European Commission DG TREN

Preparatory Studies for

Eco-design Requirements of EuPs (II)

[Contract N°TREN/D3/390-2006/Lot18/2007/S07.75202]

Lot 18

Complex set-top boxes

Final Report

December, 2008

In association with

Fraunhofer Institut Zuverlässigkeit und Mikrointegration

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Content

0. Preface

The European energy policy in the recent years has been focusing on improving the overall energy efficiency. Its importance on the agenda of the European Commission is demonstrated by recent directives adopted for this purpose viz., Directive on Energy Performance of Buildings (2003), on Promotion of Cogeneration Based on Useful Heat Demand (2004), on Ecodesign for Energy-using Products (Ecodesign Directive) (2005), and Energy end-use Efficiency and Energy Services (2006). In this perspective, the Ecodesign Directive adopts a product based approach and attempts to improve the Energy-using Products (EuPs) of the future from environment and energy efficiency point of view.

Negative impacts of EuPs, like energy inefficiency or other effects on the environment (emissions to air including greenhouse gases, to soil, water consumption, etc.), are well recognised and this has been identified as an area where a large potential for improvement exists. Particularly, the Integrated Product Policy (IPP) approach promotes the idea that requirement on the environmental performance of products should address **all environmental aspects** during **the complete lifecycle** of the product. In this context, Ecodesign Directive is a rather unique initiative which attempts to improve the energy and environmental performances of the products at the same time and that from the design phase itself, while taking into account the market, consumer, and all other stakeholders' interests, and effectively moving in the direction of sustainable development.

One of the very important feature of the Ecodesign Directive is the development of implementing measures for improving priority products (i.e. where currently significant impacts exist and there is a significant improvement potential). All relevant stakeholders are involved in the legislation (implementing measures) making process from the very beginning by the means of preparatory studies.

A preparatory study is the first step in identifying and recommending ways to improve the environmental performance of the product throughout its life cycle during the design phase.

The present study focuses on the lot 18 of the preparatory studies relating to complex set-top boxes1 (STBs).

1 In simple language, a set-top-box is a device that connects to a television and some external source of signal, turns the signal into content, and then displays it on the screen.

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1. Task 1 – Definition

The objective of this task is to discuss definition and scope issues related to the lot 18 EuP preparatory study. It consists of categorisation of products, description of product definitions, scope definition as well as identification of key parameters for the selection of relevant products to perform detailed analysis and assessment during the next steps of the study.

Harmonised test standards and additional sector-specific procedures for product-testing are also identified and discussed, covering test protocols for:

- Primary and secondary functional performance parameters
- Resource use (energy, etc.) during product-life
- Safety (electricity, EMC, stability of the product, etc.)
- Other product specific test procedures.

Finally, this task targets to identify existing legislations, voluntary agreements, and labelling initiatives at the European Union (EU) level, in the Member States, and outside Europe.

1.1. PRODUCT CATEGORY AND PERFORMANCE ASSESSMENT

The objective of this sub-task is to understand set-top boxes (STBs) from the functional point of view and classify them into appropriate sub-categories. This is the first step in defining the broad scope of the study.

In order to understand the evolution of STBs, it is essential to understand the developments in the services for which it is needed, i.e. television broadcasting and more recently broadband internet access.

- **Television broadcasting – evolution from analogue to digital, static to interactive**

Interactive television (ITV) allows the viewer to interact with the television set beyond changing channels, controlling volume, and handling videotapes. Digital television (DTV) is the transmission of television signal using digital rather than conventional analogue methods. Development of these two technologies started rather independently and resulted in Interactive digital television (IDTV), i.e. digital TV signal transmission, which includes interactivity enabling elements. Interactivity can be achieved either by using a service locally (remote control – set-top-box) or by connecting to return channel. In this way the passive viewer increasingly becomes an active user.

Most of the TVs still being analogue in the 90s, it was impossible for the viewers to watch digital content on an analogue TV. This gave birth to one of the first STBs in the form of decoders that transform the digital signal to an analogue. Very quickly, TV providers realised those decoders could be used as an interactive TV platform. As they could send more data using digital signals, they used this opportunity to send extra information, extra services, and to create interactivity.

Currently, IDTV enables wide variety of interactivity for users. For example, sports programmes may offer online betting services during games and races where the end user is able to make instant bets as events evolve. Interactive TV advertising provides various ways for interaction between user and advertiser, e.g. ordering additional information and product samples via return channel, participation to competitions or giving feedback to the advertiser.

Today, most consumers watch digital television via a STB, which decodes the digital signals into signals that analogue televisions can understand. From 2006, leading TV manufactures have started to integrate this function as digital tuners into the television sets itself. However, different tuners are needed depending on the source of television broadcast (terrestrial, cable, satellite, etc.).

- **Transmission platform of media content delivery**

There are four different ways to transmit the digital TV signal to the viewers depending on transmission platform. These are terrestrial (DVB-T), satellite (DVB-S), cable (DVB-C), and internet.

- In terrestrial Broadcasting, the media signal is transmitted via air and it requires an aerial for receiving the signal.
- Cable Broadcasting system is rather expensive to set up but flexible. It supports both analogue and digital TV and is usually a pay-TV network: for a monthly or yearly subscription, users can be connected to the cable and receive the signal. If the signal is analogue, users do not need equipment besides TV (some cable operator may provide the STB for securing their content). If the signal is digital, users need a set-top box transforming the signal from digital to analogue (in case the TV set is analogue).
- For Satellite Broadcasting, the signal is broadcasted (often encrypted) by the media content provider to the satellite that transmits it back to earth. The viewers need a satellite dish antenna to receive the signal and a STB to control the access to the signal (to decrypt the encrypted signal). The signal can be analogue or digital.
- IPTV (Internet Protocol TV) is also an emerging distribution model for TV content. IPTV utilises Internet connection for both distributing the content and for return channel purposes.

“Combo” STBs also exist which are compatible with more than one transmission platform.

- **Set-top Box**

A STB[2] is a device that connects to a television and some external source of signal, and turns the signal into content then displayed on the screen.

The signal source might be a satellite dish antenna, a coaxial cable (cable television), a telephone line (including DSL connections), Broadband over Power Line, an ethernet or optical fibre cable (IPTV), or a VHF or UHF antenna.

Content, in this context, could mean any or all of video, audio, internet web pages, interactive games, or others.

STBs exist in various forms, however they share a common set of characteristics:

- As their name indicates they sit on "top" of a TV "set," or more pragmatically they are connected to the TV set using analogue or digital connectors. They can potentially be connected to Home Theatre systems to offer optimal sound, while still being connected to a TV set for the video part.
- They are connected to a transmission medium (satellite, cable, terrestrial, or internet) from which they receive content.
- They are usually a part of the media content service (and often leased/given by the service operator to the consumer) on the contrary to most other consumer electronic devices which the consumer buys on his own choice.

Bush et al. provide another sub-categorisation for STBs[3]:

1. FTA receivers (free-to-air) - With these very basic models it is only possible to receive non-encrypted programmes. They do not have any slots for subsequent expansion.
2. Receivers with a smartcard or common interface slot - These mid-range devices are equipped with at least a smartcard slot or conditional access module slot and are capable of receiving encoded channels. The same functionality might be provided through a secure micro chip in the STB.
3. Recorders (personal video recorders or PVRs) - These high-end models are capable of recording programmes on an integrated hard disk, and are usually equipped with card readers for smartcards or integrated encryption systems.

Category (1) above clearly covers “simple STBs” and category (2) “complex STBs”. STBs of category (3) are even more sophisticated, but can be considered “complex” for the purpose of this study, if they fulfil additional criteria besides recording (see definitions in § 1.1.1).

In terms of the services provided, STBs can be categorised as follows[4]:

1. Access to Free To Air broadcast programs (same free program for all users)

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2 Before cable-ready TV sets, a set-top box known as a cable converter box was used to receive analogue cable TV channels and convert them to video that could be seen on a regular TV. Nowadays, cable converter boxes are used to descramble premium cable channels and to receive digital cable channels.

3 Eric Bush et al., *Measurement of the power consumption of set-top boxes, S.A.F.E. and HTW Chur*, Swiss Federal Office of Energy (SFOE), Final report, May 7, 2007

4 Following a stakeholder comment

2. Access to Pay TV broadcast programs
3. Access to full Video on Demand (VoD) programs with several levels of interactivity (real VoD, near VoD, push VoD)
4. Access to other services such as voice (telephone) and data

STBs providing services of category (1) only are “simple STBs”, those providing services of category (2) and (3) are “complex STBs”, and STBS used for services of category (4) will very likely have some kind of triple-play business concept, i.e. TV with conditional access, making these STBs to fall under “complex STB” category as well.

- **Convergence of products**

An important phenomenon in STBs is the trend towards ‘converged’ products, in which multiple functions - which previously may have been the exclusive purpose of one product type - are combined in a single multi-function device. Examples include STBs that combine services, such as digital video recording (DVR) that has historically been in separate units, and set-top STBs boxes with integrated data modems. Lately, an increasing crossover with the ICT products has been observed and there are PC-Digital TV add-in card which provide the STB functionalities to the computer.

- **Interactivity functionality**

A return channel is needed for interactivity functions, sometimes also referred to as “red button” interactive TV, but this is not a differentiation criterion for simple vs. complex STB. Some basic interactive TV functions can be implemented even without a return-path, in which case ‘interactivity’ is provided by the data pre-pushed to the STB (e.g. weather forecasts, Electronic Programme Guide). Currently, there is no standard definition of “red button” type interactive television at both EU and local levels. Interactive television is defined by trade body AFDESI[5] as “a service that allows the viewer to interact with the television content or programme”. To define interactivity, AFDESI suggests that the user action must have a result on the screen.[6]

Table 1-1 provides an overview of technical options for interactive TV and different transmission platforms, viz. internet, cable, satellite, terrestrial.

- **Data Decryption**

Many digital TV services are encrypted and can only be accessed using a viewing card which allows decryption of the signals. Access to services can be constrained for a number of reasons: broadcasting rights are usually bought only for specified territories; regionalisation of programming and advertisements; and revenue collection for Pay-TV services. STBs, initially used only for digital to analogue conversion, currently provide an effective means to implement various levels of decryptions. Such implementations add further complexities to the design and often require the STB to stay in some type

[5] Association Française des Développeurs, Editeurs et Fournisseurs de Services en Télévision Interactive (www.afdesi.org)

[6] European Commission, Screen Digest Ltd, CMS Hasche Sigle, Goldmedia Gmbh, Rightscom Ltd (Hrsg.): Interactive content and convergence: Implications for the information society, 10/2006. p. 85

of power consumption mode (for the purpose of programme and firmware updates) even when they are not being used and nobody is watching television.

1.1.1. Definitions

Key definitions related to functions that are used in the context of complex STBs:

- VoD (Video on Demand): Possibility for a user to request his TV provider to start a video for him on a chosen time, on his TV and only for him.
- T-commerce: E-commerce like service, but instead of the computer, the TV is the interface.
- Pay per view: Similar to VoD, it is the possibility for the user to watch a video that the TV provider broadcast. The difference is that the TV provider decides which movie and when it starts and the same video is accessible by any paying user.

Table 1-1: Interactive television: Feasibility and status for the different platforms[7]

		Transmission platform			
		Internet	Cable	Satellite	Terrestrial
Functionality	Interactivity • VoD • t-commerce	⇧ return path integrated	⇨ return path requires network upgrade	⇩ hybrid option only	⇩ not available (hybrid)
	Addressability • Pay-TV bouquets • Pay per view • Customer relation	⇧ direct access to every customer	⇧ direct access to every customer	⇧ direct access to every customer, but with hybrid option only	⇨ dominated by free-to-air
	Capacity • many programmes • HDTV channels • Additional services	⇨ "last mile" limited	⇧ highest capacity	⇧ highest capacity	⇩ very limited capacity
Services	Pay-TV • subscriptions • PPV / VoD	⇨ Pay-TV and VoD possible, but technical constraints	⇧ Pay-TV and VoD possible, customer addressable	⇨ Pay-TV and VoD possible, but technical constraints	⇨ Pay-TV and VoD possible, but technical constraints
	Telephony	⇧ Basic service for IPTV customers	⇨ Problems with fragmented NE3/NE4	⇩ Not relevant	⇩ No possible application
	Internet	⇧ Basic service for IPTV customers	⇨ Problems with fragmented upgrade NE3/NE4	⇩ Low consumer acceptance; dominated by hybrid options	⇩ Only through hybrid options, not realised yet

⇧ Functionality and services enabled / realised
⇨ Functionality and services can be implemented under certain conditions
⇩ Functionality and services not provided / with severe technical restrictions

Two types of product related definitions are essential for this study: definitions of the product group and possible sub-categories and the definitions of various power modes.

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[7] Adapted from K. Goldhammer, M. Schmid, C. Stockbrügger, *Zukunft der TV-Übertragung*, Berlin, August 2007, Goldmedia GmbH

1.1.1.1 Product Definitions

Following definitions for STBs are used in existing legislation, labels, and voluntary agreements:

- **EU Code of Conduct (CoC)**[8]
  - Complex STB

According to CoC, any STB with conditional access is a complex STB." However, it does not make reference to "always-on" functions and thus STBS with such functions can be considered to be covered by the CoC. Nevertheless, these functions could be associated to both, "simple digital TV converter boxes" or "complex STBs".

- **California Energy Commission (CEC)**
  - Digital television adapter (DTA)

A commercially-available electronic product for which the sole purpose is the conversion of digital video terrestrial broadcast signals to analogue NTSC video signals for use by a TV or VCR.

With this definition, there is no overlap between DTAs and complex STBs. Thus, CEC definition is not relevant for this study.

- **Energy Star**

Similar (but not identical) to the CEC definition, the Energy Star requirements for "Digital television adapters" define them as very basic units and thus doesn't have any relevance for this study.

Currently, there is a document on Energy Star Program Requirements for Set-top-Boxes Version 2.0[9] which is intended to complement the Energy Star requirements on DTAs.

- Set-top Boxes

All STB types can come as stand-alone tuners or as part of a larger device with other tuners and/or secondary functions such as, but not limited to, DVR and DVD playback/recording.

- o **Cable STB**: A STB whose principal function is to receive television signals from a broadband, hybrid fibre/coaxial, community cable distribution system and deliver them to a consumer display and/or recording device.
- o **Internet Protocol (IP) STB**: A STB whose principal function is to receive television/video signals encapsulated in IP packets and deliver them to a consumer display and/or recording device. Source: CSA C380-08.
- o **Satellite STB**: A STB whose principal function is to receive television signals from satellites and deliver them to a consumer display and/or recording device. Source: CSA C380-08.

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8 Code of Conduct on Energy Efficiency of Digital TV Service Systems, version 7, January 2008

9 Energy Star Program Requirements for Set-top Boxes, Eligibility Criteria, Version 2.0, April 23, 2008

- **Terrestrial STB**: A STB whose principal function is to receive television signals over the air (OTA) and deliver them to a consumer display and/or recording device. Source: CSA C380-08.
- **Thin-Client/Remote**: A STB that is designed to interface between a Multi-Room STB and a TV (or other output device) that has no ability to interface with the Service Provider directly and relies solely on a Multi-Room box for content. Any STB that meets the definition of Cable, Satellite, IP or Terrestrial STB is not a Thin-Client/Remote STB.

No distinction is made between simple and complex STBs.

- **Australian MEPS**

In Australia, Minimum Energy Performance Standards for STBs are currently under development, but not yet adopted. The following definition is taken from the Consultation Regulatory Impact Statement[10].

- Digital set-top box

"A digital STB may also be referred to as a digital television adaptor, decoder or receiver and is used to convert digital free-to-air (FTA) signals and subscription TV (STV) services to a signal compatible with the existing audiovisual display technology. This regulatory proposal is for STBs capable of decoding video transport streams that are MPEG2 and without a recording function (i.e. without a hard drive)."

No distinction is made between simple and complex STBs.

1.1.1.2 Mode Definitions

- **EU Code of Conduct[11]**

- On

The appliance is connected to a power source and fulfils a main function, including the provision of signals to supported devices.

- Standby active

The appliance is connected to a power source, does not fulfil a main function but can be switched into another mode with the remote control unit or an internal signal. It can additionally be switched into another mode with an external signal or it is receiving a minimal level of data from an external source.

- Standby passive

The appliance is connected to a power source, does not fulfil a main function but can be switched into another mode with the remote control unit or an internal signal.

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10 EnergyConsult: Consultation Regulatory Impact Statement – Minimum Energy Performance Standards And Alternative Strategies for Set-Top Boxes, issued by the Equipment Energy Efficiency Committee under the auspices oft he Ministerial Council on Energy, Report 2007/11, October 2007

11 Code of Conduct on Energy Efficiency of Digital TV Service Systems, version 7, January 2008

- Off

The equipment is connected to a power source, fulfils no function and cannot be switched into any other mode with the remote control unit, an external or internal signal.

Energy Star

The final version 2.0 on Energy Star Program Requirements for Set-top Boxes[12] defines the following operational modes.

- On/Active: An operational state in which the STB is actively delivering one or more of its principal functions and some or all of its applicable secondary functions.
- Sleep: A state in which the STB has less power consumption, capability, and responsiveness than in the On/Active state. The STB may enter a Sleep state from the On/Active state after:
  - the STB receives a notification from the user to enter a sleep state via a power button press on a remote control or front panel of the unit, or through an electronic signal or data packet received via a digital interface on the STB; or
  - the STB auto powers down to a Sleep state. The energy consumption after auto power down to Sleep and after a user initiated power down to Sleep may, or may not be, equivalent.
- Auto Power Down

The capability to automatically switch from the On state to the Sleep or Off state after a period of time without user input, generally based on the amount of time the unit has remained "idle" from last active use (i.e., user input such as channel change, volume change, menu access, etc.)

The Energy Star Program Requirements for TVs introduced an additional mode in its version 3.0[13], which is also of relevancy for STBs:

- Download Acquisition Mode (DAM)

The product is connected to a power source, produces neither sound nor a picture, and is downloading channel listing information according to a defined schedule for use by the electronic programming guide, monitoring for emergency messaging/ communications and/or otherwise communicating through a network protocol. The power consumption in this mode is typically greater than the power requirement in Standby and less than that in On Mode.

12 Energy Star Program Requirements for Set-top Boxes, Eligibility Criteria, Version 2.0, April 23, 2008

13 Energy Star Program Requirements for TVs, Eligibility Criteria, Version 3.0, February 4, 2008

- **Australian MEPS**

In Australia, Minimum Energy Performance Standards for STBs are currently under development, but not yet adopted. The following definition is taken from the Consultation Regulatory Impact Statement[14].

- On mode (in-use)

The device is connected to a power source and fulfils the main function of a STB, including the provision of signals to supported devices.

- Active Standby

The device is connected to a power source, does not fulfil the main function but can be switched into another mode with the remote control unit or an internal signal. It can additionally be switched into another mode with an external signal or it is receiving and processing a minimal level of data from an external source.

- Passive Standby

The device is connected to a power source, does not fulfil the main function but can be switched into another mode with the remote control unit or an internal signal.

- Off

The device is connected to a power source, fulfils no function and cannot be switched into any other mode with the remote control unit, or an external or internal signal.

The Regulatory Impact Statement (RIS) provides further explanation regarding the various modes:

The **On mode** power consumption and the hours of use are critical in determining total energy consumption of products. However, in the case of STBs, the way on mode functions means the in-use status has similar power usage characteristics to the **active standby mode.** STBs can be left in this in-use or active standby mode for extended periods either while producing no visible output or while the connected display device is turned off or in passive standby. The **passive standby mode** is a standard feature of STBs and allows the unit to be put 'to sleep' either via a remote control or manual standby switch. The majority of normal functions of the device are disabled under this mode which results in lower power consumption by the device. In theory, the **off mode** disconnects the mains from most electrical circuits in an appliance ("hard off"). Normally the appliance cannot be activated with a remote control while switched "off".

The definitions given by the RIS document, which are also proposed to be used by the relevant AS/NZS 62087.2:200X standard, correspond to the definitions used by the European Code of Conduct.

- **IEC 62087: Methods of measurement for the power consumption of audio, video and related equipment**

IEC 62087[15] differentiates the following modes for set-top-boxes:

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14 EnergyConsult: Consultation Regulatory Impact Statement – Minimum Energy Performance Standards And Alternative Strategies for Set-Top Boxes, issued by the Equipment Energy Efficiency Committee under the auspices oft he Ministerial Council on Energy, Report 2007/11, October 2007

- Disconnected
- Off
- Standby-passive
- Standby-active, low
- Standby-active, high
- On (play)

Also these mode definitions largely correspond to the CoC terminology, except that the standby-active is split into two sub-categories.

1.1.2. SCOPE OF THE STUDY: DEFINITIONS

From the functionality point of view, STBs are best divided into two categories: simple boxes that decode digital signals for analogue televisions (DTA) and more complex boxes that operate in an interconnected environment such as exists in subscription services and networked home entertainment systems.

Siderius[16] proposed the following distinction between simple and complex STBs: "Functionality that is required by others (than the manufacturer [of the STB]) defines the boundary between simple … and complex … STBs". "Required by others" refers to service providers (e.g. Pay-TV) and their specification for STBs, either by:

- Directly specifying e.g. conditional access functionality for an STB they deliver to the customer together with a Pay-TV subscription package, or
- As STB manufacturers follow the specification of service providers to make their products compatible with these services.

Another proposal to define complex STBs was given by Jones et al.[17]:

"A complex STB is one…

1. …in which a service provider is capable of remotely extending or controlling the feature set beyond the basic STB functionality...

and/or

2. …where the STB's energy use could be determined by a connected network...

   …and override the user power control and power optimisation features…

and/or

15 IEC 62087 Ed. 2.0, Methods of measurement for the power consumption of audio, video and related equipment, 100/1224/CD

16 H.-P. Siderius, *Categorising STBs - simple or complex?* International Workshop on Energy Efficient Set-Top Boxes & Digital Networks, IEA, July 4-5, 2007, Paris, France

17 K. Jones, M. Armishaw, B. Harrison, *What would a coherent policy to maximize efficiency for complex STBs encompass?* International Workshop on Energy Efficient Set-Top Boxes & Digital Networks, IEA, July 4-5, 2007, Paris, France

3. …converts/de multiplexes DVB transport streams for recording purposes into formats other than direct image mapping for a Hard Disk Recording, e.g. Recording on a DVD"

Points (1) and (2) of the Jones et al. definition largely correspond to Siderius' approach, but point 3 is also applicable to the simple STBs in the relevant preparatory study. For reasons of compatibility across EuP Preparatory Studies, the approach of Jones et al. will not be followed. Simple STBs are covered by a separate preparatory study[18]. The scope of this study on complex STBs has to be complementary to that of the simple STB study. Initially it has been proposed to take conditional access and/or always-on functions as the distinction criterion (Figure 1-1). As the study on simple STBs only refers to conditional access as distinction criterion, the always-on functions are not part of the definition of "complex" STBs to avoid an overlap of scope definition of both studies (Figure 1-2).

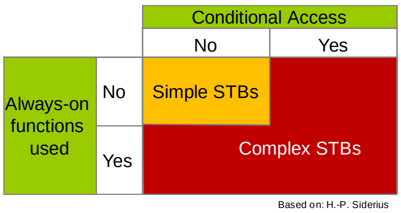

Figure 1-1: Scheme "simple" vs. "complex" STBs according to Siderius

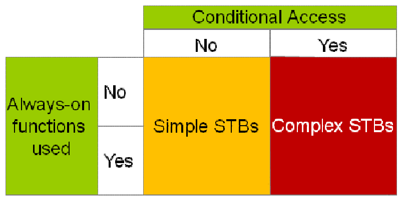

Figure 1-2: Scheme "simple" vs. "complex" STBs according to the scope of the EuP preparatory studies on STBs

Definition of Complex Set-Top Boxes for this study (scope):

Complex STBs are STBs which allow 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 analogue RF and/or line signals and/or with a digital output signal.

STBs might have additional features, such as

- Return path / integrated modem / internet access,
- Multiple tuners (for picture-in-picture or to serve several end-devices),
- Connectivity with external devices (video recorders, PC, digital cameras, external hard disks or memory etc.),
- Recording with internal mass storage media, and
- Entitlements[19].

Digital receivers with recording function based on removable media in a standard library format (DVD, VHS tape, "Blu-ray" disc etc.) are excluded from the scope of this study[20], but complex STBs with players for removable media are included

[18] *Final report EuP Preparatory Study Simple Digital TV Converters* (Simple Set Top Boxes), 2007 ec.europa.eu/energy/demand/legislation/doc/2007_12_17_simple_stb_en.pdf

[19] Entitling is the process of managing and processing subscriber requests, for premium services, on-demand content, such as video, music or games or signing up for a new service offering

"Conditional Access" means an active system that enables the complex STB to process and apply targeted data from a service provider.

The following appliances are **not** in the product scope of this study:

- Simple STBs (as defined by the EuP preparatory study on simple STBs)
- Digital TVs with integrated receiver and decoder (IRD)[21]
- USB-port digital receivers for computers (as they fail the definition "using an integral or dedicated external power supply) and TV add-in card for computers
- Devices that require a separate signal processing device (e.g. PC, PS3, and Xbox)
- Larger reception installations, such as communal satellite installations, which are not intended to serve one household only
- Personal computers with the add-on functionality of a STB

Related to the last bullet point above, so called Media Centres (or Home Theatre Personal Computer) including the functionality of STBs are covered by the scope of this study, if they do not allow recording on removable media (a DVD or CD-ROM writer disqualifies a media centre to be a "complex STB") and/or if they are not intended for standard office software, such as text editing and calculation programmes.

Both, simple and complex STBs can have a recording function, a return channel for interactivity[22] and decode high-definition signals therefore these criteria are not included in the scope definition of complex STBs for this study.

Software aspects related to complex STBs, including middleware, are within the scope of this study and will be addressed in later tasks.

Conditional access is related to Pay-TV. Parental control systems are not considered as conditional access since they intend to restrict viewing times and/or content by control of the user.

Table 1-2 lists the various modes relevant for STBs for which the definitions are taken from the Code of Conduct. Furthermore, correlations with the definitions used in the EuP preparatory study on standby and off-mode losses ("lot 6") are given.

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20 Complex STBs including a recording function based on removable media in standard library format are estimated to represent a very small share of the market (see later in Task 2)

21 Note: in contrast to this study these are included in the scope of the Code of Conduct on Energy Efficiency of Digital TV Service Systems

22 Note: a return channel in principle also falls under "functionality that is required by others (than the manufacturer)", but does not per se mean conditional access or an always-on function and therefore is not part of the scope definition of complex STBs for this study

Table 1-2: Definition of modes

Definition of modes[23]	Corresponding modes in the EuP Preparatory Study on standby and off-mode losses	Guidance
On The appliance is connected to a power source and fulfils a main function, including the provision of signals to supported devices.	**Active mode**	Includes providing a video signal to the TV set (regardless if the TV set is switched on or off, ready to process this signal respectively), recording on a hard disk, active WLAN modem and other modems for internet access
Standby active The appliance is connected to a power source, does not fulfil a main function but can be switched into another mode with the remote control unit or an internal signal. It can additionally be switched into another mode with an external signal or it is receiving a minimal level of data from an external source.	**Networked standby**	Corresponds to IEC 62087 definitions of standby-active low and high Includes VoIP enabled, reception of software updates, EPG updates, authentication, i.e. includes also what is called Download Acquisition Mode (according to Energy Star Requirements for TVs)
Standby passive The appliance is connected to a power source, does not fulfil a main function but can be switched into another mode with the remote control unit or an internal signal.	**Passive standby**	
Off The equipment is connected to a power source, fulfils no function and cannot be switched into any other mode with the remote control unit, an external or internal signal other than by the user pressing the “ON” button located on the product.	**Off-mode**	e.g. hard-off, soft-off
Disconnected The appliance is disconnected from all external power sources.	**Disconnected mode**	Power cable removed, device unplugged

Note: The wording of the mode definitions in the EuP Preparatory Study on standby and off-mode losses deviates from the wording of the CoC, but the meaning – applied

23 Following the EU Code of Conduct; off-mode definition adapted according to stakeholder comment

to STBs – is the same. For details of the "lot 6" mode definitions see the EuP lot 6 final report[24].

The Lot 18 study will complement the study on simple STB (Figure 1-2) in terms of products coverage. Moreover, it can be expected that the issues related to the energy use of complex STB will be different from the simple STB. Indeed, the complex STB can be remotely controlled by service providers (in terms of functionalities, energy use, etc.). However, this will be further analysed in Task 4.

1.1.3. Technical Parameters

- **Functionality of complex STBs**

Relevant functionalities for STBs include the following (non-exhaustive):

Basic functionalities:

- Digital tuner (DVB-S, -C, -T STBs) or basic ethernet or networking capability for reception of IP video packets (IPTV STBs)
- Picture and sound: Standard Definition (SD) capability, surround sound (digital radio)
- Standard codecs capability (MPEG-2)

Sophisticated[25] functionalities:

- High Definition (HD) capability
- Multiple decode capability for advanced codecs (H.264/MPEG-4 AVC, VC1), multiple tuners
- Interfacing: USB, IEEE 1394, 802.3 and 802.11, Bluetooth, HDMI, etc.
- Digital video recording (including time-shift television capability), high capacity (internal mass storage media)
- Drives for removable media
- Networking: the STB may provide networking functions:
  - Internet access (e.g. VoIP, video conferencing capability) and/or
  - Principal signals for other products (home networked devices: One STB serving multiple TV sets or additional, e.g. computer devices; primary box / slave box configurations; gateway / router functionality; MoCA Broadband Home Networking, etc.)

