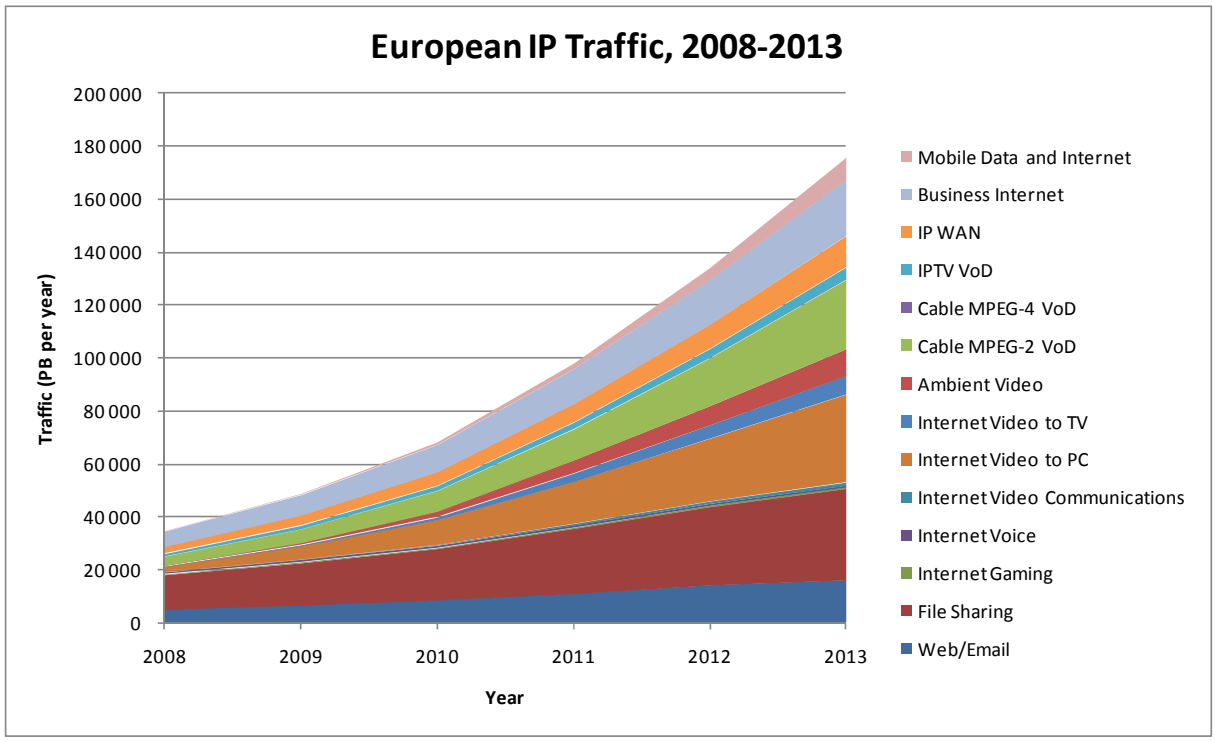


Figure 2-4: European IP Traffic, 2008-2013

Figure 2 5: European IP Traffic comparison, 2009 and 2013compares the IP traffic (volume) from 2009 with that expected in 2013. In terms of volume, File Sharing, Internet-Video-to-PC, and Video-on-Demand have the most significant impact in the coming years followed by business internet and web services.