Complex-STB-only functionalities:

- Conditional access, i.e. Pay-TV, including

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24 N.F. Nissen et al., *EuP Preparatory Study Lot 6 Standby and Off-mode Losses*, Task 1 Definition, Final Report, October 2, 2007

25 Note: Differentiation of "basic" and "sophisticated" functionalities are not distinction criteria for "simple" and "complex" STBs

- Video on Demand (VoD; including progressive download to VoD),
- Pay per view,
- T-commerce,

Realised through either:

- Conditional access system (Conax, Cryptoworks, Nagravision, Dreamcrypt, Videoguard, PowerKEY, etc.) and/or
- Common Interface (CI) slots for (external) encryption modules

In general all of these functionalities, if implemented and used, are correlated with additional power consumption.

Typical levels of complexity of STBs in the market can be described as follows:

1. Basic set-top box (one tuner)
2. Basic set-top box with front panel display
3. Basic set-top box with conditional access
4. Set-top box with CA and return path (cable, DOCSIS modem, ethernet, telephone modem / PSTN/POTS)
5. Set-top box with CA, return path, and second tuner (picture in picture, for second TV set)
6. Set-top box with CA, return path, second tuner and internal mass storage media
7. Set-top box with CA, return path, multiple tuner, internal mass storage media and high definition capability

This kind of classification represents typical configurations. However, there are also STBs which do not fit in this scheme[26].

Set-top boxes with complexity levels 3-7 in the above scheme are covered by the scope of this study due to conditional access. Levels 1 and 2 come with passive standby, for level 3 and beyond typically active standby is relevant. These levels do not only represent levels of functionality, but also increasing power consumption in on mode and (active / passive) standby.

Block diagram

The following generic block diagram for a digital receiver is taken from the EU Code of Conduct[27]. Aspects of specific relevancy for complex STBs are marked in blue, namely the local and external network capability, which is an enabler for always-on functionalities, and the conditional access module (CAM) may it be internal or connected via the CI-slot.

26 See the EuP Preparatory Study on Simple Set top Boxes, 2007, which analysed also set top boxes without CA, but with recording capability (PVR)

27 Code of Conduct on Energy Efficiency of Digital TV Service Systems, version 7, January 2008

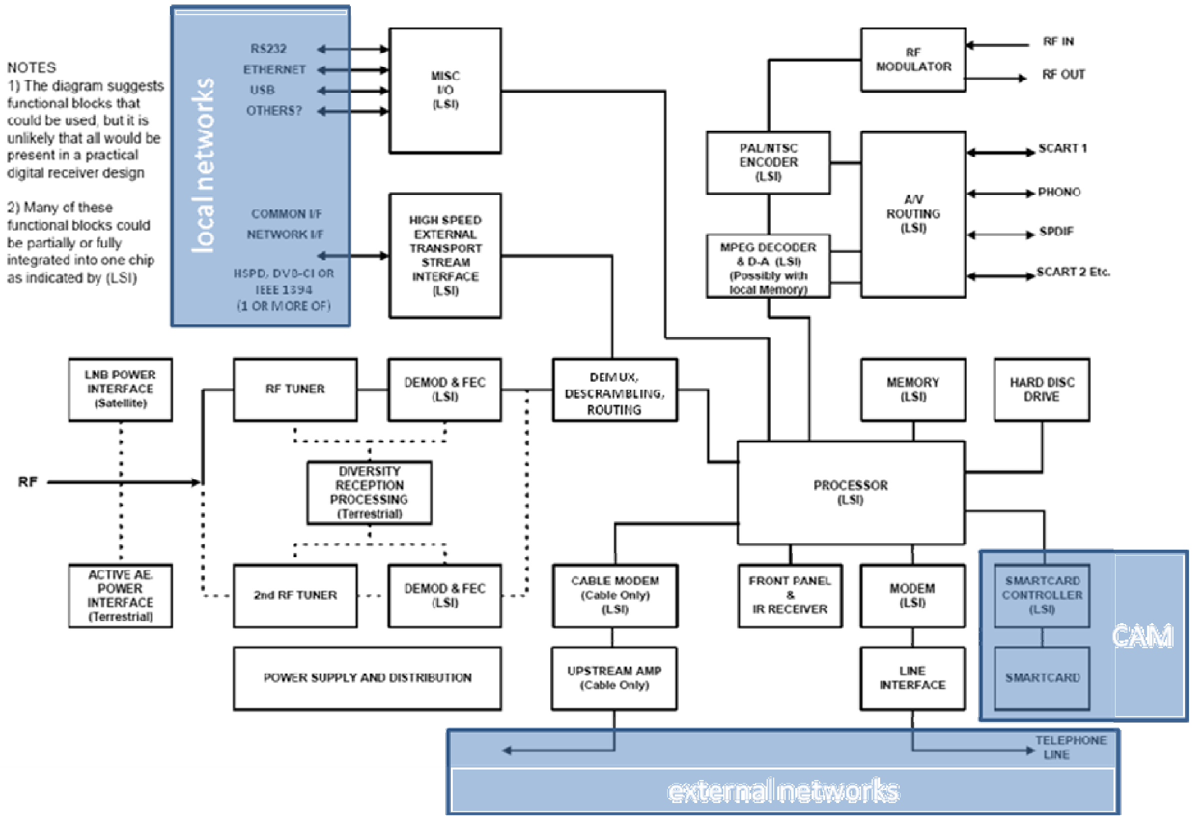

Figure 1-3: Generic block diagram for a Digital Receiver

- **External components**

External components of a STB considered as being part of the STB (in the scope of the study) are:

- External power supply (for the STB)
- Remote control
- Modem (if they are required for the functionality of the STB and dedicatedly specified for the STB it is sold/provided with, e.g. external ADSL modem for IPTV, including external power supplies for these modems, if applicable)

As a guiding principle, all components usually sold/provided to the end-customer together with the STB in one package are in the scope of this study.

Following external components are only considered for system interaction aspects (communication with the STB and related power consumption of the STB) and are not subject to any eco-design analysis in this study:

- DiSEqC (Digital Satellite Equipment Control) switch / LNB (low noise block converter) / satellite dish
- (External) conditional access module (to be connected to the CI-slot)
- Smartcard
- (External) mass storage media, etc.

- Amplifier and loudspeaker
- External router
- LNB and power supply for antenna

- **Functional unit**

The functional unit for STBs is basically to provide a TV set for a given time with a signal that can be transformed in a displayed content, plus certain add-on functionalities as listed above.

1.2. TEST STANDARDS AND PRODUCT TESTING PROCEDURES

A “test standard” is a standard that sets out a test method, but that does not indicate what result is required when performing that test. Therefore, strictly speaking, a test standard is different from a “technical standard”. Namely, in technical use, a standard is a concrete example of an item or a specification against which all others may be measured or tested. Often it indicates the required performance.

However, “test standards” are also (but not exclusively) defined in the “technical standard” itself. For example, an ISO standard for a certain product or process gives the detailed technical specifications, which are required in order to conform to this standard. It also defines test standards (or rather methods) to be followed for validating any such conformity. A standard can be either product or sector specific, and it can concern different stages of a product’s life cycle.

EN/CENELEC internal regulations define a standard as a document, established by consensus and approved by a recognised body that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Standards should be based on consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits. The European EN standards are documents that have been ratified by one of the three European standards organisations, CEN[28], CENELEC[29] or ETSI[30].

In addition to “official” standards, there may be other sector specific procedures for product testing, which could be considered as standards when they have been recognised both by the sender and the receiver, that is, when they are using the same parameters or standards. Those procedures are discussed later in this chapter.

Following the EU’s ‘New Approach’, any product-oriented legislation should preferably refer to harmonised (EN) test standards in order to verify the compliance with set measures. The referenced test standard should be accurate, reproducible and cost-effective, and model as well as possible the real-life performance. If no suitable test standard exists, they need to be developed (possibly based on existing sector specific procedures) for the relevant parameters in the view of implementing measures.

[28] CEN - European Committee for Standardisation
[29] CENELEC - European Committee for Electrotechnical Standardisation;
[30] ETSI - European Telecommunications Standards Institute

Note: External power supplies (EPS) used in some complex STBs were already treated in the Lot 7 EuP preparatory study[31], and consequently standards (and legislations) related to these products will not be discussed here.

1.2.1. Test Standards on Energy Use of Set-Top Boxes

1.2.1.1 European (EN) Test Standards on Energy Consumption

Standards directly related to the environmental performance of complex STBs are relevant for this preparatory study and especially for power consumption testing.

- **EN 62087:2003 (IEC 62087:2002) - Method of measurement for the power consumption of audio, video and related equipment**

The scope of products covered by this standard includes digital terrestrial, digital cable and digital satellite STBs.

The measuring conditions in this standard represent the normal use of the equipment and may differ from specific conditions, e.g. as specified in safety standards. Furthermore, this standard defines the different operating modes of a STB as detailed in § 1.1.1.2.

The part of this standard related to STB is currently under revision.

The European Code of Conduct for Digital TV Services (§ 1.3.1.2) and the Group for Energy Efficient Appliances (GEEA) (§ 1.3.1.2) refer to a testing method derived from the EN 62087, with two specifications to the standard testing method: the LNB[32] current (for single LNB) should be set at 80 mA during the test, and the current for active antennas should be set at 35 mA during the test.

This standard (or its IEC counterpart) is also the reference testing method in:

- Swiss energy consumption regulation under preparation (§ 1.3.3.1)
- Korean "e-Standby Program" (§ 1.3.3.4)

Furthermore, the standard specified in the Australian/New Zealand draft legislation (test standard AS/NZS 62087), is similar/same to this EN/IEC standard (see § 1.2.1.2).

- **EN/IEC 62301:2005 - Method of measurement of standby power for household electrical appliances**

This standard aims at allowing measuring power consumption in standby mode as well as in low power modes where the mode is steady state or providing a background or secondary function.

This standard is currently under revision.

This standard could allow measuring electricity consumption of a complex STB both in active and passive standby modes.

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31 www.ecocharger.org

32 Low Noise Block

1.2.1.2 Third country test standards on energy use

- **AS/NZS 62087 – Methods of measurement for the power consumption of audio, video and related equipment**

As mentioned in previous §, this test standard applicable in Australia and New-Zealand in order to measure the electricity consumption of STBs is similar to the European standard EN 62087. To comply with the proposed Australian MEPS, a STB will have to be tested according to this standard.

- **ANSI/CEA 2013-A - Digital STB background power consumption**

This ANSI/CEA[33] standard, published in July 2007, deals with the “digital STB background power consumption”. It presents methods to measure the electricity consumption in standby mode (“sleep mode”) of any digital STB (both simple and complex) whose primary function is video reception and delivery. Moreover, it defines maximum values in this sleep state. This mode is important as digital STBs spend a lot of time in it and as its power consumption is significant.

This standard also discusses on the treatment of parasitic peripherals, such as Low Noise Blocks (LNBs) and security cards.

- **ANSI/CEA 2022 - Digital STB active power consumption measurement**

This standard, published in July 2007, is related to the ON mode of any digital STB whose primary function is video reception and delivery.

- **CSA C380-06 - Test procedure for the measurement of energy consumption of STBs**

Energy Star plans to use this test standard, developed by the Canadian Standard Association, for the measurement of the power consumption of STBs.

This standard is still under development.

1.2.1.3 Other sector-specific procedures for product testing

These methods cannot be considered as official standards as official standardisation bodies have not adopted them. Nevertheless, for example the test method proposed under the Energy Star programme (see below), may be adopted by standardisation bodies (e.g. in Canada) and voluntary programs, and by industry.

- **ENERGY STAR Test Procedure for STB (Draft)**

The latest ENERGY STAR Program Requirements for Set-top Boxes (Version 2.0, April, 2008) specifies a test procedure to be used to certify those models that meet the program requirements. The specific instructions have been drawn heavily from CSA C380-06.

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33 A standard developed by the Consumer Electronics Association (www.ce.org), an American association comprising about 2200 members, and approved by the American National Standards Institute (ANSI) (www.ansi.org).

In the programme, the energy consumption requirements are expressed as annual energy allowance (kWh/year) (see § 1.3.3.2). The power consumed in the on and standby modes will be multiplied by the number of hours a defined typical device spends in these modes. To determine if a STB meets the ENERGY STAR specification criteria (Annual Energy Allowance), the TEC of the STB shall be calculated as follows:

The yearly electricity consumptions are to be established assuming that the duty cycle of the STB as follows:

- 14 hours in on mode and 10 hours in active standby mode for a product with no auto power down[34],

7 hours in on mode, 7 hours in "auto power down mode" and 10 hours in active standby mode for a product with auto power down.

Therefore, the calculation of the Base energy consumption of the STB is based on the following equations:

a) Annual energy (kWh/yr) for a product with no auto power down

$$kWh_{\text{Base}} = 0.365 \times \left(14 \times P_{TV} + 10 \times P_{Standby}\right)$$

b) Annual energy (kWh/yr) for a product with auto power down capability

$$kWh_{\text{Base}} = 0.365 \times \left(\left(7 \times P_{TV}\right) + \left(10 \times P_{Standby}\right) + \left(7 \times P_{\text{Auto PD}}\right)\right)$$

P_{TV} (= P_{ON}), $P_{Standby}$ and $P_{Auto\ PD}$ are power levels in Watts as measured according to the Energy Star test procedure.

Table 1-3 and equation below illustrate how to calculate from the values measured in the test procedure the annual energy consumption for the added functionalities such as playback and record. These apply only to products with a DVR, Removable Media Playback, or Removable Media Playback with Record capabilities. P_{TV}, $P_{Playback}$ and P_{Record} are power levels in Watts as measured according to the Energy Star test procedure.

$$kWh_{Play/Record} = 0.365 \times \sum_{1}^{2} \left(P_{mode} - P_{TV}\right) \times H_{mode}$$

Table 1-3: Duty cycle for playback and record functions

Mode	DVR (Hours/Day)	Removable Media Playback (Hours/Day)	Removable Media Playback w/ Record capability (Hours/Day)
Hours On-Playback ($H_{Playback}$)	2	2	2
Hours On-Record (H_{Record})	3	0	1

Lastly, the total annual electricity consumption of the STB is the sum of the Base consumption and the consumption of the additional functions (if any): if the STB

34 Auto power down = The capability to automatically switch from the On state to a Standby state after a period of time without user input, generally based on the amount of time the unit has remained "idle" from last active use (i.e., user input such as channel change, volume change, menu access, etc).

includes a DVR, Removable Media Playback, or Removable Media Playback with Record capability, the total electricity consumption (TEC) is the results of kWh_{base} and $kWh_{function}$. If the STB does not include DVR, Removable Media Playback, or Removable Media Playback w/ Record capability, the TEC is equal to kWh_{base}.

1.2.1.4 Comparison of the Test Standards on Energy Use

The existence of several test standards on the energy use of complex STBs, developed by various working groups, implies the need to compare them. Therefore, Table 1-4 summarises the main characteristics of the four standards for the measurement of the electricity consumption of STBs in various power modes.

Table 1-4: Comparison of the existing test standards related to the energy use

	EN 62087	EN 62301	CEA 2013-A	CEA 2022
Scope	Specific to digital STBs with detail coverage of test signals and external loads	Not specific to STBs but detailed methodology on low power measurement	Specific to digital STBs	Specific to digital STB whose primary function is video reception and delivery
Measurement modes	Disconnected Off Standby Passive Standby Active (Low) Standby Active (High) On (Play) On (Record)	Standby Low power modes	Sleep	On
Temperatures	15°C to 35°C, with 20°C preferable	23°C ± 5°C	22°C ± 4°C	*n/a*
Power supply	Device rated voltage and frequency, ± 2%	230 V ac / 50 Hz / ± 1%	115 V RMS ± 3 V 60 Hz ± 3 Hz	*n/a*
Instrument Accuracy	Not given	P≤10W ⇨ 0.01W 10W<P≤100W ⇨ 0.1W P>100W ⇨ 1W	Resolution to be 0.1 W or better. True power wattmeter preferred	*n/a*

Drawing up any conclusions from this table is not straightforward. Furthermore, some of these standards are under revision. Nevertheless, the test standard EN 62087 is the most complete as it defines all power modes of a complex STB. Yet, it does not allow evaluating the impact of power management, i.e. shifting to lower power modes where possible.

1.2.2. TEST STANDARDS ON SAFETY

Standards on safety are indirectly linked to the study as they could introduce some requirements that affect the design of the product. The main standards, referenced under the Directive 2006/95/EC on low voltage, are presented below.

- **EN 60065:2002 (IEC 60065:2001) - Audio, video and similar electronic apparatus**

-Safety requirements

This standard specifies safety requirements for any audio, video and similar electronic apparatus.

These requirements aim at ensuring protection to persons as well as to the surroundings of the apparatus. Damages can occur due to the following hazards:

- Electric shock,
- Excessive temperature,
- Radiation,
- Implosion,
- Mechanical hazards, and
- Fire.

Moreover, EN60065 clause 5.4.2 requires the instructions supplied with the apparatus to state that the mains disconnect device (e.g. mains plug or hard-off switch) "shall remain readily operable" when the apparatus is installed.

A complex STB falls into the scope of this safety standard and consequently must fulfil its requirements.

- **EN/IEC 60335:2005 - Safety of household and similar electrical appliances**

This standard deals with the safety of electrical appliances for household and similar purposes, their rated voltage being not more than 250 V for single-phase appliances and 480 V for other appliances.

The standard is dedicated to the measurement of parameters for the use phase of the equipment: input; electric strength; earth continuity; touch current; humidity; heating; flammability; stability; stress relief; drop; steady force; steel ball; abnormal; over-voltage; accessibility; durability

The application of this standard will influence the specification and choice of the product material content. The level of flammability could also impact the composition, in particular regarding the hazardous substances.

1.3. EXISTING LEGISLATION

In this section, environmental and other European directives relevant for Lot 18 are identified. In addition, relevant legislations at Member State level, as well as in Third Countries (extra-EU) are discussed. Voluntary agreements and already existing eco-design standards of the sector are also presented.

1.3.1. LEGISLATION AND VOLUNTARY AGREEMENTS ON COMPLEX STB AT EUROPEAN COMMUNITY LEVEL

1.3.1.1 EU legislation

Currently, there is no specific EU legislation concerning energy efficiency or consumption for complex STBs. Against this situation, the environment relevant obligatory policy measures at the European level are the WEEE and RoHS Directives. Among other EU Directives that apply to electrical and electronic equipment, the most relevant to STB are the Low voltage and Electromagnetic compatibility Directives. The latter two are based on the principles of the so-called "New Approach", prescribing essential requirements, the voluntary use of standards, and conformity assessment procedures to be applied in order to apply the CE marking[35].

- **The Eco-design Directive 2005/32/EC[36]**

This Directive applies to different categories of Energy-using Products. It establishes a framework for setting Eco-design requirements (such as energy efficiency requirements) for all energy-using products in the residential, tertiary, and industrial sectors.

- **Directive 2002/96/EC on waste electrical and electronic equipment (WEEE)[37]**

It applies to the categories of electrical and electronic equipment which are dependent on electric currents or electromagnetic fields in order to work properly and equipments for the generation, transfer and measurement of such currents and fields and designed for use with a voltage rating not exceeding 1000 Volt for alternating current and 1500 Volt for direct current. Hence, complex STBs fall within the scope of this regulation.

Effective since 13 August 2005, this Directive requires separate collection of electrical and electronic waste.

- **Directive 2002/95/EC on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)[38]**

This Directive applies to the categories of electrical and electronic equipment that are covered by the WEEE Directive with the exception of Medical devices and Monitoring and control instruments. Although complex STBs are not explicitly mentioned in the indicative list of product categories, they can be considered falling into the category 4 (IT and telecommunication equipment). Therefore, they must be designed respecting the prescriptions of the RoHS directive.

It requires the substitution of various heavy metals (lead, mercury, cadmium, and hexavalent chromium) and brominated flame retardants (polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE)) in new electrical and electronic equipment put on the market from 1 July 2006 onwards.

- **Low Voltage Directive (LVD) 2006/95/EC**

This Directive is applicable to all electrical equipment designed for use with a voltage rating[39] 50 – 1000 V ac and 75 – 1500 V dc. It requires products to have protection

35 europa.eu.int/comm/enterprise/electr_equipment/index_en.htm (download 15-08-2005)
36 Official Journal L 191, 22/07/2005, p. 29-58
37 Official Journal L 37, 13/02/2003, p. 24-39
38 Official Journal L 37, 13/02/2003, p. 19-23
39 Voltage ratings refer to the voltage of the electrical input or output, not to voltages, which may appear inside the equipment.

against hazards that could arise from within the product itself or from external influences. All risks arising from the use of electrical equipment, including mechanical, chemical, and all other risks. Noise and vibration, and ergonomic aspects, which could cause hazards, are also within the scope of the directive.

- **Electromagnetic Compatibility (EMC) Directive 2004/108/EC**

This Directive lays down requirements in order to ensure that an apparatus is compatible with its electromagnetic environment (covering frequency band 0 to 400 GHz), i.e. that it functions as intended without disturbing other equipment and without being disturbed by other equipment. Equipment must be designed to minimise any potential electromagnetic interference with other equipment and also must itself be immune to specific levels of interference.

1.3.1.2 European voluntary agreements and initiatives

- **Code of Conduct**

One of the main European actions relevant to STBs is the EU Code of Conduct for digital TV Services[40] and this voluntary initiative is one of the pioneers in this field, even at the international level. The Code of Conduct aims at minimising the energy consumption of appliances linked to Digital TV Services, i.e. equipment for the reception, decoding, recording and interactive processing of digital broadcasting and related services.

Examples of such equipment are **complex integrated receiver decoders and other STBs**, digital TVs with built-in integrated receiver decoder, internet TV and simple converters to adapt analogue TVs and equipment with recording capabilities (PVR: personal video recording equipment). Furthermore, the Code of Conduct also covers analogue PVR equipment for household use that is capable of receiving analogue broadcasts and related services, and of recording on non-volatile memory and of playing the recorded signals.

The code of conduct defines targets for the basic configuration of a complex STB for the different platforms (see Table 1-5).

[40] EU CoC (July 2007) Digital TV Services Code of Conduct, version 7.

Table 1-5: EU CoC targets for complex ('stand alone') STBs in the basic configuration

Mode	from 1-1-2007 to 31-12-2008			
	Cable	*Terrestrial*	*Satellite*	*DSL*
Standby passive (if specified)	3.0 W	3.0 W	3.0 W	3.0 W
Standby active	7.0 W	6.0 W	8.0 W	6.0 W

Mode	From 1-1-2009 to 31-12-2009		
	TV with built in Cable(IRD)	*TV with built in Terrestrial(IRD)*	*TV with built in Satellite(IRD)*
Standby passive (if specified)	1.5 W	1.5 W	1.5 W
Standby active	7.0 W	6.0 W	8.0 W

Targets are also defined for analogue PVR and simple digital TV converter boxes but these products are not in the scope of this study.

For additional functionalities, more components may be added on to the equipment in the basic configuration and additional power allowance can be added to the maximum standby active power consumption targets above as shown in Table 1-6.

In any case the total maximum power consumption targets in standby active mode should not exceed **15 W** (until 31.12.2008) and **13 W**[41] (from 1.1.2009) for complex STB (except for MPEG4 and multi-decode platforms; see below).

Table 1-6: Additional power consumption allowance for different components[42]

Feature	Indicative additional maximum power consumption (at the AC mains) for additional features in standby active mode
Internal hard disk drive	2.2 W
IEEE1394 interface	0.8 W
Ethernet interface 100Mbit	0.4 W
Each home network interface	2.5 W
Each serial USB interface	0.3 W
Home automation interface	0.4 W
HDMI interface	1.0 W
ADSL modem	2.0 W
Docsis 1.1 or 2.0 modem	4.5 W
Out of Band Transport	4.0 W
Additional LNB feed	1.3 W (with an additional 80 mA for the LNB current)
Additional tuner/demodulator	2 W
Powered remote IR receiver (loaded at 15mA)	0.25 W

For MPEG4 and multi-decode platforms, i.e. products being capable of decoding more than one signal stream, the following additional power allowance (Table 1-7) can be

41 For cable with DOCSIS modem (except for MPEG4 and multi-decode platforms) the maximum power consumption in standby active mode is: 15 W (until 31.12.2009)

42 EU Code of Conduct on Digital TV Services (version 7)

added to the allowances resulting from the foregoing table and the maximum standby active power consumption targets above.

In any case the total maximum power consumption target in standby active mode should not exceed **20 W** (until 31.12.2008) and 17 W[43] (from 1.1.2009) for MPEG4 and multi-decode respectively.

Table 1-7: Additional power consumption allowance for MPEG4

Feature	Indicative additional maximum power consumption (at the AC mains) for additional high definition features in standby active mode
MPEG4 standard or high definition decoder	2.5 W
Each additional decoder	1.5 W
Each DVBS2 front end (or demodulator)	2 W

Further, another EU Code of Conduct exists related to external power supplies (EPS) targeting to improve their efficiency. If a STB is supplied with an EPS, the power supply has to meet the current on-mode efficiency requirements specified by this CoC.

Besides these specific requirements on the energy consumption of complex STBs, the CoC suggests to communicate the following information to consumers:

- Power consumption of the equipment in the off mode.
- Power consumption of the equipment in the standby passive mode.
- Power consumption of the equipment in the standby active mode.
- Power consumption of the equipment in the on mode.

The CoC specifies that the power consumption shall be measured according to the test standard IEC 62087:2002, i.e. EN 62087:2003. However, the LNB current (for single LNB) should be set at 80 mA during the test, and the current for active antennas should be set at 35 mA during the test.

The Code of Conduct has several signatories including both STB manufacturers and broadcasters (the list of participants is available under the section "Standby loads" at the address: re.jrc.ec.europa.eu/energyefficiency/) and they are obliged to provide, on a yearly basis, information concerning the power consumption of the equipment they produce. The data reported by the signatories show (see Figure 1-4) that the Code of Conduct was successful in bringing about reduction in energy consumption of STBs in Europe from 2001-2004. However, due to developments towards better performance and additional features, the absolute power consumption in the three modes (On, Standby Active and Standby passive) has started increasing again since 2005.

43 For cable STB MPEG4 and multi-decode platforms with DOCSIS modem the maximum power consumption in standby active mode is: 22 W (until 31.12.2008) and 19 W (from 1.1.2009)

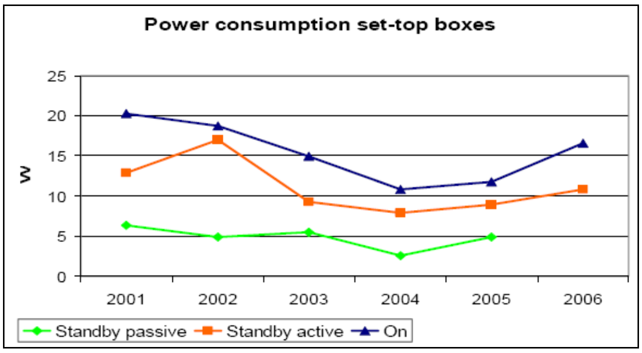

Figure 1-4: Power consumption of STBs (source: EU Code of Conduct)

The Code of Conduct on energy efficiency on digital TV service systems is revised every year and **the 2009-2010 values will be discussed and agreed in spring 2008.**

- **Group for Energy Efficient Appliances (GEEA)**

The Group for Energy Efficient Appliances (GEEA), which is made up of representatives from a number of European national energy agencies and government departments, provides tools for promoting the use of energy efficient appliances (home electronics and office equipment) especially in areas where suitable tools or labels are available. The criteria for receiving the GEEA label are decided by the board based on technical documents submitted by the working groups.

Figure 1-5: GEEA label

STBs have been categorised as stand-alone STBs and digital to analogue converters (simple converter STBs) with separate criteria. Maximum power consumptions in standby active mode are the same as defined in the Code of Conduct (see above Table 1-5), but the electricity consumption in standby passive mode is 1 W or less (compared to 3 W in the CoC). Measurement conditions are also similar to those specified in the CoC, i.e. based on the test standard IEC 62087.

All GEEA activities were discontinued as of January 1, 2008 as GEEA requirements for STBs were similar to those defined in the Code of Conduct.

1.3.2. LEGISLATION AND VOLUNTARY AGREEMENTS AT MEMBER STATE LEVEL

Currently, no legislation exists in the EU Member States related to complex STBs, neither to simple STBs.

The GEEA (see in § 1.3.1.2) was initiated by government energy agencies and institutions from Denmark, the Netherlands, Sweden, and other Member States have joined the group: Germany, France and Austria.

Furthermore, in UK, the market transformation programme (MTP) is following STBs on a voluntary basis. MTP also participates actively in the EU Code of Conduct on the Energy Performance of Digital TV Service Equipment. In collaboration with two major STB manufacturers, MTP has developed a 'best practice' specification for a basic terrestrial adapter. This has also led to a deal whereby a major retailer has agreed to procure a box to this specification in a volume that will offset the risk associated with delivering improved technology. This deal has attracted a subsidy from the Energy Efficiency Commitment scheme, allowing these improved STBs to be retailed at a price competitive compared to less efficient STBs.

MTP has also worked at the international level to take into account the fact that many products placed on the EU market are now produced by non-EU manufacturers. MTP has assisted USA and Australia in setting effective product criteria. Further, MTP brought a delegation of Chinese standards organisations to the UK testing facilities and this led directly to the setting of Chinese national product standards. MTP has also helped to establish an international working group to explore the harmonisation of international performance criteria of STBs.

1.3.3. THIRD COUNTRY LEGISLATION AND VOLUNTARY AGREEMENTS ON STB

1.3.3.1 Switzerland

Since the beginning of 2006, any STB fulfilling the requirements defined in the Code of Conduct can receive the following endorsement label from the Swiss Federal Office of Energy (SFOE).

Figure 1-6: Swiss label for energy efficient STB

The SFOE is preparing a regulation for the maximum consumption values of STBs. This is linked, on the one hand to the Federal Council's intention to propose at the end of 2007 measurements to increase energy-efficiency, and on the other hand, a request from the parliament to do this.

For Switzerland, it is important to set the regulative values to a level which is as far as possible in line with international activities and mainly with the values of the Code of Conduct. As Switzerland has already a national voluntary agreement about the STBs, based on the levels of CoC version 4, these values will be the first step in the proposed regulation.

The current draft proposed by SFOE sets the following timeline and steps, which may still be modified:

- **Tier 1**: Beginning 1.1.2008
  - Values as the CoC, version 4

- **Tier 2**: Beginning 1.1.2009 or at the latest 1.1.2010 (depending on the political process)
  - Possibility to simply go into Standby passive (with values of CoC)

    or

    Standby active values for a simple Set-top Boxes of 3W
  - Capability to self attachment, if completely disconnected manually
  - Maximum Value for On Mode (not defined yet)

Moreover, allowances for additional functionalities are presented in Table 1-8[44].

Table 1-8: Additional allowances for the basic configuration

Feature	Indicative additional maximum (standby active mode) power consumption (at the AC mains) for additional features
Internal hard disc drive	0.3 W
IEEE1394 interface	0.3 W
Ethernet interface 100 MBit	0.3 W
Each homenetwork interface	0.3 W
Each serial USB interface	0.3 W
Home automation interface	0.3 W
HDMI Interface	0.3 W
ADSL modem	2,0 W
Docsis 1.1 or 2.0 modem	2,0 W
Out of Band Transport	1.0 W
Additional LNB feed	0.3 W
Additional tuner / demodulator	0.3 W
Powered remote IR receiver	0.25 W

Feature	Indicative additional maximum (standby active mode) power consumption (at the AC mains) for additional features
MPEG4 standard or High Defintion decoder	0.5 W
Each additional decoder	0.5 W
Each DVBS2 front end	0.5 W

In any case the total maximum power consumption targets in standby active mode should not exceed 7 W for the stand-alone STB and 8 W for MPEG4 and multi-decode platforms.

- **Tier 3**: Is a step foreseen in the regulation path, but values and additional specifications have not been defined yet. The SFOE suggests that the Swiss regulation and the CoC harmonise their requirements from 2010 onwards, and the proposed 'roadmap' is presented in Table 1-9.

44 Power consumption should be measured according to the test procedure specified in the Code of Conduct.

Table 1-9: SFOE possible roadmap for the CoC and the Swiss regulation 2010 - 2012

Mode	1.1.2010 to 31.10.2010 tier 3	1.1.2011 to 31.12.2011 tier 4	1.1.2012 to 31.12.2012 tier 5
Standby passive	1 W	0.5 W	0.5 W
Standby active -allowance for networking ***Total Standby activ***	3 W 3 W ***6 W***	2 W 2 W ***4 W***	1 W 0.5 W ***1.5 W***
On -allowance for recording ***Total On***	TBD TBD TBD	TBD TBD TBD	TBD TBD TBD

These specifications for the regulation in Switzerland are still in a draft version.

1.3.3.2 United States

State of California MEPS

The California Energy Commission (CEC) is responsible for setting minimum energy performance standards in California and is about to include STBs as a regulated appliance. However, the latest rulemaking documents (Rulemaking 07-AAER-1) have proposed obligatory minimum standby and in-use power levels only for Digital TV Adaptor (DTA), i.e. simple STB.

US ENERGY STAR Program

The voluntary ENERGY STAR program, initiated by the US EPA (Environmental Protection Agency), has now matured into a world-wide energy efficiency program, run in partnership by the US EPA, the EU, Japan, Australia, New Zealand, Taiwan and Canada, to promote energy-efficient office equipment on a world-wide market. However, the EU ENERGY STAR program concerns only office equipment (products such as printers, copiers, scanners, fax-machines, and multifunctional devices) while the USA Energy Star program (including Canada) covers a larger range of products. The US ENERGY STAR has covered STBs since 2001. However, it was decided to suspend this programme in mid-2005, due to the following reasons:

- The potential for significant savings does not exist in the absence of a Sleep Mode for STBs that is compatible within the current network environment.
- Introducing a Sleep Mode within the current service provider network for STBs would adversely affect product performance, as they could miss channel map updates and other data downloads from service providers and may not be able to respond quickly enough when consumers turn them back on.
- STBs are a classic example of a ‘split-incentive’ product. Service providers are the primary purchasers of these products, but they would not benefit directly from any energy savings or any investment in making subscriber networks capable of supporting a Sleep Mode.
- Testing has identified few variations in energy use across STB models. No technology currently exists on the market to effectively incorporate Sleep Mode into STBs while maintaining the necessary network connectivity.

- Any new specification approaches would have required a new test procedure (e.g., to measure component or Sleep Mode energy consumption). EPA was willing to make the investment in developing this test procedure, but the current environment (e.g., the set-up of subscriber networks and STB technology) does not allow for the necessary stakeholder buy-in to move forward with it at this time.
- There is little variation in the power consumption of STB models currently available in the market. As such, EPA determined that there was not a current role for the Energy Star label in the marketplace.

Nevertheless, on March 15, 2007, EPA announced its intention to re-open the process to revise the ENERGY STAR programme for STBs[45]. In keeping with the ENERGY STAR Guiding Principles for specification development, EPA intended to:

- Develop a STB programme that drives for the greatest energy savings practical for this category;
- Develop energy efficiency specifications for STBs that are performance-based and technology neutral – recognising leaders in the market in terms of energy efficiency;
- Make use of existing test procedures and harmonise, where technically appropriate, with domestic and international partners on both test procedures and requirements; and
- Develop Program Requirements that offer longevity, as well as simplicity, fair comparison of products, and consideration of feature richness.

EPA finished working on these specifications, together with manufacturers and broadcasters, and has published the second version in April 2008. For each STB types as described in § 1.1.1.1, Table 1-10 presents EPA's proposal for maximum energy consumption per year. Furthermore, Table 1-11 presents additive energy allowances for additional functions. Tier 1 is planned for January 1, 2009, and Tier 2 for January 1, 2011.

Table 1-10: Base functionality annual energy allowances

Base Functionality	Tier 1 Annual Energy Allowance *(kWh/year)*	Tier 2[1] Annual Energy Allowance *(kWh/year)*
Cable	70	50
Satellite	88	56
IP	45	36
Terrestrial	27	22
Thin-Client/Remote	27	22

45 www.energystar.gov/index.cfm?c=revisions.settop_box_spec

Table 1-11: Additional functions annual energy allowances

Additional Functionalities	Tier 1 Annual Energy Allowance *(kWh/year)*	Tier 2 Annual Energy Allowance *(kWh/year)*
Additional Tuners[2]	53	16
Additional Tuners – Terrestrial /IP[3]	14	8
Adv. Video Processing[4]	18	12
DVR	60	32
High Definition[5]	35	12
Removable Media Player	12	8
Removable Media Player/Recorder	23	10
Multi-Room[6]	44	25
CableCARD[7]	15	TBD
DOCSIS[8]	20	TBD
Home Network Interface	20	10

[1] Tier 2 limits have been provided throughout this specification as preliminary targets that will be reevaluated by EPA and finalized at least nine months prior to the Tier 2 effective date.
[2] Additional Tuners adder applies only once, regardless of the number of tuners.
[3] Additional Tuners adder applies only once, regardless of the number of tuners.
[4] The Adv. Video Processing adder only applies once per box and can not be applied multiple times.
[5] Credit for High Definition applies to all STBs except those with Base Functionality of TERRESTRIAL.
[6] The Multi-room adder applies only once, regardless of the number of rooms served by the device.
[7] The cable card adder can be applied on a per cable card basis.
[8] OEMs must test with DOCSIS enabled if DOCSIS is present. Service providers can test with it and take the allowance only if they use it.

Maximum yearly electricity consumptions were established assuming that the duty cycle of the STB was as follows:

- 14 hours in on mode and 10 hours in active standby mode for a product with no auto power down[46]
- 7 hours in on mode, 7 hours in "auto power down mode" and 10 hours in active standby mode for a product with auto power down

For the test procedure and the calculations of the base and additional energy consumption of STBs, see § 1.2.1.3.

1.3.3.3 Australia / New Zealand

Australian government agencies responsible for product energy efficiency are currently investigating whether to set requirements for the energy performance of STBs that are imported and sold in Australia and New Zealand. STBs were among a group of products identified for immediate action in the standby power program.

Introducing Minimum Energy Performance Standards (MEPS) is the most appropriate option identified by the Equipment Energy Efficiency Committee (E3 Committee)[47] and two Regulatory Impact Statements were published out in April and October 2007. MEPS aim at removing the worst performing products from the marketplace, rather than promoting the best.

Proposed MEPS that covers STBs suitable for free-to-air (FTA) broadcast TV and subscription (or pay) TV (STV) is described in Table 1-12. The maximum power levels for

46 Auto power down = The capability to automatically switch from the On state to a Standby state after a period of time without user input, generally based on the amount of time the unit has remained "idle" from last active use (i.e., user input such as channel change, volume change, menu access, etc).

47 www.energyrating.gov.au/naeeec.html

the MEPS are based on the European Code of Conduct (version 4) and the mandatory requirements for digital television adapters in California (regarding simple STB).

Compliance with MEPS is determined by taking the maximum power allowance (MPA) according to features included in the applicable basic form, adding the additional features allowance (AFA) as specified in Table 1-13, if applicable, and ensuring that the total of MPA plus AFA is no greater than the maximum power level (MPL), as shown in the formula below:

$$MPA + AFA \leq MPL$$

Where MPA is Maximum Power Allowance
AFA is Additional Features Allowance
MPL is Maximum Power Limit

Table 1-12: Australian MEPS proposal for STBs

	Product type		Passive standby–Max power (W)	Active standby–Max power (W)	On mode –Max power (W)
				MPA/MPL	MPA/MPL
Simple STB	FTA SD STB	Option 1	1.0 W	8 W/15 W	8 W/15 W
		Or Option 2	2.0 W	7 W/15 W	7 W/15 W
	FTA HD STB	Option 1	1.0W	12 W/19 W	15 W/22 W
		Or Option 2	2.0W	11 W/19 W	14W/22W
Complex STB	STV STB		Not Used	9 W/15W	Not Specified

Table 1-13: Australian proposal of additional allowances

Feature	Additional power consumption (Active Standby Mode)	Additional power consumption (On Mode STB FTA only)
SCART Port	1.0 W	1.0 W
IEEE1394 interface	0.8 W	0.8 W
Ethernet interface 100 Mb	0.4 W	0.4 W
Wireless interface	2.5 W	2.5 W
SPDIF port	0.1 W	0.1 W
Serial USB interface (low power mode)	0.3 W	0.3 W
Home automation interface	0.4 W	0.4 W
Broadband (ADSL) modem	2.7 W	2.7 W
Cable modem	2.7 W	Not applicable
LNB/masthead amplifier feed	No allowance	No allowance
Additional tuner	2.0 W	2.0 W
Powered remote IR receiver	0.25 W	Not applicable
HDMI	0.5	1 W

Power consumptions are measured under the test standard AS/NZS 62087.

The proposed MEPS should be introduced from 1 October 2008. Nevertheless, **as mentioned before, limit values presented in this section are still discussed with manufacturers and other relevant stakeholders.**

1.3.3.4 Korea

The "e-Standby Program" has been implemented since April 1, 1999 for the purpose of enhancing the spreading of the energy-saving products that enable to decrease the electric power consumption during the standby mode. This is a voluntary labelling scheme supported by the Ministry of Commerce, Industry and Energy (MOCIE) and the Korea Energy Management Corporation (KEMCO). STBs are one of the 18 product groups covered by this programme.

According to the "e-Standby Program", a STB is a "commercially available electronic product encased in a single housing whose purpose is to receive, send, process, translate, and/or record signals that are then sent to a television or similar display device for viewing or to a computer for processing".

However, in the current situation, this programme does not apply to complex STBs, as the programme is related to the passive standby mode (maximum values of power consumption are presented in Table 1-14). Passive standby mode does not currently exist in complex STBs. The endorsement label for STBs that fulfil the requirements is shown in Figure 1-7.

Table 1-14: Maximum standby power consumption for STBs in Korea

Classification	Standby mode	Remark
-Satellite TV -Wireless TV -Cable TV -Internet Access Device -Video Game Console -Video Phone -With CableModem	≤3.0W	Add 0.5 W to standby mode if they have a switch to cut off input power source. [probably intended to mean a hard off switch]
-Satellite TV (Multi function) -Wireless TV (Multi function) -Cable TV (Multi function) -PVR	≤10.0W	
-Multi-function	≤20.0W	

Figure 1-7: Korean Energy-Saving Label – "Energy Boy"

1.3.3.5 China

The Chinese standards organisation – China Certification Centre for Energy Conservation Products – CECP is one of the organisations charged with responsibility for fulfilling the requirements of the "Energy Conservation Law" of the Peoples Republic of China. CECP announced China's plans to label and regulate the energy use of STBs. However, up to date the Energy Conservation Specification has been drafted only for simple cable STBs (presented at the IEA workshop held in Paris in July 2007), with the assistance of Australia and USA.

Confusingly, the CECP defines a simple STB as a box with conditional access support, aiming at receiving and decoding digital cable broadcast signals, and including Standard definition (SD) decoding (video transport streams are MPEG 2 MP@ML) and High definition (HD) decoding (video transport streams are MPEG 2 MP@HL). Maximum power consumptions might be defined only for on mode and passive standby which implies that only simple STBs are targeted.

1.3.3.6 Taiwan

In Taiwan, the "Standby Power Promotion Alliance" initiated regulations in order to decrease power consumption in standby mode of domestic electric appliances, including STBs. The first stage of the regulation, based on a voluntary agreement, targets on decreasing the standby power consumption to 2 W in 2008, and the second stage sets the maximum value at 1 W in 2012. However, this values a likely to be applicable only for passive standby mode which currently does not exist in complex STBs.

The electricity consumption in the standby mode will be measured according to the test standard IEC 62301.

1.3.3.7 International initiatives

- **International Energy Agency (IEA)**

The International Energy Agency (IEA) has been promoting the "One Watt Initiative" energy saving program to cut world-wide electricity losses from appliances in standby. Launched in 1999, this campaign aims to guide government policy-makers and appliance manufacturers towards equipment that consumes no more than 1W when in standby. IEA already conducted two workshops in 2004 and 2007 focusing on improving STBs worldwide where experts, manufacturers, broadcasters and national energy agencies were present to share their vision on this topic.

Moreover, the IEA has made two recommendations to the G8 summits at St Petersburg (2006) and in Heiligendamm (2007) containing 16 energy efficiency measures. One of theme was related to the STBs and DTAs:

> "The IEA concludes that international best practice with respect to energy efficient STBs are policies that establish is a minimum efficiency standard for Digital Television Adaptors. These regulations should specify the maximum power levels while "on" and "off" and ensure that the consumer can easily switch the unit to the lower power level. A second aspect of best practice is to ensure that government-subsidised units meet higher efficiency requirements."

Furthermore, the IEA is currently developing another initiative, namely "Implementing Agreement of efficient electrical end-use equipment". In this context, two workshops took place in Paris in March and July 2007. The aim of these workshops was firstly to provide interested Governments with an early opportunity to discuss the principle aims and tasks of this Implementing Agreement and to define priority areas of work, and secondly to discuss on first draft proposals. Several projects (called 'Annexes') of which Set-top Boxes, as well as Standby power, have been identified by the participants and will potentially be the topic of an Implementing Agreement.

The aims of this proposed Implementing Agreement are to:

- Improve co-operation between participating Governments and Sponsor organisations in activities to promote the deployment of efficient electrical end-use energy efficient technologies (excluding vehicles);
- Facilitate on-going international dialogue and public awareness of end-use electrical efficiency (excluding vehicles); and
- Undertake research and investigative activities, and to provide such information as deemed necessary to enhance the deployment of efficient electrical end-use energy efficient technologies (excluding vehicles).

It is an important feature of this proposal that the Implementing Agreement cannot impose requirements on participating countries, but can provide a forum where country responses and activities can be co-ordinated voluntarily. The extent to which individual countries wish to participate in such co-ordinated actions will remain the sole responsibility of each country.

1.3.4. STANDARDS RELATED TO THE DATA BROADCAST

Standards related to the global delivery of digital televisions and data services also exist and are mainly based on technical specifications elaborated by various working groups from different associations/federations. The content of data broadcast supplied to the complex STBs can influence their design and power consumption. These specifications may limit the possibilities to radically redesign the STBs in the short term, especially regarding software. On the other hand, in the mid- to long-term possible eco-design requirements on STB may call for a change in these broadcasting standards.

- **Standards based on technical documents of DVB**

Several technical specifications are developed by the Digital Video Broadcasting Project[48] (DVB), an industry-led consortium of over 270 broadcasters, manufacturers, network operators, software developers, regulatory bodies and others over 35 countries.

These specifications produced by DVB are subsequently standardised in one of the European competent bodies, usually the European Telecommunications Standards Institute[49] (ETSI).

48 www.dvb.org
49 www.etsi.org

These standards can be listed in several categories:

- Transmission
- Multiplexing
- Subtitling
- Interactivity
- Interfacing
- Conditional access

Other technical documents approved by the ETSI but not adopted as standards are also available and fall in the categories listed above as well as in others such as conditional access, middleware, Internet Protocol (IP) and source coding.

The complete list of specifications developed by the DVB can be found at the following Internet address: www.dvb.org/technology/standards/#content and the EN standards are provided in ANNEX A.

- **Standards based on technical documents of DLNA**

The Digital Living Network Alliance[50] (DLNA) is an international organisation whose members (manufacturers of audio and video equipments or components, broadcasters) "share a vision of a wired and wireless interoperable network of Personal Computers (PC), Consumer Electronics (CE) and mobile devices in the home enabling a seamless environment for sharing and growing new digital media and content services".

In this context, the DLNA established some "Network Device Interoperability Guidelines", and the specifications published in its last version in March 2006 have received the agreement in March 2007 of the IEC to be transposed in an international standard, namely IEC 62481 ("DLNA home networked device interoperability guidelines"), split in two parts:

- **IEC 62481-1 (Architecture and Protocols):** This first part of the standard specifies the information needed to build interoperable networked platforms and devices for the digital home on audio, video and multimedia systems, including interoperable components for devices and software infrastructure, physical media, network transports, device discovery and control, media management and control, media formats, and media transport protocols. It also provides product developers with a long-term architectural view, plus specific guidance for IP-networked platforms, devices and applications in the home.
- **IEC 62481-2 (DLNA Media Formats):** This second part of the standard lists the DLNA media format profiles applicable to IEC 62481-1. Media format profiles are defined for each of the following media classes: audio, image, and AV. In addition, profile ID values that identify media collections and printer XHTML documents are also introduced.

50 www.dlna.org

Products designed to the DLNA Networked Device Interoperability Guidelines are granted use of the DLNA CERTIFIED™ Logo (see Figure 1-8) after meeting all DLNA certification and testing requirements. The first DLNA CERTIFIED™ products appeared on retail shelves in 2006, enabling a better experience for consumers, building consumer confidence and adding value to the Consumer Electronics, PC and mobile device markets.

Figure 1-8: DLNA Certified TM Logo

1.4. CONCLUSIONS FOR TASK 1

The discussion presented in §s 1.1 and 1.2 outlined the key issues and parameters related to the products relevant to the lot 18. Further, it defines the scope of the study which is restricted to STBs with conditional access. Figure 1-9 summarises scope and functionality aspects to be considered in the following tasks. Market analysis, consumer behaviour analysis and the definition of Base Cases have to consider this structure.

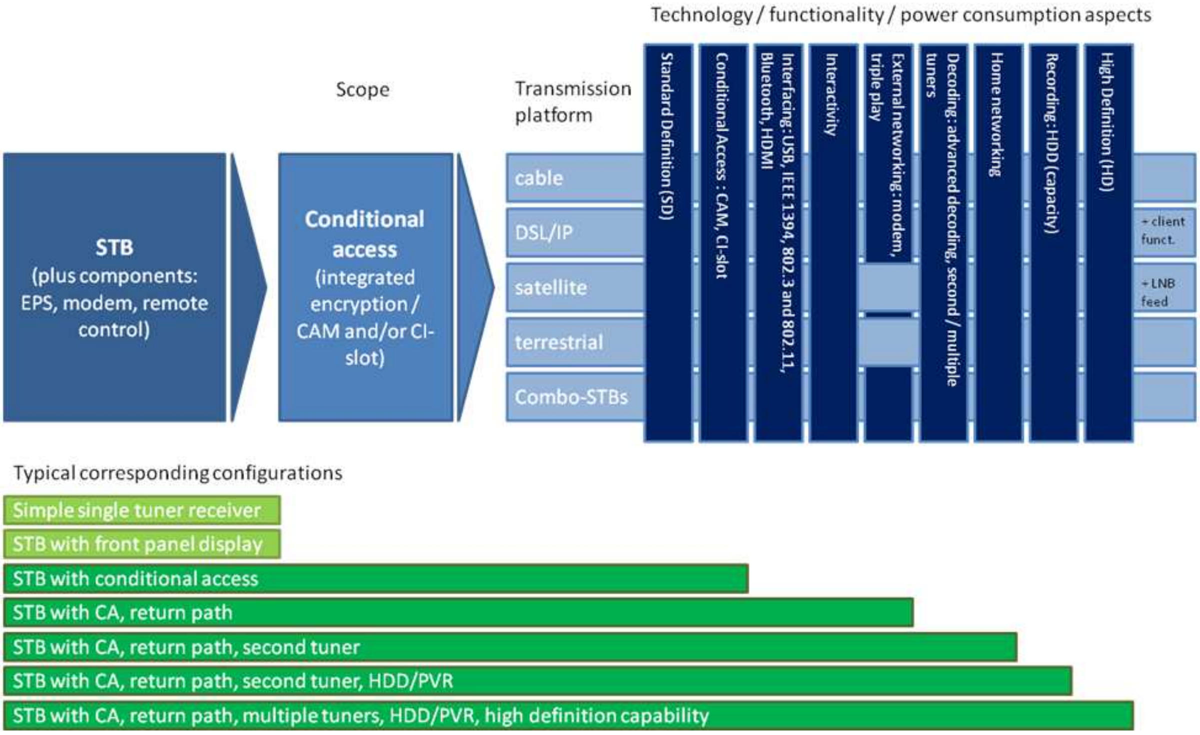

Figure 1-9: Summary of functionalities of (complex) STBs and typical configurations[51]

Several test standards on energy consumption exist and they present some discrepancies about testing conditions and the measurement modes. The standard EN 62087:2003 is the reference one for several European (Code of Conduct, GEEA) and third country programmes (Switzerland, Australian MEPS and Korea). Nevertheless, it is currently under revision.

The identification of the relevant legislation worldwide reveals that currently only Switzerland is developing obligatory standards related to the energy consumption of complex STBs.

[51] A combo-STB is a STB which can deal with more than one transmission platform; e.g. satellite STB with a modem, which allows DSL access.

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2. Task 2 – Economic and Market Analysis

The purpose of this section is to present the economic and market analysis for the purpose of the lot 18 EuP preparatory study on complex STBs. The aim is, firstly, to place this product group within the total context of EU industry and trade policy. Secondly, it provides market (stock) and cost inputs for the assessment of EU-wide environmental impact of the product group. Thirdly, it aims at providing insights in the latest market trends so as to indicate the market structures and ongoing trends in product design. This will serve as an input for the subsequent tasks such as improvement potential. Finally, the data on consumer prices and rates is provided to be used later in the study for Life Cycle Cost (LCC) calculations.

2.1. GENERIC AND ECONOMIC DATA

Ideally, official EU statistics on import, export and production of complex STBs in the EU would be presented here, as to be coherent with official data used in EU industry and trade policy. However, official EU production and trade statistics do not provide useful data on complex STBs. PRODCOM, the system for the collection and dissemination of statistics on the production of manufactured goods in EU, mentions three categories of products referring to STBs (which is the recent terminology for TV-decoder/receiver) however, these categories are much aggregated. The three PRODCOM codes which can be related to the products in the scope of the Lot 18 preparatory study are:

- 32.30.20.75: Tuner blocks for CTV/VCR and cable TV receiver units
- 32.30.20.79: Satellite TV receiver/decoder
- 32.20.11.60: Transmission apparatus for radio broadcasting and television, with reception apparatus

However, as these PRODCOM codes do not distinguish between simple and complex STBs, PRODCOM may not serve as a useful data source for the products falling into the scope of this study.

Further, since the Eurostat data is not available in the necessary level of detail, it was necessary to investigate other sources of market and product stock data. Therefore, a questionnaire was sent to gather market and economic data from both to manufacturers of complex STB as well as to some of the European broadcasters that procure these products. However, due to the restricted number of responses and the complexity of the product and market segmentation it was not possible to get consistent data for the overall EU 27 situation.

2.2. MARKET AND STOCK DATA

The STB market covers a wide range of products for which the terminology is often complex to understand. Depending of the source (e.g. market survey, broadcaster, STB manufacturer), various categories of products are defined, which makes it difficult to analyse and aggregate the data. For example, existing categories of products include: "higher-end DTV STB"[52] (Digital TV STBs) which are defined as interactive STBs with or without internal mass storage media; "stand-alone" STBs; "basic zapper STB"[52] defined as digital receivers which are not equipped with interactive capabilities and typically designed to facilitate tuning to digital TV channels only, "simple STBs" (= basic zappers), etc. STBs can also be named by their TV reception platform: e.g. cable DTV STB, satellite DTV SBT, without the possibility of knowing whether the product refers to a simple or complex STB.

EU is rapidly moving towards the complete switchover to digital TV transmission and thus phase-out of the analogue broadcasting. Consequently, the current stock of analogue TVs will need digital-to-analogue converter boxes in order to function. These boxes are typically simple STBs, which were the subject of a separate preparatory study[53].

The complex STB market development is rather independent of the digital switchover phenomenon that affects the simple STB market and the number of complex STBs can be linked to the pay-TV subscription which is competing on the market with the free broadcasting. Further, due to the tricky segmentation of the complex STB market, which often leads to overlapping categories of products, market data is not readily available for the Lot 18 products. Thus, the approach to estimate the market data for complex STBs is to make the pragmatic assumption that the number of installed complex STBs (i.e. the stock) is approximately the same as the number of pay-TV subscriptions.

As the conditional access is related to pay-TV, the stock data for complex STBs can be roughly estimated based on the number of pay-TV subscribers for each platform, assuming that each subscriber of pay-TV services uses one complex STB. This leads to obtaining market data according to the transmission platform.

Another segmentation of the complex STB market data, according to parameters that strongly influence the overall electricity consumption (will be analysed in detail later in Task 4[54]) of complex STBs, was made according to the resolution, i.e. SD (Standard Definition) or HD (High Definition); and according to the recording capability (functionality), i.e. internal mass storage media (STB fitted with a recording media), non-internal mass storage media. This results in following four categories of complex STBs[55]:

- SD-STB (Standard Definition Digital STB)
- HD-STB (High Definition Digital STB)
- SD-STB with internal mass media (Standard Definition Digital STB with an internal mass storage media)

52 Booz Allen & Hamilton, *Set Top Box Market Assessment Europe*. 2007

53 Final report EuP Preparatory Study Simple Digital TV Converters (Simple Set Top Boxes)

54 Indeed the HD capability typically adds about 5-10 W of power use because the STB has to process more picture information. The DVR functionality adds about 10 W of power use. [Horowitz, Foster. *Cable and Satellite Set Top Box Energy Savings Opportunities*. National Resources Defense Council, NRDC, 2005]

55 Section 2.3.4.1 provides more details on the "High Definition" technology

- HD-STB with internal mass media (High Definition Digital STB with an internal mass storage media)

It was assumed that the sales and stock data presented the same transmission platform distribution and the same technical features distribution. Transmission platform distribution was based on the stock data, and technical feature distribution was based on the sales data.

Task 2 attempts to collect the data for the EU 27 and provides market estimates for the reference years 2007 (current situation) until 2020, subjected to data availability.

2.2.1. SALES DATA

2.2.1.1 Current sales and future projections

It has been estimated that about 22 million complex STBs were sold in the EU 27 during the year 2007[52]. The sales projections for the year 2008 are estimated to 30 million, and are expected to reach 42 million in 2009. Assuming a constant annual growth rate of 40%[56], it can be estimated that the complex STB sales will reach about 58.8 million in 2010 (Table 2-1).