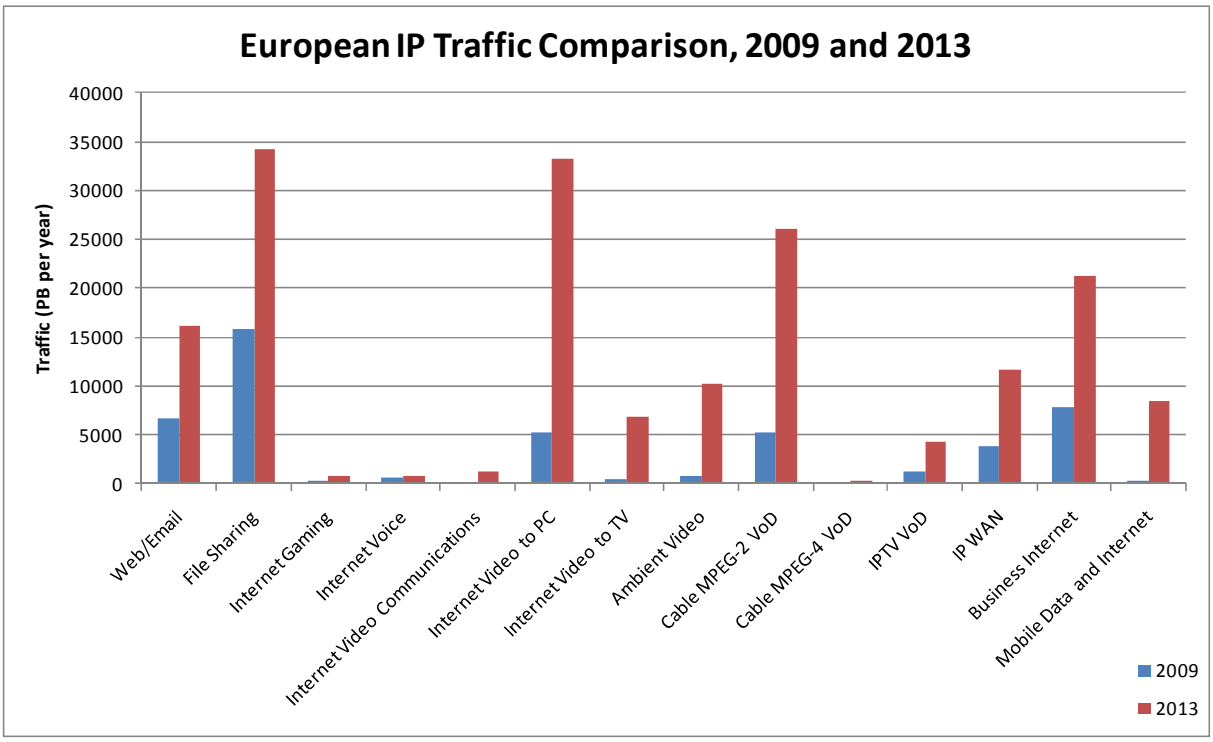


Figure 2-5: European IP Traffic comparison, 2009 and 2013

This data traffic prognosis clearly indicates the significant portion of growth that will be due to B2C services such as Internet Video and TV. This is a typical downstream application for which the current access networks are asymmetrical optimized. But the significant amount of file sharing indicates an increasing C2C traffic with growing symmetrical bandwidth requirement. This also indicates a growing ad hoc remote access demand for instance through Virtual Private Networks. This general development is influencing the network infrastructure and respective services of the provider industry.

2.3.3 Network Provider and Services

The technology and structure of Wide Area Networks, the respective wired and wireless Access Networks (AN) and related Customer Premises Equipment (CPE) will successively adapt to the growing bandwidth requirements by the customers though the utilization of the internet. The demand for symmetrical (wide area) network access in support of basic triple play services (voice, video/TV, and data) will grow from currently about 1Mbit/s to 1Gbit/s and more in the next five to ten years.

At the present the access network market is basically shared by national and regional telecom enterprises including wireless provider as well as Cable and Satellite TV access provider. The network services such as telephone, internet, and television are in some cases provided by the same entity which provide the access network (triple play service). Another trend is that a service (e.g. PayTV) is provided over an existing network access (modem)

with a provider controlled CPE. The service provider administrates the CPE periodically by updating software (e.g. security patches) or uploading Electronic Programme Guides (EPG). The service provider might activate the CPE for this purpose during night time in order to reduce peak traffic during day time and in the early afternoon when most customers activate their TVs. Critical issues for software update are copying protection and interoperability.