Table 2-1: Estimated current and future sales of complex STBs (EU 27)

	2006	2007	2008	2009	2010
Sales (million units)	18.0	22.0	30.0	42.0	58.8*

**calculation based on the annual growth rate 2008-2009*

- **Data by transmission platform**

Assuming the sales distribution of complex STB by platform follow the same proportion as the stock (see Table 2-13), the sales data for complex STB for different TV transmission platforms was calculated (Table 2-2) and is presented in Figure 2-1.

Table 2-2: Estimated complex STB sales by transmission platform (EU 27)

Sales per platform (million units)	2007	2008	2009	2010
Cable	8.2	10.8	14.8	20.6
Satellite	10.0	12.7	16.7	21.9
IP	2.0	3.6	5.9	9.0
Terrestrial	1.8	2.9	4.7	7.2
Total	**22.0**	**30.0**	**42.0**	**58.8**

[56] Corresponds to 2008-09 growth

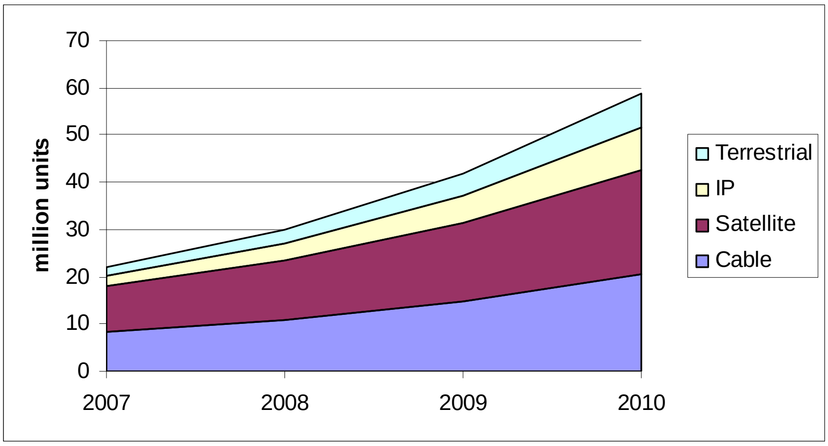

Figure 2-1: Estimated complex STB sales per transmission platform (EU 27)

- **Sales data by technical features**

The total sales of complex STB for the year 2007 can also be classified according to technical features. The worldwide sales of STBs (simple and complex) for the IP platform[57] are distributed as presented in Table 2-3 and depicted in Figure 2-2, showing increasing HD and DVR capabilities.

Table 2-3: Distribution of the sales of STB according to resolution and functionality[58]

IP STB sales (world)	2003	2004	2005	2006	2007	2008	2009	2010
SD	100.0%	100.0%	100.0%	98.4%	97.7%	95.7%	88.3%	85.7%
HD	0.0%	0.0%	0.0%	1.6%	2.3%	4.3%	11.7%	14.3%
DVR[59]	100.0%	100.0%	100.0%	96.8%	90.2%	87.1%	81.3%	75.6%
DVR	0.0%	0.0%	0.0%	3.2%	9.8%	12.9%	18.8%	24.4%

Here, the functionality is not “internal mass storage media” but DVR (Digital video recording). It should be noted that DVR is a broader functionality which can include STBs having an integrated DVD recorder (excluded from the scope of the EuP Lot 18 study and estimated to represent a very small share of the overall STB market).

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57 No data could be found related to the other platforms

58 IMS research (*IPTV: A global Market Analysis*) 2005

59 Please note that the term “DVR” differs from “internal mass storage media” as “DVR” STBs can also include STBs with a DVD recorder which are out of the scope of the Lot 18 EuP Study (refer to Task 1).

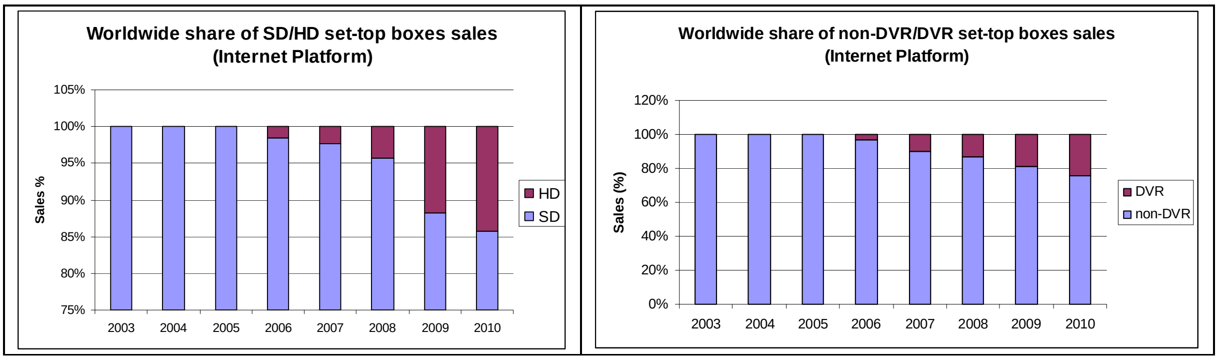

Figure 2-2: Worldwide distribution of the sales of STBs (Internet platform)

Assuming that 50% of the HD boxes worldwide have the DVR functionality in 2007 and 2008 and assuming that the share of HD-DVR sales in the total HD-STB market will be of 60% and 75%[60] for the years 2009 and 2010 respectively, following distribution of sales for STB with different technical features can be calculated (Table 2-4):

Table 2-4: Distribution of the sales of IP-STB according to features (worldwide)

IP STB sales	2003	2004	2005	2006	2007	2008	2009	2010
SD non-DVR	100.0%	100.0%	100.0%	96.0%	89.0%	84.9%	76.6%	72.1%
HD non-DVR	0.0%	0.0%	0.0%	0.8%	1.1%	2.2%	4.7%	3.6%
SD-DVR	0.0%	0.0%	0.0%	2.4%	8.7%	10.8%	11.7%	13.7%
HD-DVR	0.0%	0.0%	0.0%	0.8%	1.1%	2.2%	7.0%	10.7%

In USA, the stock of STBs (simple and complex) for the satellite and cable platforms is distributed as presented in Table 2-5. The table shows that there is not a great variability across platforms (cable and satellite) and that the distribution is similar to the worldwide data related to the sales presented above (Table 2-4). It is assumed that the distribution across features for the stock can be applied to the sales data (and vice versa).

Table 2-5: Distribution of the stock of STBs per feature in USA[61] (2007)

Stock of complex and simple STB	Cable	Satellite
SD	87.5%	87.4%
HD	2.1%	2.0%
SD-DVR	8.3%	8.6%
HD-DVR	2.1%	2.0%

60 In a report for the US Consumer Electronics Association [McKenney, R. *Energy Consumption of Electronics in U.S. Residences*. Report for the CEA. 2007] the assumption was made that for the year 2007, **50% of HD STB are HD DVR STB.** Also, in a market research by IMS research [*Worldwide Market for Digital Set Top Boxes* and iDTVs – 2007], it was found that about 30% of the HD STB have the DVR functionality in 2007, against 50% in 2008. For the years 2007 and 2008, we therefore estimate that worldwide, 50% of HD STB have the DVR functionality. For the years 2009 and 2010, we estimate the share of HD-DVR over total HD-STB to be of 60% and 75% based on data from IMS research [*Worldwide Market for Digital Set Top Boxes and iDTVs* – 2007].

61 McKenney, Roth. *Energy Consumption of Electronics in U.S. Residences*. Report for the CEA. 2007

Based on the worldwide and US situation, and assuming that the shares of HD and DVR STB are slightly higher in complex STBs than in simple STBs[62], the EU 27 sales of complex STB can be estimated as shown in Table 2-6.

Table 2-6: Estimated sales of complex STB according to technical features

<table>
<tr><th></th><th>Complex STB sales (EU 27)</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th></tr>
<tr><td rowspan="2">According to resolution</td><td>SD</td><td>95%</td><td>93%</td><td>86%</td><td>83%</td></tr>
<tr><td>HD</td><td>5%</td><td>7%</td><td>14%</td><td>17%</td></tr>
<tr><td rowspan="2">According to recording capability</td><td>No Internal Mass Storage Media</td><td>85%</td><td>82%</td><td>77%</td><td>71%</td></tr>
<tr><td>Internal Mass Storage Media</td><td>15%</td><td>18%</td><td>23%</td><td>29%</td></tr>
</table>

Further, on the basis of following assumptions[63], the sales distribution according to technical features was calculated as shown in Table 2-7.

- in 2007 and 2008, 50% of HD complex STB have internal mass storage media,
- in 2009, 60% of HD complex STB will have internal mass storage media,
- in 2010, 75% of HD complex STB will have internal mass storage media,

Table 2-7: Estimated sales distribution of complex STB according to technical features (EU 27)

Complex STB sales	2007	2008	2009	2010
SD	82.5%	78.6%	70.9%	67.1%
HD	2.5%	3.5%	5.7%	4.2%
SD-STB with internal mass storage media	12.5%	14.4%	15.0%	16.3%
HD-STB with internal mass storage media	2.5%	3.5%	8.5%	12.5%

When applied to the total sales of complex STBs in EU 27 (Table 2-1), we arrive at the sales distribution of different types of complex STB classified according to technical features (see Table 2-8). Figure 2-3 shows that the STB with HD and internal mass storage media will be the categories of products having highest sales growth potential in the short term future (i.e. until 2010).

62 The preparatory study on simple STBs states that 6% of simple STB are Personal Video Recorder (PVR) STBs

63 See estimates presented in footnote [60]

Table 2-8: Estimated sales of complex STB according to technical features (EU 27)

Complex STB sales (million units)	2007	2008	2009	2010
SD	18.2	23.6	29.8	39.4
HD	0.6	1.0	2.4	2.5
SD-STB with internal mass storage media	2.8	4.3	6.3	9.6
HD-STB with internal mass storage media	0.6	1.0	3.6	7.4
Total	22.0	30.0	42.0	*58.8*

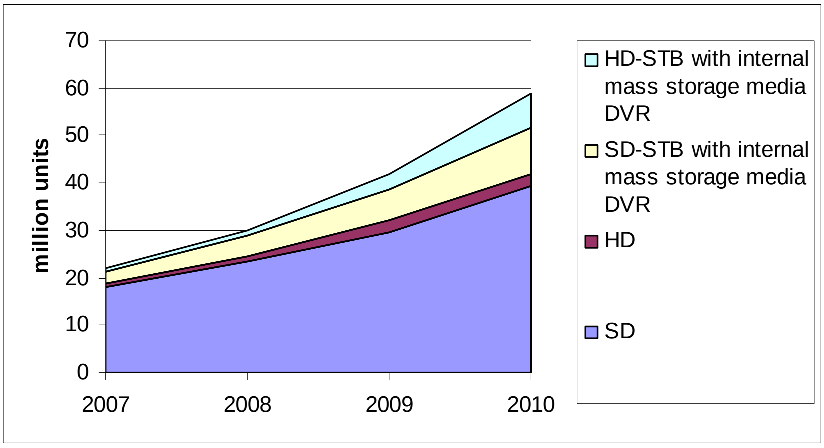

Figure 2-3: Estimated sales of complex STBs by feature (EU 27)

2.2.1.2 Annual sales growth rate

Data presented in Table 2-8 allows calculating sales growth rates and the compound annual growth rate over the period 2007-2010. As shown in Table 2-9, the sales of complex STBs will be more than double between 2007 and 2010, and have a compound annual growth rate (GAGR) of 38.8% over the period 2007-2010.

Table 2-9: Annual sales growth rate of complex STB (EU 27)

Complex STB	2006-2007	2007-2008	2008-2009	CAGR 2007-2010
Annual Sales growth rate	22.2%	36.4%	40.0%	38.8%

This is in-line with the worldwide projections: it has been estimated[64] that approximately 96 million digital STB (simple and complex) were sold in 2005, and forecasted that worldwide sales of digital STBs will more than double over the next 5 years, surpassing 200 million units sold in 2011.

64 IMS research (*Worldwide Market for Digital Set Top Boxes and iDTVs)* 2007

2.2.1.3 Replacement sales

The share of the replacement sales were calculated using data on stock provided in § 2.2.2. Table 2-10 shows that over 80% of the STB sales are the replacement sales. This sounds reasonable because very often a new STB replaces the existing one. The situation might change with the arrival of multi-decode (also called multi-room) STB where one STB might be able to serve different televisions in a typical home and might replace the individual STB existing in the living room, sleeping room, kitchen, etc.

Table 2-10: Estimated share of replacement sales of complex STBs (EU 27)

Year	Total sales	Replacement sales[65]	Share of the replacement sales
2007	22	N/A	N/A
2008	30	24.4	81.2%
2009	42	36.7	87.5%
2010	58.8	53.4	90.8%

2.2.2. Stock data

2.2.2.1 Current stock

As stated in the introduction of the § 2.2. , the stock data for complex STB is estimated on the basis of the number of pay-TV subscriptions in the EU. However, the data on the number of pay-TV subscribers was available only for Western Europe[66]. This data was extrapolated to EU 27 as a function of the population in Western Europe and EU 27 (Norway and Switzerland excluded).

Such extrapolation by reception platform estimates the overall stock of **complex STBs in EU 27 to be 65.7 million for the year 2007**.

According to the Eurobarometer household survey[67], 36% of European households received pay-TV services in 2006. This leads to roughly 70 million complex STBs in EU, assuming that each household has one complex STB to receive the pay-TV channels. This is slightly higher than the above-mentioned estimate of 65.7 million, but this could be explained by the fact that some households receive pay-TV services without having subscribed to a pay-TV service (e.g. community shared satellite installations).

- **Data by reception platform**

Based on the number of subscriptions to pay-TV services, the stock of complex STBs for different transmission platforms was estimated as presented in Table 2-11.

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65 Replacement sales for the year n = sales (n) –[stock (n)-stock (n-1)]

66 e-Media Institute, *European Pay-TV Forecasts Map (Western Europe)* 2008. Western Europe includes AT, BE, CH, CY, DE, DK, ES, FI, FR, PT, IE, IS, IT, LU, MT, NL, NO, PT, SE. Data for Western Europe, excluding Norway and Switzerland, was extrapolated based on the proportion of the population in order to provide EU 27 data estimates.

67 EC(2007) E-Communications Household Survey, Special Eurobarometer ec.europa.eu/public_opinion/archives/ebs/ebs_274_en.pdf

Table 2-11: Estimated stock of complex STBs in EU 27

Complex STB stock (million units)	2007	%
Cable	24.4	37.2%
Satellite	29.9	45.5%
IP	6.0	9.1%
Terrestrial	5.4	8.2%
Total	65.7	100.0%

These European averages hide large differences between different Member States (MS). For example, in France[68] where about 56% of the households receive pay-TV, the IP platform has developed very rapidly and represents currently 30% of the pay-TV subscriptions (as much as cable). Terrestrial and satellite pay-TV only represent about 20% each. On the other hand, in the UK, where 47% of households receive pay-TV services, the satellite platform represents 70% of pay-TV services followed by the cable platform (28%), the terrestrial platform (2%), and the IP platform (1%).

- **Data by technical features**

Assuming the distribution of the stock per technical features is similar to the distribution of the sales (see Table 2-7); the shares of the stock were calculated and are presented in Table 2-12.

Table 2-12: Estimated stock of complex STBs by technical features (EU 27)

Complex STB stock (million units)	2007	%
SD	54.2	82.5%
HD	1.6	2.5%
SD-STB with internal mass storage media DVR	8.2	12.5%
HD-STB with internal mass storage media DVR	1.6	2.5%
Total	65.7	100.0%

2.2.2.2 Past and future stocks

In the year preceding the digital switchover and a little beyond (2008-2012 period, see § 2.3.1. for more details), the majority of televisions (i.e. the analogue ones) will use simple STBs. However, beyond complete digital switchover, the subscriber technology platforms (i.e. involving complex STBs) are foreseen to increasingly become the dominant as consumers are introduced to and getting used to new services which these systems can deliver e.g. Video on-Demand (VoD), broadband access, interactive programmes and content.[69] Further, the consumer electronics market is perceived to become more and more technology than consumer demand driven[69]. Thus, future projections cannot be based on current consumer attitudes, which may still indicate little interest in advanced digital service features and which can be observed to be

[68] France is the biggest of Europe's IPTV markets and will still be in 2009 according to market research by Screen Digest. Screen Digest (2005) European IPTV: Market assessment and forecasts to 2009

[69] MTP (2007) BNDA3: Digital TV adapters in the UK – rationale/assumptions for projecting future energy consumption, version 1.1.

going through a transformation and can be expected to change substantially in the future.

Figure 2-4 presents the digital TV penetration scenario in Europe. It shows that digitalisation is expected to go hand-in-hand with the increase in the number of pay TV subscribers.

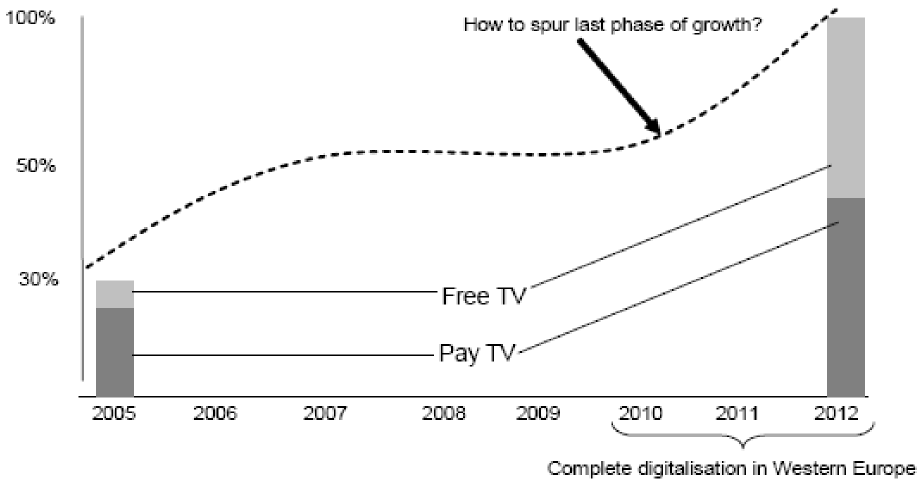

Figure 2-4: Digital TV penetration scenario in Europe[70]

Available projections on the future evolution of pay-TV subscriptions[71] and services enable making estimates of the future stock of complex STBs until 2010. Long term projections until 2020 are roughly estimated later in the study in § 2.3.5.

- **Data by transmission platform**

Based on projections of the number of pay-TV subscriptions by reception platforms, the future stock of complex STBs was estimated for each reception platform. Results are presented in Table 2-13 and depicted in Table 2-4.

Table 2-13: Estimated stock of complex STBs by platform (EU 27)

Complex STB stock (million units)	2007	%	2008	%	2009	%	2010	%
Cable	24.4	37.2%	25.7	36.0%	26.9	35.2%	28.7	35.0%
Satellite	29.9	45.5%	30.2	42.4%	30.4	39.7%	30.5	37.2%
IP	6.0	9.1%	8.5	11.9%	10.7	14.0%	12.6	15.4%
Terrestrial	5.4	8.2%	6.9	9.7%	8.5	11.1%	10.1	12.3%
Total	65.7	100.0%	71.3	100.0%	76.6	100.0%	81.9	100.0%

[70] European Broadcasting Union (EBU) in DigiTAG (2006) Analogue Switch-off - Strategies to end analogue terrestrial television in Europe, www.digitag.org/DVBHandbook.pdf

[71] *European Pay-TV Forecasts Map (Western Europe)* from the e-Media Institute (2008). Western Europe includes AT, BE, CH, CY, DE, DK, ES, FI, FR, PT, IE, IS, IT, LU, MT, NL, NO, PT, SE. Data for Western Europe, excluding Norway and Switzerland, was extrapolated based on the proportion of the population in order to provide EU 27 data estimates.

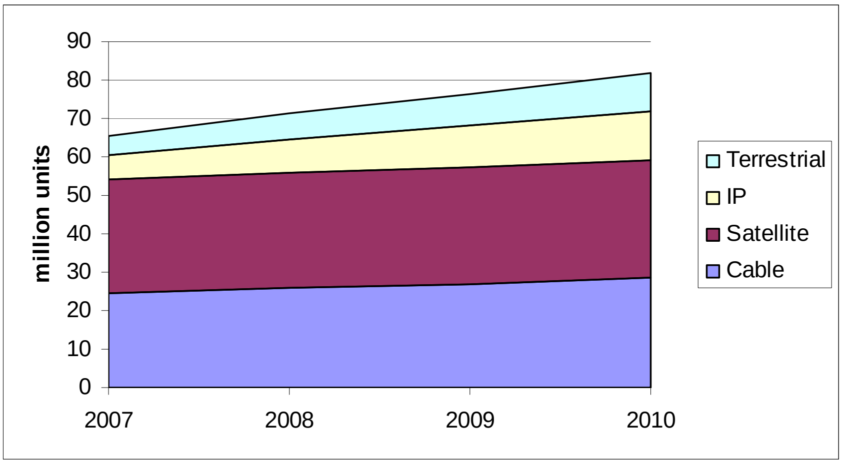

Figure 2-5: Estimated stock of complex STBs by platform (EU 27)

According to these estimates, the total stock of complex STB will reach 81.9 million units by 2010. The trends for the cable and satellite are rather flat (very slight increase) whereas the terrestrial and IP platforms show an increase.

The estimates presented in Table 2-13 for the total stock correlate with a European study[52] stating that the number of Digital interactive-TV households (i.e. households requiring a complex-STB to receive TV-services) will amount 79 million in 2009; and projecting that in 2009, among the total European digital TV households (not only pay-TV), 34% will receive digital TV through the Cable platform, 33% through Satellite platform, 21% through the terrestrial platform and 13% through IP.

However, the estimated distribution of complex STB across platforms can be challenged when compared with another estimate covering 16 European countries[72] for the year 2009 (see Figure 2-6).

For the Internet platform, the previous estimate is in line with this alternative source (see Figure 2-6) projecting the number of IPTV subscribers to reach 8.7 million by 2009, representing about 13% of the market. However, for other platforms, estimates for the year 2009 covering 16 European countries provide slightly different results with the terrestrial platform representing 3%, the satellite representing 13%, and the cable platform representing over 70% of the digital pay-TV market.

The differences in the share of transmission platforms show that the existing market statistics are controversial. For the purpose of this study, the estimates from Table 2-13 will be used.

[72] Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Slovenia, Spain, Sweden, Switzerland, UK

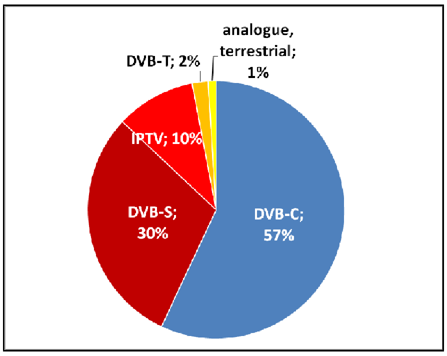

Figure 2-6: Pay-TV and related transmission platforms in Europe, 2009[73]

Cost, added functionality, and quality of signal determine the final choice of consumers when deciding about a transmission platform. The conversion from analogue to digital, in general, does not directly impact television services involving complex STBs. However, it does indirectly force these service providers to take action in order to remain competitive: offering STB with added functionality, such internal mass storage media and HD display capability may be used as a technique to encourage consumers to subscribe to a particular service.[74]

- **Data by technical features**

The pay-TV service providers are increasingly moving to boxes with high definition (HD) image quality and internal mass storage media (i.e. program recording capabilities).

Assuming that the distribution of the stock of complex STBs by technical features follow the same trends as the sales (see Table 2-7), the stock data by technical features was calculated as shown in Table 2-14 and Figure 2-7.

Table 2-14: Estimated stock of complex STBs by technical features (EU 27)

Complex STB stock (million units)	2007	%	2008	%	2009	%	2010	%
SD	54.2	82.5%	56.0	78.6%	54.3	70.9%	55.0	67.1%
HD	1.6	2.5%	2.5	3.5%	4.3	5.7%	3.4	4.2%
SD-STB with internal mass storage media DVR	8.2	12.5%	10.3	14.4%	11.5	15.0%	13.3	16.3%
HD-STB with internal mass storage media DVR	1.6	2.5%	2.5	3.5%	6.5	8.5%	10.2	12.5%
Total	65.7	100.0%	71.3	100.0%	76.6	100.0%	81.9	100.0%

73 Goldmedia Screen Digest; European IPTV (2005) press release: IPTV set for boom time in Europe as convergence finally becomes a reality – by 2009 IPTV will account for almost ten per cent of the European pay TV market, November 21, 2005
DVB-C: Cable/DVB-S: Satellite/DVB-T: Terrestrial/IPTV: Internet platform (IP)

74 NRDC (2005) Cable and Satellite Set Top Box Energy Savings Opportunities.

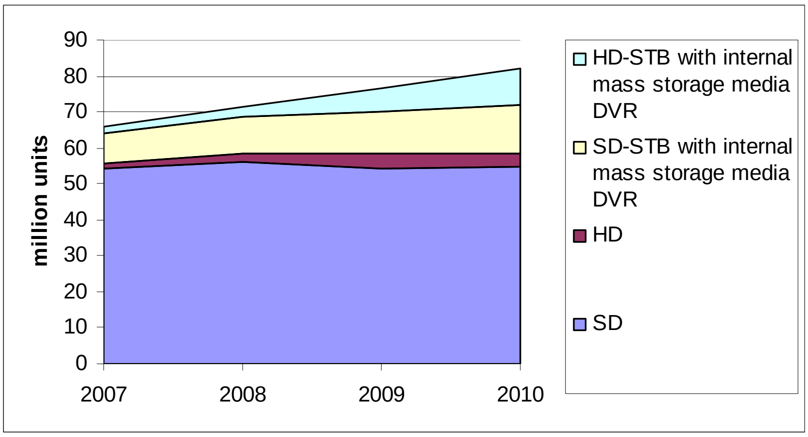

Figure 2-7: Estimated stock of complex STBs by technical features (EU 27)

2.3. MARKET TRENDS

2.3.1. MARKET PENETRATION OF BROADBAND / DIGITAL TV

As of mid 2006, in addition to 122 analogue nationwide channels, some 1335 digital channels were available over multiple platforms (cable, satellite, terrestrial, IPTV) throughout the EU. A number of these channels targeted the market of another Member State or were based outside the EU. In addition to channels available nationally or trans-nationally, the number of regional channels is estimated at around 3000.[75]

In the broadband area, there are no major roadblocks hampering mass market adoption at least in Western Europe (predicted 27.1% of penetration by end 2010), but disparities remain high between MS.[76]

As the planned transition to digital television continuous, the existing analogue services will be removed over the next five to ten years. Therefore, digital television will ultimately replace the analogue systems in Europe.

The digital transmission allows transporting more information while requiring the same bandwidth as analogue standard due to new compression algorithms such as MPEG-2. This allows a greater number of channels to be broadcasted and also a better quality of TV signals for a given distribution network bandwidth. This development marks a trend that is similar to the development in the video sector (e.g. additional information for movies on DVD´s). When using MPEG-2 compression methods, only the changes between frames are sent. Consequently the transmission speed is raised and the amount of data is reduced. Digital television produces pictures with a higher resolution than traditional analogue television and it has the benefit of digital surround sound and the possibility of high definition television. Further add-ons of digital TV combined with a return channel offer a wide range of interactive services like interactive TV, an

75 Sixth Report on the application of Directive 89/552/EEC "Television without Frontiers", Brussels, 24.10.2007, COM(2007) 452 final, data based on: European Audiovisual Observatory, Yearbook 2006

76 European Commission, Screen Digest Ltd, CMS Hasche Sigle, Goldmedia Gmbh, Rightscom Ltd (Hrsg.): Interactive content and convergence: Implications for the information society, 10/2006. p. 40

electronic program guide (EPG), video on demand (VOD) or Pay TV. Interactive TV defines a lot of new market concepts for TV: there will be the possibility to implement voting on game shows or to get information about the accessory of movie stars.

There are different existing standards for digital television such as Digital Video Broadcasting (DVB), Advances Television System Committee (ATSC), and Integrated Services Digital Broadcasting (ISDB). All European countries have adapted to the DVB standard. DVB defines transmission standards for Cable TV (DVB-C), Satellite (DVB-S), terrestrial (DVB-T) and Handheld TV (DVB-H), the latter being irrelevant for STB. Furthermore, DVB-H is not expected to have an influence on the other DVB transmission channels and market sizes as handheld TV will not replace stationary TV significantly.

All DVB standards have recently been adapted to new requirements or are currently under revision accordingly (DVB-T2, -C2, -S2). The STB specified for the first generation of these standards will not be compatible with the revised formats.

- **DVB-T / DVB-T2 (Terrestrial Platform)**

Table 2-15 shows the timeline of different MS for switching from analogue terrestrial TV to DVB-T.

Table 2-15: Switchover from analogue terrestrial TV to DVB-T in Europe

Country	Official launch	Closedown finished	Country	Official launch	Closedown finished
Luxembourg		2006	Slovenia		2010
The Netherlands	2003	2006	Austria	2006	2010
Finland	2001	2007	France	2005	2011
Andorra		2007	United Kingdom	1998	2012
Sweden	1999	2007	Bulgaria		2012
Belgium	2002/2003	2008	Ireland		2012
Germany	2002	2008	Italy	2004	2012
Denmark	2006	2009	Portugal	2008	2012
Czech Republic	2007	2010	Slovakia		2012
Greece	2006	2010	Hungary	2010	2013
Spain	2000	2010			

The majority of MS will have switched over by 2010. High digital household penetration rates are usually realised 2 years prior to the closedown, meaning the number of households watching analogue terrestrial TV will be negligible by 2010.

Currently, a new standard DVB-T2 is under development to enhance bandwidth and robustness of transmission of terrestrial digital TV. The publication of the DVB-T2 draft specification is expected at the end of June 2008. According to the “DVB project”[77] the new standard could enable, for example, the roll out of new nationwide multiplexes offering multichannel HDTV services, or perhaps innovative new datacasting services. However, terrestrial HDTV does not necessarily need DVB-T2 and can work with DVB-T as well. Countries deciding for a transition from DVB-T to DVB-T2 will see a co-

[77] www.dvb.org/technology/dvbt2/index.xml

existence of both systems for a couple of years. Products that implement the DVB-T2 standard (i.e. STB and/or TV sets) are not likely to become widely available until 2010 and prices of these devices are expected to be rather high in the beginning as shown by the past experience with DVB. DVB-T2 is meant for countries /regions, where analogue switch-off (ASO) has already taken place, i.e. as a successor of DVB-T, not instead of DVB-T at first introduction of digital terrestrial TV.

- **DVB-C / DVB-C2 (Cable Platform)**

The digital standard has been developed for cable networks. Yet it is not very common in Europe as most countries in Europe have concentrated on satellite TV. Nevertheless, in some countries such as Germany cable network is very important for TV broadcasting, according to the European household survey[78].

Currently, development of a DVB-C2 standard to address specifically the needs of HDTV and Video on Demand is under discussion, but still at an early stage[79].

The current business and technology market trends relevant for the DVB-C segment are reflected by the needs identified by the DVB-CM-C2 ad-hoc group in 2007:

- Need for more transport capacity in cable networks applicable to new services such as HDTV, VoD, and other advanced personalised and interactive services.
- Need for cable operators to remain competitive and flexible and to be able to keep a digital offering competitive in mature digital TV markets.
- Need for cable operators to remain capable to retransmit entire multiplexes received via satellite or terrestrial networks using higher modulation schemes.
- Need to have more and better technical tools providing new opportunities to expand operators' offerings into the business and residential markets.
- Need for an overall performance improvement and improved customer experience that will be necessary when marketing new services.

- **DVB-S / DVB-S2 (Satellite Platform)**

Digital satellite TV (DVB-S) is the central technological base for digital TV and HDTV. Furthermore, DVB-S has the big advantage of having a greater frequency range than other DVB-standards. DVB-S2 is a subsequent technology to DVB-S with a higher compression rate (MPEG-4 AVC) and a better error correction. DVB-S2 has a high potential for becoming the main transmission path for the digital TV of the future including HDTV.

It is also possible to integrate a return path in a DVB-S/S2 system. This capability has been standardised with EN 301790 (2005) as DVB-RCS[80]. Communication in both

78 EC(2007) E-Communications Household Survey, Special Eurobarometer
79 DVB TM-C2: Second Generation Transmission Technologies for Cable Networks - Call for Technologies, 15.02.2008
80 RCS: Return Channel Satellite

directions works via satellite: “DVB-RCS implementations can dynamically provide anywhere up to 20 Mbit/s to each terminal to the outbound link and up to 5 Mbit/s or more from each terminal on the inbound link”[81]. The DVB-RCS hub is connected to the internet, meaning a merging of DVB-S and IPTV. Besides DVB-RCS standard compliant systems, there are also proprietary solutions available on the market.

Besides realising a return path for a DVB-S system via satellite, the alternative is a cable based return path (DOCSIS modem).

Regarding mid-term market development for both return path options, Laura Wood, Senior Manager at Research and Markets Ltd, cites a 2003 market report: “While the prospects for standards-based broadband satellite growth are apparent, it is not yet clear whether DVB-RCS and DOCSIS will generate the competitive edge satellite players require to penetrate the broadband market.”[82] Actually, this has been confirmed by a 2007 report: "Overall, the impact of open standards on the satellite broadband industry seems to be minimal at this point of time, particularly as product performance and price are seen to be more essential. Having said that, there exists a growing notion within this industry that the presence of a truly open standard solution would help to achieve low-cost, high-performance solutions, thereby driving the demand and growth of two-way satellite broadband communication systems."[83]

- **Internet Protocol Television (IPTV) (Internet Platform)**

An alternative transmission path for TV is the combination of the IT-Technology with digital broadcasting. One way is MHP[84] standard for interactive television (iTV), while other is the new technology of IPTV. IPTV defines the transmission of moving pictures over the broadband internet to a TV or a computer. It contains "On Demand Services" such as video-on-demand.

Cable providers also use this new market strategy of triple–play which creates a new business competing with telecommunication providers. The reaction of telecommunication companies is IPTV – in order to offer a triple play themselves. Owing to rising data rates from the telecommunication network up to 28 Mbit/s (France) over DSL, today IPTV services providing up to one hundred TV channels, is already state of the art in some countries like France and Italy. But regional distinctions are tremendous. France alone supplies more than 500,000 households with IPTV[85] since 2005. The situation is similar in Italy and Spain. In Germany, only in some regions the IPTV is available. Since spring 2006, the test phase of VDSL from Deutsche Telekom started. A market survey of “Goldmedia GmbH Media Consulting & Research” shows an annual growth rate of 75% of earned profit for the next 4 years until 2010. A model for this progress is the marked situation in France and Italy.

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81 DVB Fact Sheet: Return Channel Satellite, The open standard for two-way satellite broadband VSAT systems, April 2008, www.dvb.org/technology/fact_sheets/DVB-RCS Fact Sheet.0408.pdf

82 Northern Sky Research: Evaluating the Prospects for Standards-Based Broadband Satellite Growth - DVB-RCS and DOCSIS, February 2, 2003

83 Frost & Sullivan: Impact Analysis - Satellite Transmission Standards, June 29, 2007

84 Multimedia Home Platform (MHP) - European standard for interactive television

85 Accenture, IPTV Monitor - Issue 1,06,2006 www.accenture.com, 26.10.2006.

The base for a growing IPTV market is given by the demand of the consumer who wants to be more actively involved in self-selecting TV programs at any time, adopting use patterns known from internet usage. Moreover, IPTV combines the advantages of broadcasting and internet. The installed broadband infrastructure, with a penetration rate of 23% in the EU-25, provides the technical foundation for IPTV. The problem of limited bandwidth in the past has been addressed with broadband accesses via ADSL[86] and VDSL[87] in combination with new compression methods like WM9 and H2.64. The upcoming optical fibre technology is expected to increase the bandwidth further, thus making broadband internet an attractive transmission platform.

Telecoms operators view Internet Protocol TV (IPTV) and triple-play as strategies for combating declines in telephony revenue and maintaining Internet revenue in the face of price erosion. Although operators continue to launch IPTV services, it remains unclear whether IPTV will create new revenue streams or merely become a necessary part of an operator's product portfolio in an environment characterised by increasing competition. According to a 2006 market report by Analysis Research, the success of IPTV will largely depend on the dynamics of the local telecoms market and the interplay between the technological platforms available for delivery of subscription-based TV services.[88]

According to a 2006 survey of executives in the communications, broadcasting and media industries[89] the STB technology is not the bottle-neck for IPTV, although only 31% consider the technology to be ready (Table 2-16).

Table 2-16: Technology status of IPTV (2006)

"How ready are the following aspects of the IPTV business to enable the delivery of IPTV services by network operators, in your opinion?"	Not ready	Developing, but incomplete	Ready
Content provision	17%	57%	26%
Development of unified standards	41%	46%	13%
Marketing and pricing strategy	38%	48%	15%
Operational capability	23%	53%	23%
Transparent regulation	56%	36%	8%
Customer understanding of product proposition	48%	40%	11%
Access and head-end technology	20%	56%	24%
Set-top box technology	16%	53%	31%
Transport network technology	15%	48%	36%
Software & video platform technology	14%	51%	35%

86 ADSL (Asynchron Digitel Subscriber Line) new Standards are ADSL2 and ADSL2+ with data from 12 to 24 MBit/s downstream also with benefit of Power Enhancement (www.dslprime.com/a/adsl21.pdf, 27.11.2006)

87 VDSL (Very high bit rate DSL) 25 MBits/s up to 50 MBit/s downstream / VDSL2 data rate up to 200Mbit/s

88 Analysis Research: Market trends - IPTV's success in Central and Eastern Europe will depend on the dynamics of local pay-TV markets, December 2006

89 Accenture - Communications & High Tech: IPTV Monitor—Issue 3, 1/2007, p. 10

- **Triple-Play / Quad-play / Multi-play**

Telephone, cable, and satellite service providers are competing to become the single provider for all the communications, audio and video needs of consumers, such as "triple-play" (wired voice, data and entertainment) or "quad play" (triple play with wireless voice). Gartner estimates that by 2010, this market will be worth more than 220 billion €. Becoming the sole provider for all consumer's needs is estimated to be the key to success in an industry where the major products and services — voice, data and entertainment — will no longer be separate and distinct, but essential elements integrated into consumers' homes[90].

2.3.2. Pay TV Trends

Analysis Research predicts a Pay TV household penetration of 64% for Western Europe by 2013, compared to 55% as of 2007, with significant differences remaining between MS (Figure 2-8). However, the data should be considered with caution, as for example for Germany, it shows penetration rates rising from 63% to 69%. Yet, the German market leader in Pay TV (Premiere) states for end of 2006 only 3.4 million subscriptions over 38 million households in Germany (i.e. a household penetration rate for Premiere is < 10%).

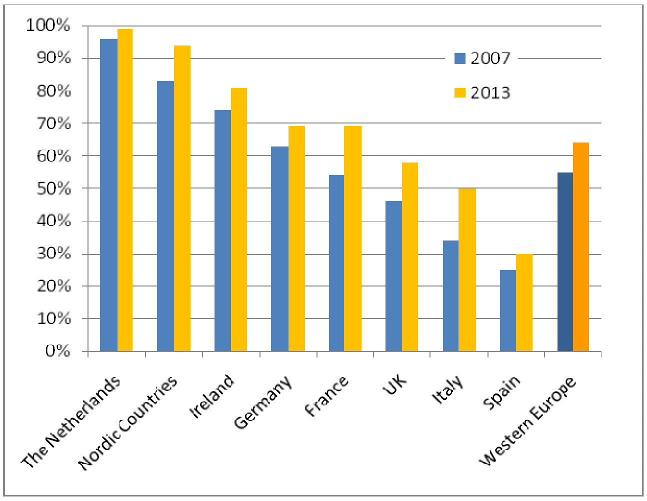

Figure 2-8: Pay-TV household penetration in Western Europe, 2007-2013[91]

The predicted transmission platforms for Pay TV were shown in Table 2-13. DVB-C and DVB-S are assumed to have the largest market share. IPTV is likely to see growth[92]. The short-term growth of subscription TV models for IPTV is hindered by existing rights deals in place on premium content in the traditional pay TV environment preventing online exploitation.[93]

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90 Gartner: Home Networking Is a Strong Driver of the Consumerization of IT, June 2007

91 Analysis Research Ltd.: Pay TV in Western Europe: market sizings and forecasts 2005-2013, March 2008

92 Goldmedia Screen Digest; European IPTV, 2005; press release: IPTV set for boom time in Europe as convergence finally becomes a reality – by 2009 IPTV will account for almost ten per cent of the European pay TV market, November 21, 2005

93 European Commission, Screen Digest Ltd, CMS Hasche Sigle, Goldmedia Gmbh, Rightscom Ltd (Hrsg.): Interactive content and convergence: Implications for the information society, 10/2006. p. 76

- **Access Limitations**

Already in 1995, the German DLM[94] formulated the basic principle, that every STB should be capable of receiving the full range of offered programmes, but this principle is not supported sufficiently by media laws. Differences in the STB technology, specifically regarding conditional access and application programming interfaces, severely limit the access possibilities. Consequently, the consumer might need to get an additional STB for TV reception of additional channels. Regulations in the field of telecommunications and media do not set any incentives to equip STB in a way that they are capable to deal with a variety of reception systems. Where STB are marketed together with a pay TV subscription (STB included or rebated), the service provider is in the position to dictate technical specifications, which support his business strategy.[95]

- **Piracy**

Appropriate security systems for conditional access are a crucial issue, as piracy has become relevant for the pay TV market. There are illegally manipulated STB on the market bypassing electronic security measures and pay TV content is posted on the internet, which is a threat to the revenues of the pay TV providers. It is their key interest to have the security systems on a high level and under their direct control.

- **Downloadable Conditional Access System**

The US company CableLabs[96] develops a Downloadable Conditional Access System, which requires a security chip within either the STB or the TV set allowing cable operators to download their conditional access system(s) of choice to devices connected to the cable network. This technology, once introduced to the market could make STB obsolete – provided the TV set comes with the proprietary security chip.

2.3.3. MERGING OF DEVICES AND END-DEVICE EVOLUTION

PC and classic TV are going to merge into so-called "media centres", a computer with a comfortable handling over remote control, that should have a fast boot, work silently and with a design that is oriented to hi-fi components. More and more customers prefer one device for many different tasks such as watching TV, playing DVDs and audio files or watching their own photographs in a slide show.[97] One such product is Apple TV, which serves mainly the TV function but is based on a computer platform. Also the STB functionality is typically merged in such media centres.

In 2007/08, game consoles, such as Microsoft's Xbox 360 and PlayStation 3, have been transformed into IPTV STBs[98].

Regarding TV sets, there are some important trends, which affect the STB market:

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94 Direktorenkonferenz der Landesmedienanstalten in der Bundesrepublik Deutschland

95 Gemeinsame Stelle Digitaler Zugang (GSDZ), Arbeitsgemeinschaft der Landesmedienanstalten (ALM): Digitalisierungsbericht 2006 - Aufbruch ins digitale Zeitalter, Aktuelle Entwicklungen: Plattformen, Adressierbarkeit, IP-TV, ISBN 978-3-89158-447-7, p. 25

96 www.opencable.com/dcas/

97 Flohr, Udo; Honsel, Gregor: Kampf der Kästen, Technology Review 09/2006.

98 John C Tanner: STB put the 'play' in 'triple-play', Telecom Asia, January 23, 2008

- In 2006, leading manufacturers have started to integrate digital tuners. This trend makes separate STB (for digital to analogue conversion) obsolete in principle. However, multiple tuners are currently necessary depending on the means (terrestrial, cable, satellite) by which the television broadcast is received. But once there will be no more analogue TV broadcasting, it is likely that all future TV sets will be able to process digital broadcasting signals, however, maybe not for all transmission platforms. This trend however affects simple STB only.
- TV sets with CI slots (Common Interface Slots), which allow direct connection of Conditional Access Modules (CAM). Such TV models are on the market in limited numbers (e.g. Pioneer, King View, Sony Bravia, and Philips). With such TV sets no separate STB to provide Conditional Access functionality is required (given the compatibility of the encryption system). So-called Digital Cable Ready Televisions (DCR TV) provide the ability for cable subscribers to access their digital, HDTV, or Premium service without utilising a standard STB: The TV sets use e.g. a device known as a CableCARD that is inserted into the back of the TV set (similarly to the PCMCIA cards of PCs). Current DCR TVs are only one-way devices as the cards can only receive data, not allowing interactive features, which need a return path. Both Scientific Atlanta and Motorola are setting up production of CableCARD boxes that support HD and DVR functions (this is known as Multi-Stream Cable CableCARD or “MCard"). Next to arrive, perhaps in 2008, will be CableCARD 2.0-based interactive host devices. However, interactive TV features will require buying a new 2.0-compatible TV, so in short term the impact on the complex cable STB demand is expected to remain limited, but eventually CableCARD 2.0 could make complex cable STB obsolete.
- For ultra slim designs, the TV display is separated from the main processing unit, and to have rather an extended STB, which integrates the full functionality of a TV – besides the display (outsourcing of receiver/tuner/ data processing etc. etc.). Such TVs are already on the market in very small numbers, but their market share is likely to grow.

Peripheral Devices

A couple of peripheral devices might be connected to STB (or come as integrated features), meaning the STB market is under the influence of the market for these peripherals. Some STB allow for external hard disk drives to expand the storage capacity of integrated PVRs, making the external hard disk a separate video archive. In parallel, capacity of hard disk drives (internal and external) is growing; see also technology trends towards solid state disks below.

2.3.4. TECHNOLOGY TRENDS

2.3.4.1 High Definition

High-Definition television (HDTV) refers to the broadcasting of television signals with a higher resolution than the Standard-Definition television (SDTV) - that means traditional analogue formats like PAL[99] and SECAM[100] in Europe. HDTV is defined as 1080 active interlaced lines[101], or 720 progressive lines[102] (16:9 aspect ratio in ITU-R BT.709). Table 2-17 compares the digital and analogue standards and displays of the most common resolution standards.

Table 2-17: TV display resolution standards

TV-Video standard	Resolution in pixel	Rate (Hz)	
		interlaced	progressive
NTSC / PAL-M	640 × 480	60	24-30
PAL / SECAM	768 × 576	50	25
SDTV	480 x 720, 576 x 720	50,60	
HDTV	720 × 1280, 1080 × 1920 or 1152 × 2048	50, 60	24 – 60

HDTV services in Europe began with Belgian pay TV channel Euro180 in 2004. The number of HDTV channels available in Europe increased in 2006 particularly in Germany with Pro 7 and SAT 1 and in the UK with Telewest, Sky, and the BBC[103]. A label "HD-ready" has been created by EICTA (European Information, Communications and Consumer Electronics Technology Industry Associations) to inform consumers of the benefits of High Definition. The purpose of the label is to create a single norm to simplify the purchase of a HDTV in Europe. Compliant sets accept all current SD and HD resolutions at 50- and 60-hertz rates, they need to have a native resolution of at least 720 lines at a 16:9 aspect ratio and the video interface have to provide two interfaces, analogue via YPbPr and digital via DVI[104] or HDMI[105]. Capable inputs also have to support HD formats 720p and 1080i. At least the DVI and HDMI input have to support the content protection[106].

HDTV is the key technology for the TV of the future. Referring to TV, PVR and video player, including new storage media like Blu-ray Disk, HDTV is the main driver for

99 PAL, short for phase-alternating line, is a color encoding analogue television system (625-line/50 Hz) commonly used in Europe and other parts of the world. PAL was developed by Walter Bruch at Telefunken in Germany.

100 SECAM, short for sequential color with memory (French: Séquentiel couleur à mémoire), was the first analogue color television system (625-line/50Hz) used in France and Russia. SECAM was developed by Henri de France working at Compagnie Française de Télévision (later Thomson).

101 The format 1080i50 is 1920 × 1080 pixels, interlaced encoding with 50 fields (25 frames) per second.

102 The format 720p60 is 1280 × 720 pixels, progressive encoding with 60 frames per second.

103 BBC News of 13 June 2006, in the internet: news.bbc.co.uk/2/hi/technology/5071314.stm/

104 DVI (Digital Visual Interface) is a video interface standard to provide digital displays an maximum on visual quality

105 HDMI (High-Definition Multimedia Interface) is a audio- video interface standard to transmit uncompressed streams (www.hdmi.org/about/faq.asp, 10.10.2006)

106 EICTA License Agreement (www.eicta.org, 10.10.2006)

technical changes. Hurdles for fast distribution of HDTV are the applicable hardware like TV and PVR. Most of actual delivered displays have the "HD-ready" label. But almost all TVs currently in use are not compatible with HD-signals and only a few service providers (such as Pay TV, Sat1 and Sky) broadcast their program in HDTV.

- **Encode/Decode Technology**

Regarding encode/decode technology, which is closely linked to the HD developments, two kinds of video compression standards are likely to play a role in the coming five years, namely:

- MPEG-4 / Advanced Video Coding (AVC) / H.264
- Video Codec One (VC-1) / SMPTE 421M

MPEG-4 is assumed to play the leading role.

The change from MPEG-2 to MPEG-4 compression, as a consequence of high definition TV, results in compatibility problems for STB. This leads to the expectation, that the market will see further replacement sales in the future and to address such compatibility aspects is a crucial point for overall lifetime of the STB.

2.3.4.2 Home Networking

Networking of home devices will play an important role in the coming years and the STB might become part of this IT, communication and entertainment home network. In conjunction with STB, Stone[107] stated in 2007 the following "popular functionalities in the next five years" for both wireless and wired options:

- **Wireless**

Main wireless technologies and protocols with relevancy for STB comprise of:

- Next generation WiFi: IEEE 802.11g/N wireless local area network communication standards (802.11g operates at 2.4 GHz; 802.11N – standard to be finalised by end 2008 – operates at 2.4 and/or 5 GHz)
- Low Data Rate Peripherals – Bluetooth: Might play a role for e.g. remote control and head sets, but not for video transmission to TV sets
- High Data Rate Peripherals – WirelessHD108 109 (specification defines a wireless protocol that enables consumer devices to create a wireless video area network - WVAN), Ultra Wide Band (UWB)
- Wireless HD STB for IPTV based on 802.11N have been announced by Samsung110 and Celrun111 in early 2007.

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107 C. Stone: How to improve the efficiency of complex STB, International Workshop on Energy Efficient STBs & Digital Networks, IEA, Paris, July 4-5, 2007

108 WirelessHD Specification Version 1.0 Overview, October 9, 2007, www.wirelesshd.org/WirelessHD_Full_Overview_071009.pdf

109 as some of the leading TV manufacturers are among the promoters of WirelessHD (LG Electronics, Matsushita / Panasonic, NEC, Samsung, Sony, Toshiba) this standard might gain an important market share of wireless STB

First A/V products capable of WirelessHD might enter the market by end 2008 or early 2009[112].

- **Wired**

Main wired technologies and concepts, largely based on internet protocol and consequently to certain extend restricted to IPTV, include:

- HomePlug – IP over power lines
- Multimedia Over Coaxial Alliance (MoCA) – IP over Coax
- HomePNA – IP over Coax and Phone Lines
- ANSI/CEA 2005 – Ethernet – IEEE-1394 bridge

- **Home Networking Architectures**

Home Networking requires coordination and standardisation among various component suppliers. The two main initiatives are the High-Definition Audio-Video Network Alliance (HANA)[113], and the Digital Living Network Alliance (DLNA)[114]. Some follow proprietary solutions e.g. Motorola.

With the networked home, there are potentially two opposing trends: first, increased (networked) standby power consumption of devices, which are linked through the network and second, the possibility to pool functionality instead of providing functionality redundantly. C. Stone[115] outlines an example of a "traditional" home with three separate STB, each with a DVR and 30 W power consumption each in on mode, compared to a networked home ("whole home media installation") with one host-STB (30 W power consumption), which also handles the recording for two client STB with each 14 W power consumption in on mode. However, Stone does not provide a use profile: The host STB needs to be in on mode to share content with the client STB and thus might be in on mode much longer than in a non-networked home.

2.3.4.3 Recording media (Internal mass storage media)

In addition to today's established data storage technologies, dominated by hard disk drives (HDD), there are a number of alternative approaches which will emerge over the next decade according to the iNEMI roadmap[116]. These storage technologies include magnetic random access memory (MRAM), probe-based, molecular, fluorescent

110 Wireless HD IPTV Set-Top Box Unveiled, tvover.net, www.tvover.net/2007/03/20/Wireless+HD+IPTV+SetTop+Box+Unveiled.aspx

111 Celrun and Metalink Launch Wireless High-Definition IPTV Set-Top Box, www.iptv-easterneurope.com/content/view/339/29/

112 according to John LeMoncheck, CEO of SiBEAM; see: WirelessHD, Your Plasma's New Best Friend? July 13, 2007, gigaom.com/2007/07/13/wirelesshd-sibeam/

113 www.hanaalliance.org

114 www.dlna.org

115 C. Stone: How to improve the efficiency of complex STB, International Workshop on Energy Efficient STBs & Digital Networks, IEA, Paris, July 4-5, 2007

116 R. C. Pfahl, James B. McElroy: Emerging Markets, Emerging Technologies - The 2007 iNEMI Roadmap, www.connectorsupplier.com/tech_updates_JM_iNemi_9-4-07.htm

multilayer optical, near-field optical, 3-D holographic storage components and systems, and use of NAND flash memory, replacing HDDs or used in combination.

Solid state drives (SSD, also known as solid state disks, based on e.g. NAND flash memory) might replace hard disc drives (HDD) in the mid-term future as storage medium. SSDs are already penetrating the computer market and might do so also with the STB market once costs (driven by mobile and PC applications) are significantly lower than today and become an economic alternative for STB. For illustration, in early 2008, an Apple's MacBook Air with a 64GB Solid State Drives costs 1,000 US $ more (retail price) than a MacBook Air with a conventional 80GB HDD. STB sold in the EU today come with HDDs with typical capacities of 80 or 160GB.

Samsung, one of the market leaders in SSD, expects to see solid state drives appear in high-end and corporate notebooks aimed at business users. Industry experts expect the demand for such solid state drives to remain miniscule in the immediate years following their launch. The director of product marketing at SanDisk stated in early 2007, that she eventually expects SSDs to move into the consumer laptop market, and not just limited to the business user. Although it's plausible that the SSD might appear in other consumer devices that rely on hard disk drive technology, she stated SanDisk has not explored expanding the SSD to other devices at this time[117].

The price for SSD per GB in 2007 was roughly 30 times that of conventional HDDs[118], although with rapidly declining prices for SSD (65% per year reported, less so for HDDs). Jim Handy[119] extrapolates from past developments that costs for NAND flash memory might drop below 10 US $ per GB in 2008 and below 1 US $ per GB in 2011 or 2012, which still would be significantly more than today's costs for HDDs. Extrapolating further, it is unlikely that NAND flash memory for price sensitive markets can compete with HDD before 2015.

SSD penetrate slowly high-end markets, starting with the military sector, entering the business laptop market and other mobile products in the recent past and might play a role for data centres fairly soon. Forecasts by Gartner Research suggest that by 2010 roughly 20 per cent of notebooks sold worldwide will be shipped with solid-state drives[120]. However, for price sensitive consumer electronics, SSDs will not be a mass market solution in short-term. Nevertheless, Objective Analysis considers consumer electronics (including STB and media centre) as one future field of application besides industrial, military/aerospace, and data processing equipment (such as PCs, Servers, infrastructure) for SSDs[121]. Frankie Roohparvar, vice president of NAND development at Micron Technologies, considers TVs a growing market and claimed last year that many

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117 Melissa J. Perenson, PC World: SanDisk Shows Solid State Drive - Solid state, or flash-based, drives get a boost from SanDisk's 32GB SSD; 7 January 2007, pcworld.about.com/od/tradeshows/SanDisk-Shows-Solid-State-Driv.htm

118 Bill Silvey: Tech Road Map: Solid-State Storage - When prices drop, there will be no stopping solid-state disks, InformationWeek; October 22, 2007 issue

119 Analyst at Objective Analysis, *The Changing Relationship of Flash & DRAM SSDs*, www.storagesearch.com/ssd-ram-v-flash.html, accessed March 17, 2008

120 Chad Sapieha, *In Depth Technology - Solid-state drives, What they are and why you want one,* CBC News, March 3, 2008

121 Objective Analysis, *The solid-state disk market: A rigorous look*, published September, 2007

TV makers are inserting flash into upcoming digital TVs[122]. The memory will cache incoming TV programs so that viewers at home can rewind. Some TVs are already out on the market, but Roohparvar said many have been designed but have not been announced yet.

Hybrid drives (combined HDD and SSD) according to a report by Coughlin Associates and Objective Analysis[123] could find applications in consumer electronic products that need the storage capacities of a hard disk drive but want to have power usage and ruggedness approaching that of solid state drives. STBs in principle are not among these candidates as they lack currently the requirement of low power usage and ruggedness. However, a legal framework setting MEPS for power consumption might set a framework for earlier introduction of hybrid drives for STB.

The application of **hard disc drives** for STB is assumed to grow in the coming years. As stated by Coughlin Assoc. and Objective Analysis: "Most static consumer applications [i.e. including STB and TVs] favour the growth of hard disk drives since higher resolution is required for larger screens and homes are generally where user generated content as well as commercial content libraries are kept. Backup and protection of data will also drive the use of hard disk drives in the home".

Taking this current state of development into account, it is unlikely, that SSD will play a role in STB in the mid-term future, but will be considered as Best-Not-Yet-Available-Technology (BNAT) in the task 6 of this study, at least not yet available for the STB market as it is, at "Improvement Potential" – given the significantly lower power consumption compared to hard disc drives.