Additionally, service providers have significant influence on the design requirements of CPE as well as the ultimate energy consumption of the devices. In the design phase, service providers may require the additional or removal of different components and functionalities which affect the baseline energy consumption of the device. During the use phase, the frequency of communication with the device can affect the real efficiency of the product. As such, close coordination is required between service providers and CPE manufacturers to ensure that the initial design and the use of the device are as efficient as possible.

Thin Clients and Software as a Service (SaaS) are emerging concepts for internet-based computing that is leading to new end-user products. The market for software as a service has been steadily increasing over the past few years. The worldwide market is estimated to be roughly 11 billion USD as of 2009[36]. It is expected that this trend will continue until 2020, as high speed networks and cost efficiency push thin clients and SaaS into the market. These products are basically stripped-off their storage and are mostly used as streaming clients. Although these products are based on network services (application provided through centralized computing and storage) they do not provide their own network service. From our perspective they are not in need of network standby and could be turned off after use. These product concepts however, occur in conjunction with networking equipment (e.g. home gateways) and might be powered in the future over the LAN (Power over Ethernet).[37]

Cloud Computing is a similar concept although many different definitions exist. The network service, we like to draw attention to, is customer-offered file sharing or computing capacity sharing. These types of services might lead to highest network availability demand (external access always possible). Authorization of the access may require complex protocols in order to ensure security and interoperability.

With regard to network based services, it is not necessarily the increase in traffic that is interesting, but rather the energy consumption imposed by this traffic, as well as the impact on the quantity of devices available with networked standby functionality. Each sub-segment is described below with associated devices that are often used to fulfil the function.

[36] http://www.crmlandmark.com/crmlabsindustrytrends.htm

[37] An Example is the "Jack PC EFI-6700" Thin Client powered over Ethernet. For further information: http://www.chippc.com/thin-clients/jack-pc/thin-client.asp?p=jack-pc-6700

Web/Email: includes web, email, instant messaging, and other data traffic (excluding file sharing)

Associated devices:
- Computers
- Displays
- Imaging equipment
- Network access equipment
- LAN networking equipment

File Sharing: includes peer-to-peer traffic from all recognized P2P systems such as BitTorrent, eDonkey, etc.

Associated devices:
- Computers
- Displays
- Network access equipment
- LAN networking equipment

Internet Gaming: includes casual online gaming, networked console gaming, and multiplayer virtual world gaming

Associated devices:
- Computers
- Displays
- Network access equipment
- LAN networking equipment

Internet Voice (VoIP): includes traffic from retail VoIP services and PC-based VoIP, but excludes wholesale VoIP transport

Associated devices:
- Computers
- Displays
- Network access equipment
- Telephone equipment
- LAN networking equipment

Internet Voice (VoIP): includes traffic from retail VoIP services and PC-based VoIP, but excludes wholesale VoIP transport

Associated devices:
- Computers
- Displays
- Network access equipment
- Telephone equipment
- LAN networking equipment

Internet Video Communications: includes PC-based video calling, webcam viewing, and

web-based video monitoring

Associated devices:
- Computers
- Displays
- Network access equipment
- Telephone equipment
- LAN networking equipment

Internet Video to PC: free or pay TV or Video on Demand (VoD) viewed on a PC, excludes P2P video file downloads

Associated devices:
- Computers
- Displays
- Network access equipment
- LAN networking equipment

Internet Video to TV: free or pay TV or VoD delivered via Internet but viewed on a TV screen using a STB or media gateway

Associated devices:
- Network access equipment
- LAN networking equipment
- Set-top boxes
- Televisions

Ambient Video: nannycams, petcams, home security cams, and other persistent video streams

Associated devices:
- Computers
- Displays
- Network access equipment
- LAN networking equipment

Cable MPEG-2 VoD: the standard for the generic coding of moving pictures and associated audio information. Corresponds to ISO/IEC 13818-1:2000.