2.3.5. Summary of Market Trends

In summary, the most relevant market trends having an influence on the STB market in Europe are as follows:

- **Relevancy of transmission platforms for Pay TV for the mid-term future:**
  - 1: Satellite and Cable
  - 3: IPTV (but with significant growth rates)
  - 4: Terrestrial is not significant
- **Use lifetime of complex STB will remain at a low level as**
  - Upwards compatibility of STB will remain problematic (due to evolution of transmission standards DVB-x to DVB-x2 and compression protocols)
  - Storage technology makes progress (availability of increasing storage size at mass market prices)

122 Michael Kanellos, *Coming soon: The solid state server and TVs with auto-rewind*, CNET News.com, August 14, 2007

123 Tom Coughlin, Coughlin Associates; Jim Handy, Objective Analysis, *Digital Storage in Consumer Electronics 2008*, January 2008

- Limited compatibility of encryption systems and bundle marketing concepts (service / subscription plus STB)

- **Technology / functionality trends, growing number of STB with**
  - High definition resolution (very high market penetration by 2015)
  - PVR, realised as HDD (standard configuration by 2015), whereas SSD might be of relevancy only in the long-term
  - Return path (cable: assumed to be standard by 2015; satellite: growth potential, but break-through not yet predictable)
  - Second / multiple tuners (for picture-in-picture, recording in parallel to viewing another programme; assumed to be standard in 2015)
  - Wireless connectivity
  - Networked STB / client STB

- **Trends leading as a tendency to a decrease in number of (complex) STB:**
  - Digital tuners integrated in TV sets,
  - Tvs with CI-slots for cams,
  - STB functionality included in merged products (media centres, game consoles),
  - Computer based Online TV,
  - Removable media recording (DVD, Blu-ray disk)124

- **Trends leading as a tendency to an increase in number of (complex) STB:**
  - Growing market share of Pay TV

These trends lead to the conclusion that the level of complexity of STB will grow in the coming years. This will hold true at least for the devices which are on the market still in 2015 and beyond – as it is not predictable, whether STB will survive at all or will be absorbed by other products (TV sets, computers, media centres). Consequently, it is predicted that by 2015 the stock of complex STB will see a dominance of HD products with internal mass storage media (assumed 80%). Assuming further that the trends pro and against a growing market for complex STB outweigh each other, the stock of 2010 will in terms of total units will remain the same until 2015. After 2015, the number of STB will rather decline due to merging with other devices. As a very rough outlook in 2020 the number of complex STB in use might be half of that in 2020, but all of them for HD and with integrated mass storage media. However, these figures are highly speculative, but the best available assumption for the long-term 2015/2020.

124 Which means, that the STB falls out of the scope of the preparatory study

Table 2-18: Estimated stock of complex STBs by feature

Complex STB (EU 27) Stock (million units)	2010	%	2015	%	2020	%
SD	28.7	35%	4.1	5%	0	0%
HD	30.5	37%	4.1	5%	0	0%
SD-STB with internal mass storage media DVR	12.6	15.4%	8.1	10%	0	0%
HD-STB with internal mass storage media DVR	10.1	12.3%	65.6	80%	41	100%
Total	**81.9**		**81.9**		**41**	

2.4. CONSUMER EXPENDITURE DATA

2.4.1. AVERAGE CONSUMER PRICES

Complex STBs, being linked to subscription-based services, are usually provided by the service provider as part of the contract. Therefore, the price for the consumer can be very different from the purchase price that the broadcaster will pay for a STB.

The business models vary between service providers, creating a number of possibilities. A consumer may get the box:

- Free of charge provided a minimum period of subscription to the pay-TV service
- Free of charge, against a deposit fee
- Product leased/rented
- With a discounted price
- Full price (rare)

This variety of models and the fast evolution of the prices make it difficult to estimate an average price that is representative for the European market.

Moreover, the deposit fees and the rental fees vary across broadcasters and also depending on the type of subscription ("TV package") and length of subscription. Often preferential tariffs are offered for new customers.

The price of the STB also varies depending on its level of complexity. The price of a complex STB ranges from less than € 100 for SD complex STB, to over € 350 for a HD complex STB with internal mass storage media[125]. Accordingly, the deposit or the rent of the STB that the consumer pays to the broadcaster varies.

Based on replies to questionnaires from major European Manufacturers and Broadcasters, the estimated end user price of a complex STB is presented in **Table 2-19**.

125 Database with 649 STBs www1.digitalfernsehen.de/katalog/stb.php

Table 2-19: Estimated average amount paid by consumer

Type of STB / Business model	Estimated average amount paid directly by the consumer for the STB: SD	HD	SD with internal mass storage media	HD with internal mass storage media	Estimated monthly subscription fee
Free of charge	€ 0	€ 0	€ 0	€ 0	N/A
Deposit fee paid only if the consumer does not return the equipment	€ 50	€ 190	€ 190	75% full price	€ 30-35
Product leased/rented	€ 4 /month	€ 10 /month	€ 10 /month	€ 12 /month	€ 25-30
Discounted price	20- 70% discount	20 - 70% discount	20 - 70% discount	20% discount	€ 30-70
Full price (rare)	€ 100	€ 250	€ 250	€ 350	€ 30-35

Against this variety of prices and business models, it is proposed to calculate the amount paid by the end-user for his STB, expressed as a share of the monthly payment the user pays to the broadcaster ("Monthly STB payment share"). This share is defined differently depending on the business model:

- Free of charge: not relevant
- Free of charge, against a deposit fee (most common situation):

$$Monthly\ STB\ payment\ share = \frac{Deposit\ fee \div Duration\ of\ the\ contract}{(Deposit\ fee \div Duration\ of\ the\ contract) + Monthly\ subscription\ fee}$$

- Product leased/rented:

$$Monthly\ STB\ payment\ share = \frac{Monthly\ renting\ fee}{Monthly\ subscription\ fee}$$

- With a discounted price:

$$Monthly\ STB\ payment\ share = \frac{Discounted\ price \div Duration\ of\ the\ contract}{(Discounted\ price \div Duration\ of\ the\ contract) + Monthly\ subscription\ fee}$$

- Full price (rare):

$$Monthly\ STB\ payment\ share = \frac{Full\ price \div Duration\ of\ the\ contract}{(Full\ price \div Duration\ of\ the\ contract) + Monthly\ subscription\ fee}$$

Based on the estimates in Table 2-21 and based on the tariff from major European broadcasters, it can be roughly calculated that, when considering a contract duration of 2 years, the monthly contribution to the STB cost represents about 10% of the monthly service subscription charges for a complex SD-STB, 20% for a complex HD-STB and about 25% of the monthly payments for complex STB with an internal mass storage media (either SD or HD) independently of the business model considered.

2.4.2. RATES FOR RUNNING COST AND DISPOSAL

2.4.2.1 Running costs

The only significant running costs of a complex STB are the electricity costs. Electricity prices for households in MS, as of January 1, 2007, are presented in Table 2-20. The EU average will be used in Life Cycle Cost (LCC) calculations at the later stage of the study (Task 5).

Table 2-20: European electricity prices for household consumers (01/01/2007)[126]

Member State	Overall price (€ / 100 kWh)	Share of Taxes* (% of the overall price)
Austria (AT)	15.45	32.0
Belgium (BE)	15.81	22.3
Bulgaria (BG)	6.60	17.1
Cyprus (CY)	13.76	14.5
Czech Republic (CZ)	10.67	15.8
Denmark (DK)	25.79	54.6
Estonia (EE)	7.50	15.3
Finland (FI)	11.60	24.4
France (FR)	12.11	23.9
Germany (DE)	19.49	26.5
Greece (EL)	7.20	8.2
Hungary (HU)	12.22	16.6
Ireland (IE)	16.62	11.9
Italy (IT)	23.29	28.8
Latvia (LV)	6.88	15.3
Lithuania (LT)	7.76	15.2
Luxembourg (LU)	16.84	10.4
Malta (MT)	9.47	4.8
Poland (PL)	11.84	22.4
Portugal (PT)	15.00	5.3
Romania (RO)	10.17	15.9
Slovakia (SK)	10.64	15.9
Slovenia (SI)	15.37	16.6
Spain (ES)	12.25	18.0
Sweden (SE)	17.14	36.5
The Netherlands (NL)	21.80	35.8
United Kingdom (UK)	13.16	4.7
EU 27 Average	15.28	23.3
* VAT and other taxes		
Note: EUROSTAT collects data every 6 months for five categories of household consumption, ranging between 600 kWh to 20000 kWh. This table refers to 'medium sized household' (annual consumption of 3500 kWh of which 1300 during night).		

126 Eurostat, Electricity prices for EU households and industrial consumers on 1 January 2007, 08/06/2007.

Complex STB hardly incur repair or maintenance costs to the consumer, as the service provider often replaces a defective box. Thus these costs are considered irrelevant in this study for the LCC calculations.

2.4.2.2 Disposal costs

The different end-of-life routes of complex STBs will be analysed in Task 3, § 3.3.

Irrespective of the route, disposal of complex STB does not incur significant costs to the consumer. Under the Directive 2002/96/EC on WEEE Directive, consumers can dispose of electric and electronic appliances without charge. Eventually, the costs of WEEE collection and treatment are likely to be integrated in the product prices, but as to the current situation, the disposal of existing stock of appliances is free to the consumer. Even the eventual effect on price is expected to be negligible. Currently, the "eco-participation" fee[127] for example in France is about 5 cents per STB.

If the consumer disposes of the STB as part of household waste, part of the general waste fees/taxes should theoretically be allocated to this product. However, due to its small size compared to the total amount of household waste, these costs can be neglected.

Reflecting the current situation, we assume zero disposal costs for the consumer for complex STB.

2.4.3. INTEREST AND INFLATION RATES

The following table shows (Table 2-21) national inflation and interest rates for the EU 27 as published by Eurostat and the European Central Bank (ECB).

[127] A fee paid at the purchase of EEE and which covers the costs of recycling of historic WEEE

Table 2-21: Interest and inflation rates in EU 27

Member State	Inflation rate [(a)] (%)	Interest rate [(b)] (%)
Austria (AT)	1.3	3.8
Belgium (BE)	2.3	3.8
Bulgaria (BG)	7.4	4.0
Cyprus (CY)	2.2	4.1
Czech Republic (CZ)	2.1	-
Denmark (DK)	1.9	3.8
Estonia (EE)	4.4	-
Finland (FI)	1.3	3.8
France (FR)	1.9	3.8
Germany (DE)	1.8	3.8
Greece (EL)	3.3	4.1
Hungary (HU)	4.0	7.1
Ireland (IE)	2.7	3.7
Italy (IT)	2.2	4.1
Latvia (LV)	6.6	4.2
Lithuania (LT)	3.8	4.0
Luxembourg (LU)	3.0	-
Malta (MT)	2.6	4.3
Poland (PL)	1.3	5.3
Portugal (PT)	3.0	3.9
Romania (RO)	6.6	
Slovakia (SK)	4.3	4.4
Slovenia (SI)	2.5	3.9
Spain (ES)	3.6	3.8
Sweden (SE)	1.5	3.7
The Netherlands (NL)	1.7	3.8
United Kingdom (UK)	2.3	4.4
Euro area	2.2	3.8
EU 27 Average	2.2	4.09[128]

[(a)] Annual Inflation (%) in Dec 2006 Eurostat

[(b)] ECB long-term interest rates; 10-year government bond yields, secondary market. Annual average (%), 2006

128 epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-08-009/EN/KS-SF-08-009-EN.PDF

2.5. CONCLUSIONS FOR TASK 2

Establishing the stock of complex STBs through existing data sources represented a daunting task. In the absence of a single source for comprehensive market data, current sales and stock of STBs were derived from various sources.

The accuracy of these figures can be challenged but they are believed to provide a robust estimate for the purpose of this study. They clearly show that the yearly sales of the products are higher than the 200,000 unit threshold set in the Ecodesign Directive.

The data presented in Task 2 will form the basis for selecting the most representative products on the European market and eventually formulating the base-case(s) in Task 5. Further, product price and life time are also key inputs for the Life Cycle Cost (LCC) analysis using EcoReport in Tasks 5 and 7.

3. Task 3 – Consumer behaviour and Local infrastructure

Consumer behaviour determines some of the key parameters affecting the energy use of complex set-top boxes (STBs), firstly through the selection of the STB (though it is rarely the decision of the end-user and often service provider decides), secondly through the manner in which the STB is used over its lifetime (e.g. in on/off/standby modes). Besides, the consumer behaviour is also influenced by the technological constraints of the broadcasting and data transfer "infrastructure". To some extent, it is also influenced by the product-design which consequently influences the energy efficiency and the environmental impacts associated with the STB during the use-phase.

The objective of this task is to explore these aspects for the lot 18 products and more specifically to investigate the influence of consumer behaviour on the energy and environmental performance of complex STBs.

First section focuses on the real-life efficiency of complex STBs. Consumer behaviour is an important input for assessing the environmental impacts and life cycle cost of the products and relevant parameters (e.g. frequency and use characteristics) are quantified for the purpose of later analysis during tasks 5 and 7. The next sub-section presents the requirements for local infrastructure and the restrictions to possible eco-design measures are described in the last sub-section.

Most of the analysis in this task draws on the responses to a questionnaire concerning consumer behaviour and local infrastructure which was sent to major service providers and STB manufacturers in Europe.

3.1. REAL LIFE EFFICIENCY

3.1.1. USE PATTERNS

Like all consumer electronic products, complex STBs' energy use depends on both the power requirements in different operation modes (on mode, standby active mode, standby passive mode, and off mode, as discussed in Task 1) and on the use pattern (average time in each of these modes).

As seen in Task 1, test standards exist to measure the power requirements of complex STBs and some of these standards also provide a method (e.g. a duty cycle or use pattern) to determine the electricity consumption of STBs in standard conditions which may differ from the real life conditions of use (as in the Version 2.0 of the ENERGY STAR Program Requirements for Set-top Boxes). This sub-section defines a typical use pattern of complex STBs which is a primary parameter when assessing the energy (electricity) consumption of such devices. This typical use pattern should represent as closely as possible the real-life situation in order to provide an accurate picture of the real energy consumption.

3.1.1.1 Use patterns for TV sets

Normally, as a complex STB is used with a TV (except for some triple play boxes which can also be used with a computer), the use time of a STB in on mode can expected to correlate with a TV. Thus, it may be useful to have a look at the typical viewing pattern for televisions.

The EuP Preparatory study on Televisions (Lot 5)[129] defines a general scenario for all TVs (stock) with an on mode time of **4 hours per day** for a single TV in a regular household environment in Europe. Similar average TV view durations have been the basis for many energy efficiency calculations in other parts of the world.

3.1.1.2 Use patterns of complex STBs

- **Operating modes of complex STBs**

As already explained in Task 1 (§1.1.1.2.), complex STBs can operate in five different modes: on, standby active, standby passive, off and disconnected modes. However, most of the existing STBs typically do not have a standby passive mode. The implementation of this mode is currently under development (mostly within the companies complying with the European Code of Conduct). Off mode is hardly used either, since complex STBs need to be constantly in on mode to be updated properly and be able to receive, transmit and/or recording broadcasting signals. Also, a majority of STBs provided by service providers do not even have the on/off hard switch.

Typically, the time for which the complex STB is either in “standby passive mode” can therefore be estimated to zero.

Concerning the time spent either in off mode or in disconnected mode, the EuP study on simple STBs estimates that, 20% of consumers use switch-able connection plug boards to switch off their TV equipment including STBs after watching TV in the evening[130].

In the case of complex STBs, the delay time for the STB to reboot and switch from off to on mode is long (because of software/firmware updates), and can even be as high as few minutes. It can be assumed that the number of end-users turning off their complex STB is 10 times lower then for simple STB[131].

Therefore, it can be assumed that 2% of consumers use switch-able connection plug boards to switch off their TV equipment including STBs after watching TV in the evening[130].

Logical exceptions are STBs with internal mass storage media, which might be programmed to record even when the TV is not being watched. Hence, for STB with internal mass storage media, it is assumed, that only 1% of the users put their STB in either off or disconnected mode. Among the end-users disconnecting or turning off

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129 EuP Preparatory Studies “Televisions” (Lot 5) Final Report on Task 3
130 EuP Preparatory Studies on simple STB
131 Based on a discussion held during the final stakeholder meeting for the lot 18 held in Brussels on October 15th 2008

their STB in the evening after watching TV, it is assumed that 50% disconnect their STB and other half uses the off mode.

Thus, it is important to further estimate the time of operation of complex STBs in on and standby active modes. However, in the future, the STBs' operation time in off mode and standby passive mode can be expected to change since these modes are under implementation by some manufacturers: in response to the questionnaire sent to major European service providers, some of them claimed that auto standby software[132] will soon be implemented in their STBs and/or their 2009 STB models will include a full off mode. One service provider is even targeting to have STBs using 1W in standby passive for the future.

- **Average time in on and standby active modes**

The average time for which a STB is in on mode is estimated to be higher than the average time for which a TV is in on mode. This can be explained by the fact that it is rare to have remote controls capable of turn both the TV and the STB into standby at the same time. It happens often that the viewer will just switch his TV to standby and leave the STB in on mode.

The results of an internal large-scale customer survey B-Sky-B UK[130] suggest that users of STBs often leave them in on mode almost permanently when the TV is put into standby with the remote control. Therefore, the time when the complex STB is in on mode is on average higher than the TV viewing hours. This survey estimates the on mode time of complex STBs without internal mass storage media to 9 hours. Such estimate was also confirmed by stakeholders during the final stakeholder meeting. [131]

A questionnaire was sent to major European service providers and manufacturers to assess the use pattern of complex STBs, i.e. how many hours per day STBs are used in different operating modes. The complex STBs were divided into two categories: complex STBs with or without internal mass storage media. Based on the replies, the average on mode time of a complex STB with internal mass storage media is estimated to be 1.5 hours higher than a complex STB without internal mass storage media to take into account the time of recording even when nobody is watching TV.

- **Complex STBs use patterns for the purpose of this study**

The average use pattern for complex STB assumed for the purpose of this study is presented in Table 3-1.

[132] Automatic standby feature that ensure that the STB automatically switches itself to the lowest standby mode (either active or passive)

Table 3-1: Complex STBs use pattern

Appliance	On mode (hours/day)	Standby active mode[133] (hours/day)	Off mode (hours/day)	Disconnected mode (hours/day)
Complex STB without internal mass storage media	9	14.76	0.12[134]	0.12[135]
Complex STB with internal mass storage media	10.5	13.38	0.06[136]	0.06[137]

It can be noticed that this use pattern differs from the standard use pattern defined by the Version 2.0 of the ENERGY STAR Program Requirements for Set-top Boxes (see Task 1) where the yearly electricity consumptions are to be calculated assuming following duty cycle:

- 14 hours in on mode and 10 hours in active standby mode for a product with no auto power down138,
- 7 hours in on mode, 7 hours in "auto power down mode" and 10 hours in active standby mode for a product with auto power down.

3.1.2. Power management enabling and other user settings

Currently, there are very few possibilities for a user to manage the power consumption settings of a STB (see § 3.1.3.).However, technologies are evolving and the European Code of Conduct encourages manufacturers to give user the ability to manage the energy consumption of STB.

An example of how a design measure could influence the consumer behaviour is by implementing an Energy Control Panel[139] that would enable the user to set his

133 Currently standby active only, this duration could refer to both standby active and standby passive once the standby passive mode is implemented at large scale in complex STBs –In such case, the duration in passive standby could be assumed to be equal to the duration in on-mode (4.5 hours or 6 hours) (as in the Version 2.0 ENERGY STAR Program Requirements for Set-top Boxes) and therefore the duration in standby active mode would be 15 hours or 12 hours when the STB is fitted with an internal mass storage media.

134 20% of end-users turn off or disconnect their STBs in the evening after watching TV (at night) 2% x 12 hours in off-mode or disconnected mode (="night") among which 50% use the off-mode: 2% x 50% x 12 hours in off mode

135 20% of end-users turn off their STBs in the evening after watching TV (at night) 2% x 12 hours in off-mode or disconnected mode (="night") among which 50% use the disconnected-mode: 2% x 50% x 12 hours in off mode

136 10% of end-users turn off or disconnect heir STBs in the evening after watching TV (at night)1% x 12 hours in off-mode or disconnected mode (="night") among which 50% use the off-mode: 1% x 50% x 12 hours in disconnected mode

137 10% of end-users turn off or disconnect heir STBs in the evening after watching TV (at night) 1% x 12 hours in off-mode or disconnected mode (="night") among which 50% use the disconnected-mode: 1% x 50% x 12 hours in disconnected mode

138 Auto power down = The capability to automatically switch from the On state to a Standby state after a period of time without user input, generally based on the amount of time the unit has remained "idle" from last active use (i.e., user input such as channel change, volume change, menu access, etc).

performances and energy savings preferences, as well as a mode where the STB is automatically switched off for certain periods of time. Such control panel would enable consumer to make a more informed choice of the use pattern they adopt with STB and to choose between high performance and high energy savings.

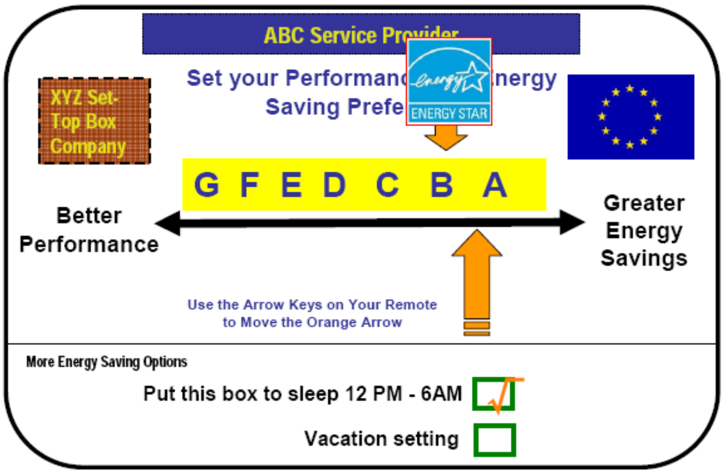

Figure 3-1: Example of user information - An "Energy Control Panel"

Such an Energy Control Panel has the double advantage to give more information to the consumer as well as to send a positive message about energy savings. However, the setting of such energy control functions might be difficult for an average user, in conjunction with other settings available in a complex STB (e.g. parental control, recording functions).

Another efficient solution would be the implementation of an auto standby passive mode with very low energy consumption. This technology would make it possible to reach significant energy savings[140]. When implemented, the end-user will be able to easily control the consumption of the STB since the switch to standby mode will be automatic and the energy consumption will be optimised.

3.1.3. Best practice in sustainable product use

A complex STB needs to remain in on or standby active modes all day long because regular updates (e.g. channel list, programme guides, firmware) need to be made by the service provider. This makes difficult for the consumer to influence the energy consumption of the STB.

3.1.3.1 Switch to standby active mode

One of the only leverage of the end-user on the energy consumption of his STB is switching the STB to standby active mode at the same time as the TV set.

139 Alan Meier, Lawrence Berkeley National Laboratory – IEA Workshop July 2007

140 For example, for a set-top box of 20W in on-mode, and an 18 W standby active, with an initial use pattern of 6 hours on-mode and 18 hours in standby active; including a 3W standby passive mode (on-mode 6 hours/day; standby passive 16hours/day, standby active 2hours/day), energy savings would be of about 50%.

3.1.3.2 Switch off or unplug the STB when not in use

If the consumer accepts waiting for a couple of minutes (necessary time for the STB to reboot and update) before being able to watch TV, he can switch off or unplug the STB (when hard off switch is not available) when not using it for a certain period of time (e.g. during the night). This action would enable a significant energy saving[141]. However, this is more difficult for triple-play boxes if the same box also delivers VoIP telephony and Internet (as the phone/internet needs to be always on).

Even if no switch off button is available, it is always feasible to unplug the STB during long period of absence, for example during holidays.

3.2. END-OF-LIFE BEHAVIOUR

3.2.1. ECONOMIC PRODUCT LIFE

The economic lifetime of a product is defined as the operating life of the product. In other words, it is the number of years of use of the product by one or several customers. In the case of complex STBs, the economic lifetime is often shorter than its technical lifetime. Like many consumer electronics devices, complex STBs are replaced even when in good working conditions because of one of the following reasons:

- The consumer terminates the service subscription
- The service provider proposes a replacement to offer new functionalities (e.g. High Definition or recording capabilities)

It is important to estimate an average lifetime of STBs in this study as a required parameter in the calculation of environmental impacts of complex STBs stock using the MEEuP methodology. In this context, what counts is the "economic lifetime", i.e. the time in service (in practice).

Typically, complex STBs are rented or provided to the end-users and returned to the service providers once the contract is terminated. The broadcaster can either discard STBs or refurbish and put them back on the market, thus resulting in more than one user during its economic product life.

It can therefore be assumed that some STBs are used by more than one end-user during its economic product life. This typically allows to save material and to reduce the impacts of the end-of-life. Indeed, the number of users per product N could have the same importance as the "product life" L (i.e. duration of time the product is owned by one single user) in describing the energy efficiency of a product per functional unit $E_{function}$ (in MJ/year.user):

$$E_{function}=(E_{production}+E_{use}+E_{disposal}-Er_{ecycling})/L*N$$

141 For example, for a STB of 20W in on mode and 18 W in standby active mode, energy savings reach about 50% if the user disconnects his STB 12h per day (at night) instead of leaving is in standby active mode. This calculation is based on an initial use pattern of 6 hours/day in on-mode and 18 hours/day in standby active mode.

Where $E_{production}$, E_{use}, and $E_{disposal}$ are the energy requirements of respectively producing, using and disposal of the product and $E_{recycling}$ constitutes the energy credits for recycling (all in MJ).

Having multiple users during the economic life cycle of a STB also means that one STB can be sold several times (each customer pays one fee), which impacts its life cycle cost. However, it is very difficult to estimate the number of products which are used by multiple users during their economical product lives. Further, this practice is not so common because of the very fast changing technologies which make STBs obsolete soon.

The responses to the questionnaire do not give a very accurate estimation of the economic lifetime of a complex STB. Figures range from 3 to 7 years but they converge to roughly 3 to 4 years for the economic lifetime of a STB.

The EuP preparatory study on simple STBs[130]estimated the average lifetime of STB to 5 years.

For the purpose of this study, typical economic lifetime for a STB used by only one customer is assumed to be 4 years (N=1; L*N= 3 – 4 years). STBs refurbished and put back to the market (less common situation) will probably have a longer economic lifetime, estimated from 4 to 7 years (N>1; 4<L*N<7).

3.2.2. Repair and maintenance practices

From the consumer's perspective, in the case of breakdown, the user rarely get the STB repaired and the service provider replaces it by a current model which is often better than the older STBs. For STBs equipped with internal mass storage media, most of the failures are related to the hard drive.

From the service providers' and manufacturers' perspectives, it is mostly the manufacturer who fixes the problem in case of technical damage if the complex STB is still under warranty. When out of warranty, the service provider is responsible for repairing the defective product. When possible, the service provider uses an external facility or a subcontractor. Usually, an effort is made to repair the STB and in most cases, the repair can be achieved by changing only the faulty component(s). However, when the component replacement cost is too high, the STB is simply discarded.

3.2.3. Re-use, recycling and disposal

3.2.3.1 Responsibility of the service provider

The end-of-life of the STB is typically of the responsibility of the service provider. In most cases, the customer is encouraged to send back the STB to the service provider. When the service provider needs his subscribers to upgrade their STB, the replaced STB are taken back. Often, the customers pay an upgrading fee in order to have a latest technology STB. Sometime, the recovered STB are refurbished and sent to smaller markets using minimal features. STB that cannot be refurbished and reused are disposed of using the service providers' recycling partner. When possible, some parts (components, metals, etc.) are recovered. Best practices include a complex STB take back program which promotes a complete recycling of the STB or its re-use. Task 4 assesses further the relationship between product design and its potential to be recycled (design for disassembly).

3.2.3.2 Responsibility of the end-user

A small proportion of STBs are sold directly to the end-users in which case the disposal will have to follow the WEEE Directive. The customer might give his STB to the municipal recycling authority or send it back to the service provider for recycling, or might simply throw it in the common waste bin.

3.3. LOCAL INFRASTRUCTURE

STBs do not operate by themselves and require to be connected to a service provider through an infrastructure which depends on the transmission platform. Such infrastructures are more or less restrictive depending on the transmission platform. Basically, satellite and terrestrial platforms only require an aerial or a receiver dish, whereas cable and Internet transmission platforms require the end-user to be connected to the cable or internet infrastructure. Cable network is not available in every household since such networks are mainly developed in the urban areas. Internet can be accessed even in rural area through a telephone line.

As shown in Table 3-1 below, in 2007, “only” 32% of EU-27 households had a DSL connection which is required to watch IPTV.

Table 3-1: Percentage of households (Hh) using a DSL connection in 2007[142]

Member State	Hh with DSL	Member State	Hh with DSL
Austria (AT)	23%	Latvia (LV)	13%
Belgium (BE)	40%	Lithuania (LT)	14%
Bulgaria (BG)	3%	Luxembourg (LU)	57%
Cyprus (CY)	20%	Malta (MT)	N/A*
Czech Republic (CZ)	9%	Poland (PL)	16%
Denmark (DK)	36%	Portugal (PT)	15%
Estonia (EE)	24%	Romania (RO)	1%
Finland (FI)	53%	Slovakia (SK)	10%
France (FR)	42%	Slovenia (SI)	29%
Germany (DE)	46%	Spain (ES)	33%
Greece (EL)	7%	Sweden (SE)	53%
Hungary (HU)	19%	The Netherlands (NL)	49%
Ireland (IE)	8%	United Kingdom (UK)	39%
Italy (IT)	23%	EU-27 Average	32%

**: Not Available*

Some variations can be observed across Member States regarding the share of DSL access; countries of Western Europe have the highest penetration rate (up to 57% of total households in Luxembourg). The differences between the MS in terms of the development of infrastructures are also reflected by the distribution of TV transmission platforms.