Associated devices:
- Set-top boxes
- Televisions

Cable MPEG-4 VoD: an update to MPEG-2 that includes further coding standards

Associated devices:
- Set-top boxes
- Televisions

IPTV VoD: a method of delivering television content using Internet Protocol infrastructure

Associated devices:
- Set-top boxes
- Televisions
- Network access equipment
- LAN networking equipment

2.3.4 Product Design and Functional Features

Circuitry design and functional features have an influence on the power consumption and power management options of products. In conjunction with networked standby we observe the following trends:

- Integration of digital functionality on the product and component level
- Increasing network capability and multi-functionality
- Power supply options

With increasing digitalization and miniaturization of information and communication functionality (including data input, processing, storage, transmission as well as output via sound, image, or display) there is now the option to combine any kind of functionality in one product. Multifunctional products are known form the imaging equipment sector, combining scanning, copying, and printing functionality into one device. But with decreasing component prices, the integration of displays, memory capacity, and network options into computing, communication and consumer electronics products is gaining ground. The limiting factors are the size (form factor) and component price (cost factor).

Despite the integration of different functional components on the product level, another trend is a further integration of functionality on a component level. The semiconductor industry is still pushing CMOS technology to smaller structures. Although Moore's Law is slowing and will eventually reach physical limits, the performance trade-off through miniaturization is still a valid trend. The chip-level large scale integration (LSI) is focusing on the monolithic (single chip SoC [System-on-Chip]) or hybrid (multi chip SiP [System-in-Package]) integration of so far separated functionality such as data processing, memory and networking. This trend in component level system integration has two implications:

- Fixed power management design but potentially lower power consumption (per function) through higher integration
- More power management options but potentially higher power consumption (per function) through less system integration.

These LSI trends are particularly noticeable (and advanced) in the computing and networking equipment industry. In the PC sector there are only few vendors (Intel, AMD) providing main processor units including complete chip-set designs. The chip-making industry for network equipment and mobiles is positioned somewhat broader and with a stronger gradient in terms of price and quality. The consumer electronics industry is pushing chip integration as well. This industry (the original equipment manufacturers) is designing their own chips (ASICs) in order to remain independent from the computing industry. As a result, we see many proprietary solutions for signal and data processing in the consumer electronics sector.

A second general trend is the increasing networking capability of products. By adding networking capability (including respective software interfaces) a product can conceivably be designed to serve any role within in a given network architecture (e.g. node, server, client). This creates first of all the dilemma for allocating new (multi-functional) products to a specific product category. It also is difficult to determine the primary or main functionality. Secondly, the interoperability of networked products is in that respect a growing issue. With the development of hybrid home networks for TV/video applications and triple play services the PC-to-CE-to-HG interoperability becomes more complex. In the PC-centered (LAN/WLAN) environment this is less of an issue. But interoperability based on Audio/Video standards seems to be problematic due to the individual system designs based on interoperability initiatives such as DLNA, MoCA, and UPnP.

The last general trend is related to the growing power supply options. Although mains powered devices are still dominant, portable (mains-independent powered by battery, fuel cell, solar,) devices are growing market. Most battery power devices come with an external power supply unit for periodical charging of the device. Some products, despite there are portable, are constantly used with the power supply connected to mains (e.g. notebook in office or home environment). Another trend is power over the network such as Power-over-Ethernet (PoE) and power-over-USB. This is becoming a viable option of supplying power to the equipment. On a practical level there are still some technical limitations and problems with interoperability and power (required voltage levels). Typical examples for such problems are external hard disk drives which are connected and powered over USB.

2.3.5 Industry Structure and Technology Provider

Our analysis is focusing on three major industry sectors including the personally computer industry, the consumer electronics industry and the end-consumer network equipment industry. These industry sectors feature globally distributed hardware and software supply chains.

There are some major industrial players which have a strong influence on the technical level and performance of products. A know example is the personal computer industry, where a few semiconductor enterprise and software houses are determining the technical level and progress of a very large market. The consumer electronics industry is less depended from a few semiconductor makers and software houses. These manufacturers are driving their own technical solutions including the designs of their active components (chips) and software. This situation results in many proprietary solutions. It seems feasible to say, that the considerable standardization regarding power management in the personal computer industry (notebooks and mobiles) is not established to that extent in the CE sector.

The network equipment industry is with respect to the supply chain structure a hybrid of the PC and CE industry. This industry is faced however with another variable. The energy performance and utilization of customer premises equipment is to some extent influenced by external service provider (Access Networks, Cable/SAT-TV). An example is the power management for xDSL access networks. A home gateway typically need to keep the xDSL interface full active, although power management could be implemented if the Network provider would support this feature in the DSLAM (DSL access multiplexer on the curb). As mentioned above, the need for coordination between service providers and OEMs is critical.

2.4 Consumer expenditure base data

The basic consumer expenditure data are listed below. This data will serve primarily as cost inputs when conducting live-cycle analysis in Chapters 5 and 7. The price of electricity in each of the EU-27 Member States is listed in Table 2-7, as well as an EU-27 average. Using a linear regression to project these trends to 2020, a value of approximately 0.21 €/kWh is obtained. So as not to overestimate the cost savings of the proposed implementing measure, this study will use 0.20 €/kWh as the electricity price.

Table 2-7: EU-27 electricity prices[38]

	Price [€/kWh]			
	2007 S02	2008 S01	2008 S02	2009 S01
Austria	0.1834	0.1812	0.1812	0.1874
Belgium	0.1873	0.2153	0.2185	-
Bulgaria	0.0619	0.0619	0.0685	0.0706
Cyprus	0.1436	0.1651	0.1713	0.1192
Czech Republic	0.1968	0.2222	0.2266	0.2251
Denmark	0.1247	0.1430	0.1550	0.1472
Estonia	0.0671	0.0659	0.0688	0.0732
Finland	0.1596	0.1673	0.1770	0.1903
France	0.1849	0.1917	0.1875	0.1331
Germany	0.2313	0.2349	0.2408	0.2498
Greece	0.1086	0.1118	0.0965	0.0959
Hungary	0.1129	0.1333	0.1311	0.1167
Ireland	0.4031	0.3919	0.4298	0.3815
Italy	-	-	-	-
Latvia	0.0694	0.0813	0.0957	0.0957
Lithuania	0.0813	0.0781	0.0782	0.0850
Luxembourg	0.1972	0.1972	0.1991	0.2156
Malta	-	0.1533	-	0.1333
Netherlands	0.2370	0.2360	0.2390	0.2520
Poland	0.1150	0.1370	0.1367	0.1141
Portugal	0.1782	0.3181	0.2710	0.3110
Romania	0.0912	0.0895	0.0915	0.0818
Slovakia	0.1884	0.1902	0.2147	0.1974
Slovenia	0.1657	0.1464	0.1523	0.1944
Spain	0.2424	0.2455	0.2622	0.2540
Sweden	0.2049	0.2022	0.2121	0.1795
United Kingdom	0.1610	0.1523	0.1603	0.1499
EU-27	**0.1887**	**0.1956**	**0.1995**	

[38] Eurostat, Energy, Energy Statistics – prices, Energy Statistics: gas and electricity prices - New methodology from 2007 onwards, Electricity - domestic consumers - half-yearly prices - New methodology from 2007 onwards, accessed 26 Nov 2009.

Table 2-8 lists the interest rate in each of the Member States, as well as the overall EU-27 rate. This study will assume an interest rate of 4.5%.

Table 2-8: EU-27 interest rates[39]