142 Eurostat

Table 3-2 shows the penetration rate of each platform among households having television access. It refers to pay TV as well as free-to-air TV.

The satellite and cable transmission platforms are the most frequently used means of TV access in Europe. The highest penetration rate for cable platform is in Belgium and the Netherlands, 93% and 92% respectively. In Romania, Luxembourg, Malta, Denmark, Hungary, Germany, Bulgaria, and Slovenia, it is also widely developed platform as more than 50% of households access television via cable. On the contrary, Greece, Cyprus, Spain, France, and Italy have a low penetration rate for cable television (less than 10%). In Turkish Cypriot Community and Austria, the satellite transmission platform has the highest market share. The penetration rate for IP television is highest in Slovenia (9%), Romania (5%) and France (5%) and in terms of number of subscribers, France tops the list.

Table 3-2: Means of reception of TV in EU-25[143]

	An aerial	A cable TV network	Satellite TV via a satellite dish	Digital Terrestrial Television	The telephone network + modem
EU25	50%	33%	22%	5%	2%
EU15	49%	32%	24%	6%	2%
NMS10	55%	38%	11%	1%	2%
BE	3%	**93%**	5%	*1%*	*1%*
CZ	**76%**	20%	10%	*0%*	1%
DK	33%	**60%**	16%	*0%*	3%
DE	5%	**56%**	38%	4%	*2%*
EE	**56%**	40%	7%	*0%*	2%
EL	**98%**	*0%*	3%	3%	*0%*
ES	**90%**	9%	9%	2%	*1%*
FR	**75%**	10%	23%	*4%*	*4%*
IE	**44%**	36%	25%	7%	*2%*
IT	**85%**	8%	17%	5%	*1%*
CY	**98%**	4%	9%	20%	*1%*
LV	47%	**49%**	9%	*1%*	2%
LT	**63%**	36%	3%	*0%*	*0%*
LU	15%	**76%**	17%	*1%*	2%
HU	37%	**57%**	7%	2%	*1%*
MT	31%	**69%**	8%	3%	*1%*
NL	*1%*	**92%**	6%	3%	2%
AT	26%	40%	**47%**	*3%*	5%
PL	**53%**	39%	12%	*1%*	2%
PT	**64%**	35%	4%	*0%*	*0%*
SI	46%	**50%**	14%	*0%*	9%
SK	**60%**	33%	19%	*1%*	5%
FI	**50%**	44%	5%	8%	*1%*
SE	39%	**45%**	27%	17%	*3%*
UK	**50%**	17%	33%	17%	*1%*
BG	42%	**53%**	8%	1%	*0%*
HR	**86%**	14%	20%	*0%*	1%
RO	22%	**78%**	1%	*0%*	5%
TR	**65%**	5%	29%	4%	*0%*
CY (tcc)	47%	*0%*	**49%**	20%	*0%*

(Results in bold represent the highest score by individual country. Results in italic represent the lowest score by individual country. Results indicated in a box represent the highest score per item. Results highlighted in grey represent the lowest score per item)

143 E-communications Household Survey July 2006 http://ec.europa.eu/public_opinion/archives/ebs/ebs_249_en.pdf

3.4. POSSIBLE BARRIERS TO ECO-DESIGN

Consumer behaviour is an important parameter for the electricity use of complex STBs. Any design measure that helps improving the consumer behaviour in that sense constitutes an important improvement potential. This section assesses the relevant parameters and identifies the barriers and restrictions for eco-design measures that would improve the situation.

3.4.1. BUYING DECISION: FOCUS ON FIRST PRICE AND SPLIT INCENTIVES

A consumer's decision to buy a complex STB with specific power requirements, determines to some extent the environmental impact of the device during the use phase. However, the consumer (i.e. end-user) is rarely the purchaser of an STB. In most of the existing business models, the service provider (e.g. broadcaster, cable company, and ISP) often rents or provides the appliance to the consumer free of charge or at an advantageous price, along with the service subscription. The end-user has either no or a very little choice regarding the STB model and rather chooses the conditions of the contract (period of the contract, TV channels provided, etc.).Thus, the decision to buy a particular STB model is currently made by the service providers who purchase complex STB from appliance manufacturers.

As reflected in the replies to the questionnaire which was sent to major European service providers and complex STB manufacturers (see Figure 3-2), technology/performance and price are considered to be the most important criteria from the purchasers' point of view (i.e. service providers). Energy consumption and product life are considered less important when influencing the purchase choice.

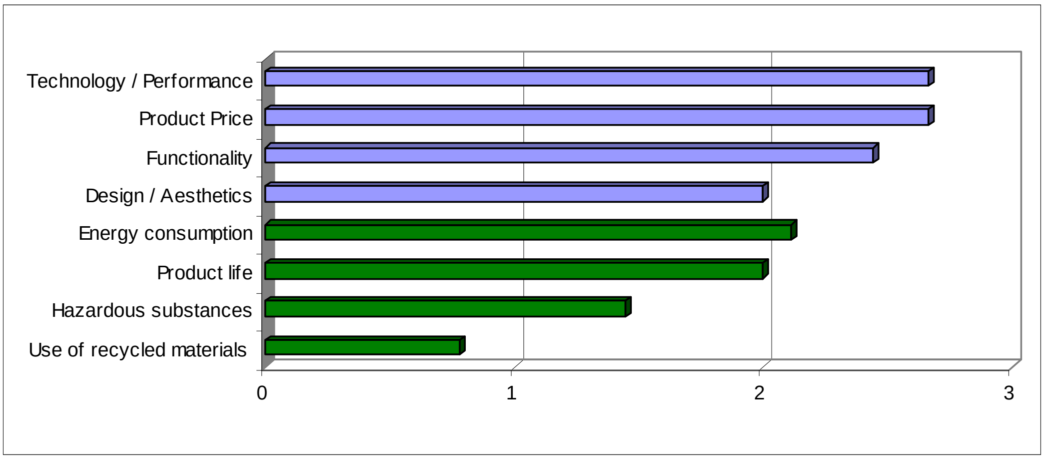

Figure 3-2 : Importance of different criteria in the purchaser's buying decision[144]

This can be explained by the fact that service providers select the equipment that meets the required technical specifications at the lowest cost. The main focus of such technical specifications is not on the energy efficiency because the service providers generally won't gain from the improved energy efficiency. This is a classical case of split

144 Three represents "Very High interest" and zero "Very Low interest"

incentive, where the equipment buyer is not the one that benefits directly from its reduced energy consumption. Consequently, energy efficiency of complex STB is not the primary criteria affecting the choice of appliance by service providers, unless explicitly demanded by customers. Therefore, this split incentive could be a barrier for a voluntary switch to more energy efficient complex STB as the end-user has to pay the electricity bill for an appliance which may have a high electricity consumption. Purchasers of complex STB mainly focus on proposed functionalities and on the product price rather than on environmental characteristics (e.g. energy consumption, use of recycled materials, hazardous substances). It is a tricky situation for subscribers who can hardly take into consideration environmental aspects in their buying decision as the choice is very limited or null.

Moreover, service providers order STB in large amounts (sometimes in millions every year) and even a marginal difference in the cost (few cents) can represent significant money at the scale of their annual orders. Nevertheless, some service providers and manufacturers are becoming more and more aware of environmental impacts of their STB[145]. The issue of energy consumption has emerged during last couples of years and is expected to remain an important aspect of the STB design in the future. Moreover, it seems that end-users (i.e. subscribers) are becoming more and more conscious of the environmental impact of their appliances.

One possibility to address the issue of split incentives could be to have the electricity consumption of the complex STB to be included in the price of the service i.e. the subscription fees, as it is currently the case with some telecommunication operators who pay for the electricity bill of the fixed telephones of their subscribers. This way they might be encouraged to select more efficient STB. However, there might be operational difficulties in applying such a mechanism at the EU-27 level because of a wide range of service providers and utility companies and the disparities existing across the Member States.

3.4.2. CONTINUOUS UPDATE OF COMPLEX SET-TOP BOX

Another main barrier to eco-design is that the complex STB has to be constantly in a mode that enables the box to receive signals from the broadcaster (i.e. in on mode or in standby active mode). This need for content provider to access the STB to download programming, update software, and perform subscription verification is the one of the main barrier for reaching lower electricity consumptions, because it implies that the STB needs to be either in on mode or in standby active mode. Of course, the end-user could turn off or unplug the complex STB in order to stop its electricity consumption, but this would lead to several minutes waiting time when the STB is switched on again. As a result, this becomes a critical issue for end-users who want to be able to watch TV as soon as they switch on the STB.

This issue could be tackled by technological changes within the box itself.

- **Auto standby and further implementation of a standby passive mode**

145 Questionnaire responses from major European service providers and complex STB manufacturers

A first possibility would be through an "auto standby" technology combined with the implementation of a passive standby mode. The auto standby would enable the STB to switch to passive standby for a determined period of time (e.g. overnight) when the user is unlikely to use his STB, and then to switch back in active standby mode when the user is likely to use his STB again. Some TV service providers are already working towards providing such "auto standby" implemented in their STB: their new feature monitors whether people are using their STB overnight between 11 PM and 4 AM. If the box has not been used for a period of two hours after 11 PM, an 'Auto Standby' warning will pop up on screen for three minutes. If there is no further use, the box will automatically go into the standby mode. Such technology has been suggested by the European Code of Conduct on Energy Efficiency of Digital TV Service Systems and in the Energy Star program for STBs. It already exists in other electrical appliances such as computers and would need to be further adapted to STBs.

An overview of the saving potentials provided by the implementation of power management and a standby passive mode are presented in Figure 3-3**.** It shows that assuming that a STB stays in on mode for 4 hours, the power management technology would enable the STB to switch to standby active 2 hours and in standby passive 18 hours daily leading to overall 69% electricity savings[146].

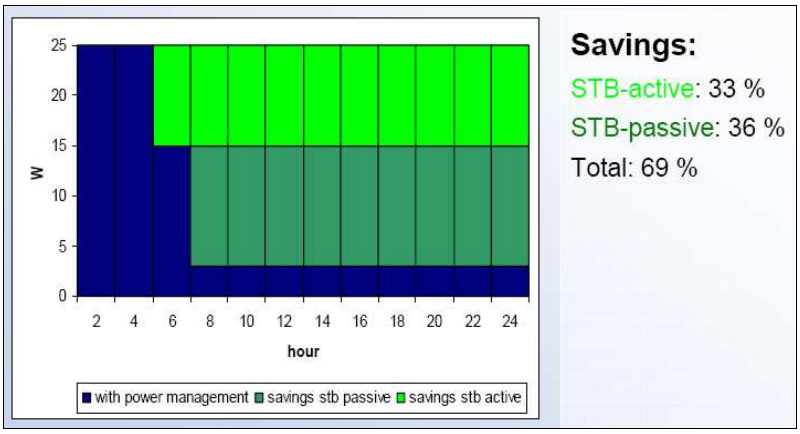

Figure 3-3: Power management saving potential

- **Set time schedule for updates**

A second option would be to modify the network infrastructure, for example by limiting the timeframe when the service provider can interact with the box. This would require a whole re-organisation of the CA system, requiring service providers to agree on a specific timeframe during which they would proceed to the updates and during which end-users would be informed that they need to have their STB on, implying that they can switch them in standby passive or off mode the rest of the time. This issue is further analysed in Task 5 and 6. In the draft version 8 of the European Code of Conduct on Energy Efficiency of Digital TV Service Systems, the section 4 on the commitments includes such an approach: "*4.7 (For service providers) Ensure that the setup of the network infrastructure of the service provider will be in a way that any interaction with the STB over the network, driven by the service provider and not by the*

146 Senter Novem www.iea.org/textbase/work/2003/set-top/siderius.pdf

customer, will be within a limited timeframe over 24 hours to give the STB the chance to go into the standby mode."

3.4.3. Lack of available information

As already mentioned in § 3.4.1. , in most cases the STB is not chosen by the end-user. The end-user can sometimes select a STB according to the features he would like to have, e.g. internal mass storage media, HD, but rarely has the choice between several STBs models with similar functionalities.

Service providers, who are the main purchasers of complex STB, do not generally request environmental information such as electricity consumption. As a consequence, they cannot communicate such information to their customers. Information on the energy consumption of a STB is usually neither available on the packaging nor on the website of the service provider. This lack of information is a barrier to eco-design but could be overcome by asking manufacturers and service providers to explicitly communicate the energy consumption information to the consumer.

Moreover, typical end-users do not know that when they "turn off" their complex STB with the remote control, the device is not in off mode or in standby passive mode but in standby active mode for which the power requirement can sometime be almost equal to the on mode. However, more and more people are becoming aware that most complex STB have poor energy efficiency through newspapers articles on this topic or other awareness raising initiatives. For instance, a French consumer NGO called "60 millions de consommateurs" published a report in October 2007[147] on the electricity consumption of STB delivered by several French companies offering "Triple play" services.

3.4.4. Product vs. service

Basically, the end-user of a complex STB (the subscriber) buys a package of one or several TV channels or a 'triple pay' offer, i.e. a service and not a product (STB). As a result of this, the subscriber's buying decision is more related to the content of the service rather than to the product itself.

Furthermore, any potential implementing measure setting eco-design requirements for complex STB will have to ensure that the service purchased by the subscriber will not be adversely affected by the product choice.

3.5. CONCLUSIONS FOR TASK 3

The assumptions for the use patterns, including times for on mode, standby active mode, off mode and disconnected modes, differentiating complex STBs with and without internal mass storage media as outlined in this task will be the basis for the calculations in Task 5 and the mid-term scenarios in Task 8. Life cycle cost calculations will be based on an economic life of 4 years.

147 www.60millions-mag.com/kiosque/mensuels/internet_et_si_vous_changiez_de_fournisseur

The STB procurement policy of service providers is mainly focused on the price and on the performance/functionalities of the product, even though awareness about energy consumption is starting to emerge. Explicit specifications of energy consumption would be a first step toward better practices in sustainable product use.

4. Task 4 - Technical Analysis Of Existing Products

Task 4 comprises of the technical analysis of existing complex STBs on the EU market. Bill of Materials (BOM) and resources consumption during product life are some of the important parameters which will serve as inputs for the Base Case analysis in Task 5.

4.1. PRODUCTION PHASE

Complex STBs were acquired from *Stiftung Warentest* in Germany and disassembled at Fraunhofer IZM laboratories for establishing the BOM. The test results for these STBs were published in November 2007[148].

Table 2-1 below lists the individual products, which were disassembled and analysed regarding their components and material composition. The main features are indicated and power consumption in on mode and standby, as published by Stiftung Warentest, are provided. Additionally, the switch-on delay times as identified by Stiftung Warentest are listed for two settings:

- Delay time from standby to full operation
- Delay time from disconnected or hard-switch switched off (when the latter is available) to full operation

The delay times are provided because this is an important indicator of user convenience, including the acceptance of low power modes. Long delay times might result in not using a hard-switch at all. The delay times from standby are typically in the range of a few seconds, e.g. the delay time from standby for two complex STBs with standby power consumption below 1 W is approximately 10 seconds and these two STBs show nearly the same delay time from disconnected / hard-off. Most of the STBs have delay times of 10 – 20 seconds from disconnected / hard-off. These delay times have been measured with the conditional access module not being active. With configured conditional access, delay times are assumed to be longer due to online update of settings.

[148] Vom Himmel geholt - Digitale Sat-Empfänger, test, 11/2007, p. 55-59; 15 tested in total, thereof 13 complex ones acquired for reverse engineering

Table 4-1: Tested and disassembled complex STBs (DVB-S)

STB model	Features					Measured power consumption (W)		Switch-on delay (s)	
	CA	Return path	second tuner	HDD / PVR	HD	On mode	Standby	from standby	from unplugged / hard-switch off
Telestar Diginova 3 CRCS	+	-	-	-	-	8.7	2.5	4.3	15.4
Boca DSL 221 CI	+	-	-	-	-	7.1	0.9	10.7	10.7
Comag SL 35 1 CI	+	-	-	-	-	7.1	0.7	10.3	10.4
Kathrein UFS 710	+	-	-	-	-	7.7	3.1	22.6	23.1
Technisat DigitSim S2	+	-	-	-	-	6.2	2.1	3.3	14.5
Humax Blu-Fox S	+	-	-	-	-	11.1	6.9	2.5	26.9
Zehnder DX 3010 CI	+	-	-	-	-	10.9	5.8	2.2	11.2
Homecast S 5001 CICR	+	-	-	-	-	11.3	8.4	2.4	16.5
Wisi OR 41 DVB-S-CI	+	-	-	-	-	13.0	8.4	9.2	11.2
Philips DSR9005/02	+	-	-	-	+	15.0	14.5	2.0	36.0
Dream Dreambox 600 PVR S	+	-	-	+	-	11.3	7.3	1.1	53.8
Skymaster DVR 7500	+	-	-	+	-	20.3	9.0	15.0	19.5
SEG PVR 62-160S	+	-	+	+	-	23.4	13.3	7.1	19.2

A complex STB with top cover removed is shown in Figure 2-6 with a schematic layout indicating the main components. Typically, the power supply circuitry comes with its own Printed Wired Board (PWB). Rather uncommon is the fact that the CI slot comes with a separate PWB. Typically, this is an integrated part of the main PWB. Tuners can also be included in two manners: as a separate component or integrated on the main PWB, but always with a separate shielding.

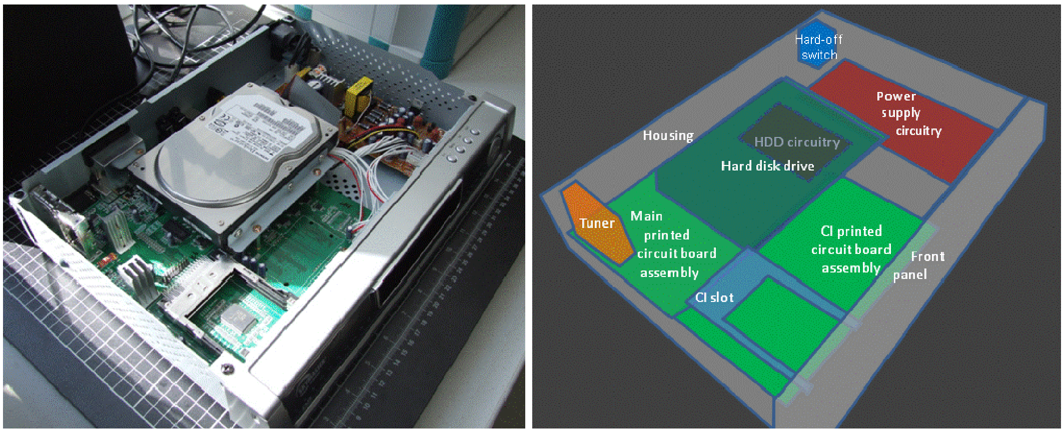

Figure 4-1: Main components of a complex STB

The main components of a complex STB are

- Front panel (including buttons, remote control sensor, display, etc.)
- Housing (with backside interfaces, occasionally with hard-off switch)
- Printed wired board assemblies (main PWB, power supply circuitry, flex circuitry for display, HDD circuitry, tuner circuitry, etc.)
- Common Interface (CI) slot
- Hard-disc drive (if any)
- Internal cables, external cables, and screws
- External power supply (if any)
- Remote control
- Packaging (including manual)

All these components have an influence on the raw material requirement and thus contribute to the environmental impacts caused during the production phase. To be coherent with the Base Case assessments in Task 5, the BOM of typical STBs and components have been split up according to the material and component categories of the EcoReport template.

Methodological aspects

Regarding the EcoReport template, following estimations have been made:

- **Gold layers** (connectors etc.) have been calculated with the default layer thickness stated in MEEuP (reverse calculation from area with default thickness).
- There are a couple of **4-layer PWBs** used in complex STBs. As there is no entry for 4-layer PWBs in the EcoReport, the entry for 6-layer PWBs has been used, which means an overestimation of the environmental impacts.
- **Flex PWBs** are used in complex STBs. As there is no entry for flex PWBs, the 1/2-layer PWB entry has been applied on a weight basis.

- Modelling of **HDD production** is not possible in the EcoReport[149]. However, regarding material composition of HDDs, the precious metals are assumed to be of significance: in 2007, the HDD industry consumed 12 t Ruthenium and 7.6 t of Platinum[150]. With roughly 500 million HDDs shipped in 2007, this is equivalent to 0.024 g Ruthenium and 0.015 g Platinum per HDD[151]. Entries for the EcoReport are 0.039 g coating Au/Pd/Pt per HDD consequently. Other materials of the HDD have been assessed with the base materials entries "glass for lamps" (platters) or metals / alloys.
- **Digit displays** of STBs are not comparable with the liquid crystal display (LCD) entry provided by the EcoReport template. As they are composed mainly of glass with a minor (weight) amount of circuitry and metal connectors, they are entered in the BOM as "glass for lamps", which most likely does not correspond to the actual glass type and quality and neglects the production impacts of display manufacturing, but is still the best possible approximation.
- **Batteries** of the remote control are entered as "big caps and coils" as there is no entry for batteries and as they show some similarities with electrolytic capacitors.

4.1.1. Typical BOM of complex STBs (DVB-S, -T, -C) without additional features, such as return path, HDD, second tuner, HD capability

Typical BOM of a complex STB for DVB-S (satellite platform) without additional features (such as return path, HDD, second tuner, and HD capability) is presented in Table 4-2. This corresponds to Wisi OR 41 DVB-S-CI STB, which in terms of BOM, material composition, and weight is the one closest to the average of all seven disassembled DVB-S-STBs with similar functionality (and metal housing, as for plastics housing results look differently, see task 6).

Power circuitry typically is integrated in the STB, i.e. the STB runs on 230V. However, there are some complex STBs with external power supplies.

This typical BOM comprises several PWB assemblies, namely the main board, tuner PWBs (canned tuner), power supply PWB, and some minor PWBs (e.g. interfaces and PWB of the remote control). The number of internal PWBs per STB varies, depending on the actual circuitry design. Some have only one PWB with all the functionalities integrated in one board and a separate section for the power circuitry, but mostly

149 The EcoReport template does not include a dataset for HDDs, therefore a HDD has to be modelled according to the material composition with the dataset provided by the methodology, e.g. "glass for lamps" as an approximation for the special glass substrate used for the disks; specific production processes, such as wafer processes for processing the read / write head, the micro-mechanical parts, and cleanroom processes for platter manufacturing, cannot be modelled with the methodology at all – nor is published up-to-date data on HDD manufacturing available as this is highly confidential data. Consequence: The results for HDDs have to be seen rather as an underestimate of real HDD production related impacts.

150 Johnson Matthey: Platinum 2007, United Kingdom, ISSN 0268-7305, www.platinum.matthey.com/uploaded_files/2007/complete_publication.pdf

151 iSuppli

tuner and power supply functionality are realised with PWBs different from the main board.

In different types of STBs, PWBs with gold finish are used which amount in milligrams of gold per board. Hence, the BOM entry lists “0.0g” for gold (as values below 100 mg cannot be displayed in this pre-defined sheet), but for the environmental assessments, these minor amounts are taken into account and are calculated – with a certain impact on the overall results (see Task 5, §5.2.).

Table 4-2: Typical BOM of complex STBs for DVB-S without additional features such as return path, HDD, second tuner, HD capability

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	HOUSING (coating)	13,3	5-Coating	38-pre-coating coil
2	Upper case	328,8	3-Ferro	25-Stainless 18/8 coil
3	Front panel	96,3	1-BlkPlastics	10-ABS
4	Screws	15,1	3-Ferro	22-St tube/profile
5	Display	21,1	7-Misc.	54-Glass for lamps
6	Bottom-back case	434,8	3-Ferro	25-Stainless 18/8 coil
7				
8				
9	HARD OFF SWITCH 2,9g			
10	Cable/plug, 50% PVC	1,5	1-BlkPlastics	8-PVC
11	Cable/plug 50% Cu	1,5	4-Non-ferro	29-Cu wire
12	HARD DISK DRIVE			
13				
14	PRINTED CIRCUIT BOARD ASSEMBLY (1) main PCB			
15	Gold	0,0	5-Coating	41-Au/Pt/Pd
16	Through-hole-components	16,2	6-Electronics	44-big caps & coils
17	Transformers	0,0		
18	Plastics	0,0		
19	Copper	0,0		
20	Ferrite	0,0		
21	Surface-mount-devices	0,4	6-Electronics	48-SMD/ LED's avg.
22	Large ICs	6,1	6-Electronics	46-IC's avg., 5% Si, Au
23	Small ICs	3,3	6-Electronics	47-IC's avg., 1% Si
24	Connectors	75,6	6-Electronics	45-slots / ext. ports
25	Printed circuit board substrate	73,0	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
26	Solder	4,1	6-Electronics	52-Solder SnAg4Cu0.5
27	Housing of the pay-TV card plastic	9,3	1-BlkPlastics	10-ABS
28	Housing of the pay-TV card metallic part	13,4	3-Ferro	25-Stainless 18/8 coil
29	Heat sink (x2)	12,6	4-Non-ferro	26-Al sheet/extrusion
30	PRINTED CIRCUIT BOARD ASSEMBLY (2) tuner 1			
31	Gold	0,0	5-Coating	41-Au/Pt/Pd
32	Through-hole-components	0,6	6-Electronics	44-big caps & coils
33	Surface-mount-devices	0,1	6-Electronics	48-SMD/ LED's avg.
34	Large ICs	0,0	6-Electronics	46-IC's avg., 5% Si, Au
35	Small ICs	0,6	6-Electronics	47-IC's avg., 1% Si
36	Connectors	1,4	6-Electronics	45-slots / ext. ports
37	Printed circuit board substrate	4,8	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
38	Solder	0,2	6-Electronics	52-Solder SnAg4Cu0.5
39	housing	29,1	3-Ferro	25-Stainless 18/8 coil
40				

42	PRINTED CIRCUIT BOARD ASSEMBLY (3) tuner lateral PCB			
43	Gold	0,0	5-Coating	**41-Au/Pt/Pd**
44	Through-hole-components	0,0	6-Electronics	**44-big caps & coils**
45	Surface-mount-devices	0,0	6-Electronics	**48-SMD/ LED's avg.**
46	Large ICs	0,0	6-Electronics	**46-IC's avg., 5% Si, Au**
47	Small ICs	0,0	6-Electronics	**47-IC's avg., 1% Si**
48	Connectors	1,2	6-Electronics	**45-slots / ext. ports**
49	Printed circuit board substrate	7,5	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
50	Solder	0,2	6-Electronics	**52-Solder SnAg4Cu0.5**
51				
55	PRINTED CIRCUIT BOARD ASSEMBLY (4) power supply PCB			
56	Gold	0,0	5-Coating	**41-Au/Pt/Pd**
57	Through-hole-components	47,6	6-Electronics	**44-big caps & coils**
58	Surface-mount-devices	0,0	6-Electronics	**48-SMD/ LED's avg.**
59	Large ICs	0,0	6-Electronics	**46-IC's avg., 5% Si, Au**
60	Small ICs	0,0	6-Electronics	**47-IC's avg., 1% Si**
61	Connectors	5,1	6-Electronics	**45-slots / ext. ports**
62	Printed circuit board substrate	25,4	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
63	Solder	2,7	6-Electronics	**52-Solder SnAg4Cu0.5**
64	Small transformers (x2) 21,2g			
65	Plastic	7,34	2-TecPlastics	**11-PA 6**
66	Copper	6,92	4-Non-ferro	**28-Cu winding wire**
67	Ferrite	6,92	3-Ferro	**24-Ferrite**
68	Big transformers (x2) 35,8g			
69	Plastic	6,43	2-TecPlastics	**11-PA 6**
70	Copper	6,62	4-Non-ferro	**28-Cu winding wire**
71	Ferrite	22,7	3-Ferro	**24-Ferrite**
72	Heat sink	4,1	4-Non-ferro	**26-Al sheet/extrusion**
73				
74				
75	FLEXIBLE PCB	0		
76				
77	EXTERNAL CABLES			
78	Cable/plug, 50% Cu	34,85	4-Non-ferro	**29-Cu wire**
79	Cable/plug, 50% PVC	34,85	1-BlkPlastics	**8-PVC**
80				
81	INTERNAL CABLES			
82	Cable/Plug, 50% Cu	6,115	4-Non-ferro	**29-Cu wire**
83	Cable/Plug, 50% PVC	6,115	1-BlkPlastics	**8-PVC**
84	Metallic holder	13,2	3-Ferro	**24-Ferrite**
90				
91	REMOTE CONTROL UNIT			
92	Screws	0	3-Ferro	**22-St tube/profile**
93	Plastic housing	45,4	1-BlkPlastics	**10-ABS**
94	Batteries	12,2	6-Electronics	**44-big caps & coils**
95	PCB	12,7	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
96	Flexible part with the buttons	12,8	2-TecPlastics	**16-Flex PUR**
97				
98				
99	PACKAGING			
100	Protector bag	5,4	1-BlkPlastics	**2-HDPE**
101	Manual	54,5	7-Misc.	**57-Office paper**
102	Box	352,5	7-Misc.	**56-Cardboard**
103	Silica gel	4,8		
136	PRINTED CIRCUIT BOARD ASSEMBLY (5) S-VHS connector PCB			
137	Gold	0	5-Coating	**41-Au/Pt/Pd**
138	Through-hole-components	0	6-Electronics	**44-big caps & coils**
139	Surface-mount-devices	0	6-Electronics	**48-SMD/ LED's avg.**
140	Large ICs	0	6-Electronics	**46-IC's avg., 5% Si, Au**
141	Small ICs	0	6-Electronics	**47-IC's avg., 1% Si**
142	Connectors	3	6-Electronics	**45-slots / ext. ports**
143	Printed circuit board substrate	1	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
144	Solder	0	6-Electronics	**52-Solder SnAg4Cu0.5**

The amount of solder is rather minor and has been estimated by visual inspection. All disassembled STBs used lead-free solders, making the use of SnAgCu[152] for the surface mounted devices (reflow soldering) very likely, whereas for the through-hole components (wave soldering; power supply circuitry mainly) rather the use of SnCu is likely.