	2006	2007	2008
Austria	3.79%	4.29%	4.27%
Belgium	3.81%	4.33%	4.42%
Bulgaria	4.18%	4.54%	5.38%
Cyprus	4.13%	4.48%	4.60%
Czech Republic	3.80%	4.30%	4.63%
Denmark	3.81%	4.29%	4.30%
Estonia	5.01%	6.09%	8.16%
Finland	3.78%	4.29%	4.30%
France	3.80%	4.30%	4.24%
Germany	3.76%	4.22%	4.00%
Greece	4.07%	4.50%	4.81%
Hungary	7.12%	6.74%	8.24%
Ireland	3.77%	4.31%	4.53%
Italy	4.05%	4.49%	4.69%
Latvia	4.13%	5.28%	6.43%
Lithuania	4.08%	4.55%	5.61%
Luxembourg	3.91%	4.56%	4.61%
Malta	4.32%	4.72%	4.81%
Netherlands	3.78%	4.29%	4.23%
Poland	5.23%	5.48%	6.07%
Portugal	3.91%	4.43%	4.53%
Romania	7.23%	7.13%	7.70%
Slovakia	4.41%	4.49%	4.72%
Slovenia	3.85%	4.53%	4.61%
Spain	3.78%	4.31%	4.37%
Sweden	3.70%	4.17%	3.90%
United Kingdom	4.38%	5.06%	4.51%
EU-27	**4.08%**	**4.57%**	**4.55%**

[39] Eurostat, Interest Rates, Long-term interest rates, Maastricht criterion interest rates, EMU convergence criterion series - Annual data, accessed 26 Nov 2009.

The annual inflation rates are listed in Table 2-9. This study will assume and inflation rate of 3%.

Table 2-9: EU-27 annual inflation rates[40]

	2006	2007	2008
Austria	1.70%	2.20%	3.20%
Belgium	2.30%	1.80%	4.50%
Bulgaria	7.40%	7.60%	12.00%
Cyprus	2.20%	2.20%	4.40%
Czech Republic	2.10%	3.00%	6.30%
Denmark	1.90%	1.70%	3.60%
Estonia	4.40%	6.70%	10.60%
Finland	1.30%	1.60%	3.90%
France	1.90%	1.60%	3.20%
Germany	1.80%	2.30%	2.80%
Greece	3.30%	3.00%	4.20%
Hungary	4.00%	7.90%	6.00%
Ireland	2.70%	2.90%	3.10%
Italy	2.20%	2.00%	3.50%
Latvia	6.60%	10.10%	15.30%
Lithuania	3.80%	5.80%	11.10%
Luxembourg	3.00%	2.70%	4.10%
Malta	2.60%	0.70%	4.70%
Netherlands	1.70%	1.60%	2.20%
Poland	1.30%	2.60%	4.20%
Portugal	3.00%	2.40%	2.70%
Romania	6.60%	4.90%	7.90%
Slovakia	4.30%	1.90%	3.90%
Slovenia	2.50%	3.80%	5.50%
Spain	3.60%	2.80%	4.10%
Sweden	1.50%	1.70%	3.30%
United Kingdom	2.30%	2.30%	3.60%
EU-27	**2.30%**	**2.40%**	**3.70%**

[40] Eurostat, Prices, Harmonized indices of consumer prices (HICP), HICP (2005=100) - Annual Data (average index and rate of change), accessed 27 Nov 2009.

The price of broadband access is shown in Table 2-10. As cost is rapidly decreasing, this study will assume an average price of 25 €/mo for the period 2010-2020.

Table 2-10: EU-27 Average monthly price of 2-4 Mb/s broadband standalone access, 2009[41]

	Price [€/mo]		
	2007	2008	2009
Austria	-	-	43
Belgium	-	-	42
Bulgaria	-	-	35
Cyprus	-	-	102
Czech Republic	-	-	43
Denmark	-	-	23
Estonia	-	-	28
Finland	-	-	34
France	-	-	-
Germany	-	-	-
Greece	-	-	-
Hungary	-	-	25
Ireland	-	-	27
Italy	-	-	-
Latvia	-	-	35
Lithuania	-	-	27
Luxembourg	-	-	29
Malta	-	-	-
Netherlands	-	-	23
Poland	-	-	-
Portugal	-	-	38
Romania	-	-	23
Slovakia	-	-	50
Slovenia	-	-	24
Spain	-	-	-
Sweden	-	-	22
United Kingdom	-	-	-
EU-27	**52**	**37**	**29**

[41] SEC(2009) 1103
http://ec.europa.eu/information_society/eeurope/i2010/docs/annual_report/2009/sec_2009_1103.pdf