Metal housing is quite common for complex STBs. Typically, the main chassis is made of steel sheet, whereas the front panel is made of plastics (assumed to be ABS), including a display and various buttons. To make the appearance more attractive (as the STBs are often placed in the living room), the front plastic parts are coated[153] in almost all cases.

With this BOM the manufacturing phase entries in the EcoReport tool are calculated automatically as shown in Table 4-3. The settings for sheet metal scrap percentage are the default settings as there is no evidence that this is not applicable for sheet metal parts used for complex STBs.

Table 4-3: Manufacturing phase entries for complex STBs for DVB-S without additional features such as return path, HDD, second tuner, HD capability

Pos nr	MANUFACTURING Description	Weight in g	Percentage Adjust	Category index (fixed)
201	OEM Plastics Manufacturing (fixed)	225		20
202	Foundries Fe/Cu/Zn (fixed)	0		34
203	Foundries Al/Mg (fixed)	0		35
204	Sheetmetal Manufacturing (fixed)	866		36
205	PWB Manufacturing (fixed)	337		53
206	Other materials (Manufacturing already included)	521		
207	Sheetmetal Scrap (Please adjust percentage only)	216	25%	37

4.1.2. Sample BOM of Triple Play Box

In principle, the BOM for DVB-S, DVB-C and DVB-T STBs is similar, whereas IPTV typically comes with triple play, which requires a triple play box (home gateway / modem) to which a STB is connected to display IPTV content on a TV screen. Mostly the triple play box is separate from the TV STB, sometimes functionality of both is integrated in one box. The BOM for a sample triple play box (without internal mass storage media and TV receiver) is listed in Table 4-4.

This BOM lists separately the WLAN and Bluetooth parts of the triple play box, which are standard for triple play, but not for other transmission platforms (cable, satellite, terrestrial). WLAN / bluetooth components in terms of weight and size make up only a minor part of the total BOM (but are quite relevant in terms of power consumption. The main PWB assembly includes the modem functionality, i.e. what can be considered return path functionality for the IPTV system.

As in the case of DSL modems, typically the triple play boxes include an external power supply. A switch mode power supply is chosen here for the BOM although there might be some linear power supplies still in use for such boxes.

[152] SnAgCu being the only provided dataset for solder material in the EcoReport template, no distinction per solder alloy is feasible

[153] Coating of plastics not accounted for in the BOM as such a dataset is not provided

A hard-off switch for triple play boxes is not common.

Table 4-4: Sample BOM of a triple play box

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	HOUSING (non coated plastic)			
2	Upper case	222,2	1-BlkPlastics	10-ABS
3	Bottom case	215,4	1-BlkPlastics	10-ABS
4	Screws	2,3	3-Ferro	22-St tube/profile
5	Plastic "label"	4,1	2-TecPlastics	12-PC
6	Plasitc protector	22,4	2-TecPlastics	12-PC
7				
8	HARD-OFF SWITCH none			
9				
10				
11	PRINTED CIRCUIT BOARD ASSEMBLY (1) main PCB			
12	Gold	0,0	5-Coating	41-Au/Pt/Pd
13	Through-hole-components	11,8	6-Electronics	44-big caps & coils
14	Surface-mount-devices	2,7	6-Electronics	48-SMD/ LED's avg.
15	Large Ics	5,8	6-Electronics	46-IC's avg., 5% Si, Au
16	Small Ics	1,7	6-Electronics	47-IC's avg., 1% Si
17	Connectors	27,3	6-Electronics	45-slots / ext. ports
18	Printed circuit board substrate	124,4	6-Electronics	50-PWB 6 lay 4.5 kg/m2
19	Solder	3,6	6-Electronics	98-controller board
20	Transformers (x2, 2g each)			
21	Plastic	0,7	2-TecPlastics	11-PA 6
22	Copper	0,7	4-Non-ferro	28-Cu winding wire
23	Ferrite	0,7	3-Ferro	24-Ferrite
24				
25				
26	PRINTED CIRCUIT BOARD ASSEMBLY (2) Wlan card 13,2g			
27	Gold	0,0	5-Coating	41-Au/Pt/Pd
28	Through-hole-components	0,0	6-Electronics	44-big caps & coils
29	Surface-mount-devices	0,3	6-Electronics	48-SMD/ LED's avg.
30	Large Ics	0,5	6-Electronics	46-IC's avg., 5% Si, Au
31	Small Ics	0,2	6-Electronics	47-IC's avg., 1% Si
32	Connectors	3,1	6-Electronics	45-slots / ext. ports
33	Printed circuit board substrate	7,6	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
34	Solder	0,3	6-Electronics	52-Solder SnAg4Cu0.5
35	Housing of the integrated Wlan Card	1,4	4-Non-ferro	26-Al sheet/extrusion
42	BLUETOOTH 2,2g			
43	Housing	0.9	4-Non-ferro	26-Al sheet/extrusion
44	PCB			
45	Surface-mount-devices	0.16	6-Electronics	48-SMD/ LED's avg.
46	Large Ics	0	6-Electronics	46-IC's avg., 5% Si, Au
47	Small Ics	0.25	6-Electronics	47-IC's avg., 1% Si
48	Connectors	0	6-Electronics	45-slots / ext. ports
49	Printed circuit board substrate	0.9	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
50	Solder	0.0262	6-Electronics	52-Solder SnAg4Cu0.5
51				
52				
53				
54	INTERNAL CABLES 0,3 g			
55	Cable 50% Cu	0.15	4-Non-ferro	29-Cu wire
56	Cable 50%PVC	0.15	1-BlkPlastics	8-PVC
57	Gold	0.002	5-Coating	41-Au/Pt/Pd

90	EXTERNAL POWER SUPPLY 175 g			
91	Housing			
92	Upper and lower case	51.345	2-TecPlastics	12-PC
93	Screws	0.4	4-Non-ferro	26-Al sheet/extrusion
94	Screws	0.4905	3-Ferro	21-St sheet galv.
95	Electronic assembly			
96	PWB (single sided)	13.815	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
97	Big caps & coils (THT)			
98	Capacitors (electrolytic)	11.943	6-Electronics	44-big caps & coils
99	Capacitor (film)	2.25	6-Electronics	44-big caps & coils
100	Coils + transformers	33.335	6-Electronics	44-big caps & coils
101	other big caps and coils	1	6-Electronics	44-big caps & coils
102	Capacitor (ceramic)	2.015	6-Electronics	44-big caps & coils
103	Slots / Ext. Ports			
104	Slot 230 V	8.49	6-Electronics	45-slots / ext. ports
105	IC's			
106	Ics	1.41	6-Electronics	47-IC's avg., 1% Si
107	SMD/THT			
108	SMD capacitors	0.113	6-Electronics	48-SMD/ LED's avg.
109	SMD resistors	0.1265	6-Electronics	48-SMD/ LED's avg.
110	diodes	2.536	6-Electronics	47-IC's avg., 1% Si
111	transistors	1.1325	6-Electronics	47-IC's avg., 1% Si
112	SMD miscellaneous	0.85	6-Electronics	48-SMD/ LED's avg.
113	Miscellaneous			
114	THT resistors	1.135	6-Electronics	48-SMD/ LED's avg.
115	THT fuse	1.095	6-Electronics	44-big caps & coils
116	THT ferrite	0	3-Ferro	24-Ferrite
117	THT bridge, jumper	0	4-Non-ferro	28-Cu winding wire
118	THT plug	2	1-BlkPlastics	8-PVC
119	Aluminum Heat sink	4	4-Non-ferro	26-Al sheet/extrusion
120	Solder	2	6-Electronics	52-Solder SnAg4Cu0.5
121	Cables			
122	Copper wire	15	4-Non-ferro	29-Cu wire
123	PVC	15	1-BlkPlastics	8-PVC
124	Plug	4	6-Electronics	45-slots / ext. ports

76				
77	Packaging (assumption)			
78	Foils	12,5	1-BlkPlastics	2-HDPE
79	Manual	145,7	7-Misc.	57-Office paper
80	Box	267,6	7-Misc.	56-Cardboard
81	Protector (x2)	105,2	7-Misc.	56-Cardboard

Manufacturing phase entries are calculated in the same way as for other STBs (see Table 4-3), i.e. as a direct result of BOM entries.

4.1.3. TYPICAL BOM OF A COMPLEX STB (DVB-S) WITH HARD DISK DRIVE

The full BOM of a typical STB with hard disk drive (HDD) is listed in Table 4-5. Three complex STBs with HDD actually have been disassembled, two of them very similar regarding the BOM – among these the Skymaster DVR 7500 for which the BOM is provided below -, one with a very slim design and being a premium product, not to be considered "typical".

Rows 89-109 and 150-153 list the dedicated components of the HDD. However, implementing an HDD results in side effects, such as changed dimensioning of the power supply circuitry and additional components required on the main PWB and larger STB housing to enclose these components. Furthermore, an STB with integrated mass storage medium represents a market segment, where additional functionalities (especially multiple interfaces) are implemented, which makes the BOM even more complex. Consequently, a complex STB with HDD in terms of BOM is more than just "basic complex STB + HDD BOM". The HDD is a typical 80 GB HDD for complex STBs, but products with 160 GB capacity are gaining ground among STB/PVRs due to the steady drop of prices for hard disk drives.

This typical STB contains 6 PWB assemblies plus the PWB in the remote control.

Power supply circuitry is integrated, i.e. STBs with HDD generally run on 230 V. An external power supply for the load requirements of such an STB is not economical. In this market segment, no STBs with external power supplies are known.

The hard-off switch and related components and materials are of very minor relevancy for the overall BOM. However, minor differences in the BOM at small margins can make a significant economic difference for a manufacturer. Hard-off switches are quite common even among complex STBs.

Regarding remote controls there are no major differences among the various STBs. They slightly differ in design, but the compositions of such remote controls are quite similar.

Table 4-5: Typical BOM of a complex STB (DVB-S) with Hard Disk Drive

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	HOUSING (silver colour coating)	19,6	5-Coating	38-pre-coating coil
2	Upper case	436,2	3-Ferro	25-Stainless 18/8 coil
3	Front panel	193,7	1-BlkPlastics	10-ABS
4	Screws (5upper case+2fornt+5back+2back)	10,1	3-Ferro	22-St tube/profile
5	Display (size 8,2x2,1 cm)	17,8	7-Misc.	54-Glass for lamps
6	Back part (silver colour coating)	99,4	3-Ferro	25-Stainless 18/8 coil
7	Bottom part	689,9	3-Ferro	25-Stainless 18/8 coil
8				
9	HARD-OFF SWITCH 9,1g			
10	Cable/plug, 50% Cu	4,6	4-Non-ferro	29-Cu wire
11	Cable/plug, 50% PVC	4,6	1-BlkPlastics	8-PVC
12				
13				
14	PRINTED CIRCUIT BOARD ASSEMBLY (1) main PCB 208,1g			
15	Gold	0,0	5-Coating	41-Au/Pt/Pd
16	Through-hole-components	13,7	6-Electronics	44-big caps & coils
17	Surface-mount-devices	0,7	6-Electronics	48-SMD/ LED's avg.
18	Large ICs	4,0	6-Electronics	46-IC's avg., 5% Si, Au
19	Small ICs	8,6	6-Electronics	47-IC's avg., 1% Si
20	Connectors	70,5	6-Electronics	45-slots / ext. ports
21	Printed circuit board substrate	103,7	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
22	Solder	4,2	6-Electronics	52-Solder SnAg4Cu0.5
23	Size of the PCB 22,6x11,9 cm			
24	Heat sink (x2)	16,7	4-Non-ferro	26-Al sheet/extrusion
25				
30	PRINTED CIRCUIT BOARD ASSEMBLY (2) display's PCB 44,1g			
31	Gold	0,0	5-Coating	41-Au/Pt/Pd
32	Through-hole-components	9,6	6-Electronics	44-big caps & coils
33	Surface-mount-devices	0,3	6-Electronics	48-SMD/ LED's avg.
34	Large ICs	0,0	6-Electronics	46-IC's avg., 5% Si, Au
35	Small ICs	0,3	6-Electronics	47-IC's avg., 1% Si
36	Connectors	0,7	6-Electronics	45-slots / ext. ports
37	Printed circuit board substrate	32,7	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
38	Solder	0,9	6-Electronics	52-Solder SnAg4Cu0.5
39	Size of the PCB 21,6x4,9 cm			

42	PRINTED CIRCUIT BOARD ASSEMBLY (3) small PCB 101,8g				
43	Gold		0,0	5-Coating	**41-Au/Pt/Pd**
44	Through-hole-components		3,5	6-Electronics	**44-big caps & coils**
45	Surface-mount-devices		0,3	6-Electronics	**48-SMD/ LED's avg.**
46	Large ICs		1,6	6-Electronics	**46-IC's avg., 5% Si, Au**
47	Small ICs		0,7	6-Electronics	**47-IC's avg., 1% Si**
48	Connectors		1,2	6-Electronics	**45-slots / ext. ports**
49	Printed circuit board substrate		59,3	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
50	Solder		2,0	6-Electronics	**52-Solder SnAg4Cu0.5**
51	Size of the PCB				
52	Housing of the pay-tv card plastic		10,03	1-BlkPlastics	**10-ABS**
53	Housing of the pay-tv card metallic part		23,17	4-Non-ferro	**26-Al sheet/extrusion**
54					
55	PRINTED CIRCUIT BOARD ASSEMBLY (4) power PCB 4,3x3,3cm				
56	Gold		0,0	5-Coating	**41-Au/Pt/Pd**
57	Through-hole-components		53,9	6-Electronics	**44-big caps & coils**
58	Surface-mount-devices		0,0	6-Electronics	**48-SMD/ LED's avg.**
59	Large ICs		0,0	6-Electronics	**46-IC's avg., 5% Si, Au**
60	Small ICs		3,5	6-Electronics	**47-IC's avg., 1% Si**
61	Connectors		2,1	6-Electronics	**45-slots / ext. ports**
62	Printed circuit board substrate		30,0	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
63	Solder		3,0	6-Electronics	**52-Solder SnAg4Cu0.5**
64	Big transformer 42,2g				
65	Plastics		7,6	2-TecPlastics	**11-PA 6**
66	Ferrite		26,8	3-Ferro	**24-Ferrite**
67	Copper		7,8	4-Non-ferro	**28-Cu winding wire**
68	Small transformer 10,1g				
69	Plastics	3,3		2-TecPlastics	**11-PA 6**
70	Ferrite	3,5		3-Ferro	**24-Ferrite**
71	Copper	3,3		4-Non-ferro	**28-Cu winding wire**
72	Heat sink (x1)		10,4	4-Non-ferro	**26-Al sheet/extrusion**
73	FLEXIBLE PCB		0		
74	INTERNAL CABLES 47,6g				
75	Cable/plug, 50% Cu		23,8	4-Non-ferro	**29-Cu wire**
76	Cable/plug, 50% PVC		23,8	1-BlkPlastics	**8-PVC**
77					
78	EXTERNAL CABLE fixed to the housing 104,5g				
79	Cable/plug, 50% Cu		52,25	4-Non-ferro	**29-Cu wire**
80	Cable/plug, 50% PVC		52,25	1-BlkPlastics	**8-PVC**

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89	Hard Disk Drive 531,3g			
90	**Size 14,6x10,1 cm**			
91	Screws (4bottom+6lateral+6upper+4PCB-HDD+2insid	13	3-Ferro	**22-St tube/profile**
92	PCB 25,8g			
93	Gold	0	5-Coating	**41-Au/Pt/Pd**
94	Through-hole-components	1,33	6-Electronics	**44-big caps & coils**
95	Surface-mount-devices	0,07	6-Electronics	**48-SMD/ LED's avg.**
96	Large ICs	1,9	6-Electronics	**46-IC's avg., 5% Si, Au**
97	Small ICs	0,2	6-Electronics	**47-IC's avg., 1% Si**
98	Connectors	10,9	6-Electronics	**45-slots / ext. ports**
99	Printed circuit board substrate	10,8	6-Electronics	**50-PWB 6 lay 4.5 kg/m2**
100	Solder	0,516	6-Electronics	**52-Solder SnAg4Cu0.5**
101	Size 9,4x5 cm			
102	Housing			
103	Upper case	179,2	4-Non-ferro	**26-Al sheet/extrusion**
104	Bottom case	220,6	4-Non-ferro	**27-Al diecast**
105	Platter	23,021	7-Misc.	**54-Glass for lamps**
106	Coating of the platter	0,039	5-Coating	**41-Au/Pt/Pd**
107	Arm	10,05	4-Non-ferro	**26-Al sheet/extrusion**
108	Copper	1,46	4-Non-ferro	**29-Cu wire**
109	Plastic	2,1	1-BlkPlastics	**10-ABS**
110	Spindle (splitted up as a motor in row 150)			
111	Flexible PCB			
112	Gold	0	5-Coating	**41-Au/Pt/Pd**
113	Through-hole-components	0	6-Electronics	**44-big caps & coils**
114	Surface-mount-devices	0,04	6-Electronics	**48-SMD/ LED's avg.**
115	Large ICs	0	6-Electronics	**46-IC's avg., 5% Si, Au**
116	Small ICs	0	6-Electronics	**47-IC's avg., 1% Si**
117	Connectors	1	6-Electronics	**45-slots / ext. ports**
118	Printed circuit board substrate	0	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
119	Solder	0	6-Electronics	**52-Solder SnAg4Cu0.5**
120				
121	Tuner			
122	Housing	27	3-Ferro	**25-Stainless 18/8 coil**
123	PCB 7,2g			
124	Gold	0	5-Coating	**41-Au/Pt/Pd**
125	Through-hole-components	1	6-Electronics	**44-big caps & coils**
126	Surface-mount-devices	0	6-Electronics	**48-SMD/ LED's avg.**
127	Large ICs	0	6-Electronics	**46-IC's avg., 5% Si, Au**
128	Small ICs	1	6-Electronics	**47-IC's avg., 1% Si**
129	Connectors	1	6-Electronics	**45-slots / ext. ports**
130	Printed circuit board substrate	5	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
131	Solder	0	6-Electronics	**52-Solder SnAg4Cu0.5**

136	REMOTE CONTROL UNIT 75,3g			
137	Screws	0	3-Ferro	**22-St tube/profile**
138	Plastic housing	47	1-BlkPlastics	**10-ABS**
139	Batteries: 2 R3 AAA	17	6-Electronics	**44-big caps & coils**
140	PCB	15	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
141	Flexible part with the buttons	13	2-TecPlastics	**16-Flex PUR**
142				
143				
144	PACKAGING			
145	Foils	1	1-BlkPlastics	**1-LDPE**
146	Manual	114	7-Misc.	**57-Office paper**
147	Box	366	7-Misc.	**56-Cardboard**
148	Protectors (x2)	86	1-BlkPlastics	**5-PS**
149				
150	Spindle 19,7g splitted up as a motor			
151	Plastic	6	2-TecPlastics	**11-PA 6**
152	Ferrite	7	3-Ferro	**24-Ferrite**
153	Copper	6	4-Non-ferro	**28-Cu winding wire**

4.1.4. TYPICAL BOM OF A TUNER

Some STBs come with multiple tuners. Tuners are either implemented as a component with a PWB assembly of its own or as integrated part on the main PWB. Table 4-6 lists the BOM of a separate tuner found in STBs.

Table 4-6: Typical BOM of a tuner

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
121	Tuner			
122	Housing	27	3-Ferro	25-Stainless 18/8 coil
123	PCB 7,2g			
124	Gold	0	5-Coating	41-Au/Pt/Pd
125	Through-hole-components	1	6-Electronics	44-big caps & coils
126	Surface-mount-devices	0	6-Electronics	48-SMD/ LED's avg.
127	Large ICs	0	6-Electronics	46-IC's avg., 5% Si, Au
128	Small ICs	1	6-Electronics	47-IC's avg., 1% Si
129	Connectors	1	6-Electronics	45-slots / ext. ports
130	Printed circuit board substrate	5	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
131	Solder	0	6-Electronics	52-Solder SnAg4Cu0.5
132	Size 5,2x3,6 cm			

The housing listed is the housing of the tuner as such (“can tuner”), not the additional housing “overhead” of the full STB.

4.1.5. TYPICAL BOM OF AN STB WITH HIGH-DEFINITION CAPABILITY

High-definition (HD) capability does not mean a simple “add-on” to a BOM as the relevant components are implemented on the main PWB and come with an adapted circuitry, also including a power circuitry adapted to higher power consumption. Furthermore, majority of HD compatible STBs are currently in the premium segment (although HD STBs will become standard mid-term), meaning in general a design reflecting an added-value appearance. As a trend, there is more electronics – in terms of weight and number of components – in HD STBs, but this plus is not caused by the high-definition functionality only. For illustration, Table 4-7 lists a typical BOM for an STB with high-definition capability, but without additional features such as return path, HDD or multiple tuners, actually this is derived for Philips DSR 9005/02. The total weight of this STB is 3.31 kg (including packaging) compared to 1.944 kg for a typical complex STB without HD capability.

The HD capability is reflected by BOM which comprises more “electronics” than a typical STB for standard definition resolution only: The weight of “large ICs” (Integrated Circuit) on the main board is 8.7 g compared to 6.1 g for the typical BOM of a complex STB for SD (see for comparison Table 4-2).

Table 4-7: Typical BOM of an STB with high-definition (HD) capability

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !
1	HOUSING (silver and grey colour coating)	17,4	5-Coating	38-pre-coating coil
2	Upper case	442,1	3-Ferro	25-Stainless 18/8 coil
3	Front panel	117,0	1-BlkPlastics	10-ABS
4	Screws (3upper+1front+4back+1back+4PCB+2lightPCB+2powerPCB)	9,6	3-Ferro	22-St tube/profile
5	Display (size 10x2,5 cm)	32,3	7-Misc.	54-Glass for lamps
6	Back part	86,7	3-Ferro	25-Stainless 18/8 coil
7	Bottom part	599,8	3-Ferro	25-Stainless 18/8 coil
8	Protectors at the bottom	2,8	2-TecPlastics	16-Flex PUR
9	Metal inlays in the front panel	102,1	4-Non-ferro	26-Al sheet/extrusion
10				
11	HARD-OFF SWITCH			
12	Cable/plug, 50% Cu	0,0	4-Non-ferro	29-Cu wire
13	Cable/plug, 50% PVC	0,0	1-BlkPlastics	8-PVC
14				
15				
16	HARD DISK DRIVE	0,0		
17				
18				
19	PRINTED CIRCUIT BOARD ASSEMBLY (1) main PCB 305g			
20	Gold	0,0	5-Coating	41-Au/Pt/Pd
21	Through-hole-components	32,0	6-Electronics	44-big caps & coils
22	Surface-mount-devices	0,5	6-Electronics	48-SMD/ LED's avg.
23	Large ICs	8,9	6-Electronics	46-IC's avg., 5% Si, Au
24	Small ICs	2,6	6-Electronics	47-IC's avg., 1% Si
25	Connectors	69,4	6-Electronics	45-slots / ext. ports
26	Printed circuit board substrate	158,2	6-Electronics	50-PWB 6 lay 4.5 kg/m2
27	Solder	6,1	6-Electronics	52-Solder SnAg4Cu0.5
28	Size of the PCB 21,7x19 cm			
29	Housing of the integrated tuner	23,3	3-Ferro	25-Stainless 18/8 coil
30	Housing of the paying-TV card plastic part	6,1	1-BlkPlastics	10-ABS
31	Housing of the paying-TV card metallic part	2,6	3-Ferro	25-Stainless 18/8 coil
32	PRINTED CIRCUIT BOARD ASSEMBLY (2) display's PCB 43g			
33	Gold	0,0	5-Coating	41-Au/Pt/Pd
34	Through-hole-components	4,9	6-Electronics	44-big caps & coils
35	Surface-mount-devices	0,1	6-Electronics	48-SMD/ LED's avg.
36	Large ICs	1,7	6-Electronics	46-IC's avg., 5% Si, Au
37	Small ICs	0,1	6-Electronics	47-IC's avg., 1% Si
38	Connectors	0,5	6-Electronics	45-slots / ext. ports
39	Printed circuit board substrate	35,8	6-Electronics	49-PWB 1/2 lay 3.75kg/m2
40	Solder	1,5	6-Electronics	52-Solder SnAg4Cu0.5
41	Size of the PCB 25,9x4,9 cm			

42	Protectors	0,3	1-BlkPlastics	**3-LLDPE**
43				
44	PRINTED CIRCUIT BOARD ASSEMBLY (3) power PCB			
45	Gold	0	5-Coating	**41-Au/Pt/Pd**
46	Through-hole-components	127,3	6-Electronics	**44-big caps & coils**
47	Surface-mount-devices	0	6-Electronics	**48-SMD/ LED's avg.**
48	Large ICs	0	6-Electronics	**46-IC's avg., 5% Si, Au**
49	Small ICs	7,9	6-Electronics	**47-IC's avg., 1% Si**
50	Connectors	5,33	6-Electronics	**45-slots / ext. ports**
51	Printed circuit board substrate	41,4	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
52	Solder		6-Electronics	**52-Solder SnAg4Cu0.5**
53	Big transformer 50,9g			
54	Plastics	9,166824645	2-TecPlastics	**11-PA 6**
55	Ferrite	32,32511848	3-Ferro	**24-Ferrite**
56	Copper	9,408056872	4-Non-ferro	**28-Cu winding wire**
57	Small transformer 21,4g			
58	Plastics	6,992079208	2-TecPlastics	**11-PA 6**
59	Ferrite	7,415841584	3-Ferro	**24-Ferrite**
60	Copper	6,992079208	4-Non-ferro	**28-Cu winding wire**
61	Size of the PCB 7,6x19,3 cm			
62	Heat sink (x3)	36,3	4-Non-ferro	**26-Al sheet/extrusion**
63				
64				
65	PRINTED CIRCUIT BOARD ASSEMBLY (4) light coloured PCB 24,5 g			
66	Gold	0	5-Coating	**41-Au/Pt/Pd**
67	Through-hole-components	8,7	6-Electronics	**44-big caps & coils**
68	Surface-mount-devices	0	6-Electronics	**48-SMD/ LED's avg.**
69	Large ICs	0	6-Electronics	**46-IC's avg., 5% Si, Au**
70	Small ICs	0	6-Electronics	**47-IC's avg., 1% Si**
71	Connectors	0,58	6-Electronics	**45-slots / ext. ports**
72	Printed circuit board substrate	15,1	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
73	Solder	0,49	6-Electronics	**52-Solder SnAg4Cu0.5**
74	Protectors at the bottom	0,7	2-TecPlastics	**16-Flex PUR**
75				
76				
77	FLEXIBLE PCB	0		
78	INTERNAL CABLES 8,4g			
79	Cable/plug, 50% Cu	4,2	4-Non-ferro	**29-Cu wire**
80	Cable/plug, 50% PVC	4,2	1-BlkPlastics	**8-PVC**
81				
82	EXTERNAL CABLES 395,8g			
83	Cable/plug, 50% Cu	197,9	4-Non-ferro	**29-Cu wire**
84	Cable/plug, 50% PVC	197,9	1-BlkPlastics	**8-PVC**
89				
90	REMOTE CONTROL UNIT			
91	Screws	1	3-Ferro	**22-St tube/profile**
92	Plastic housing	71,2	1-BlkPlastics	**10-ABS**
93	Batteries 2 R6 AA	26,4	6-Electronics	**44-big caps & coils**
94	PCB	21	6-Electronics	**49-PWB 1/2 lay 3.75kg/m2**
95	Flexible part with the buttons	24,8	2-TecPlastics	**16-Flex PUR**
96				
97				
98	PACKAGING			
99	Foils (containing the remote control unit)	1,7	1-BlkPlastics	**1-LDPE**
100	Manual	29,7	7-Misc.	**57-Office paper**
101	Box	481,7	7-Misc.	**56-Cardboard**
102	Plastic protector (with pumps)	10,2	1-BlkPlastics	**1-LDPE**
103	Protectors	157,4	7-Misc.	**56-Cardboard**

4.2. DISTRIBUTION PHASE

The entries for packaging material are included in the BOM, see tables above. Other entries according to the EcoReport template for a typical complex STB are as listed in Table 4-8. Actually, the volume is taken from the same STB for which the typical BOM is provided above.

Table 4-8: Distribution phase entries for a typical complex STB

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)	
208	Is it an ICT or Consumer Electronics product <15 kg ?		YES	59	1
209	Is it an installed appliance (e.g. boiler)?		NO	60	0
				62	1
210	Volume of packaged final product in m^3	in m3	0,007364324	63	0

The photo of the empty packaging for this complex STB is shown below, which makes clear, that this already a rather optimised packaging, where the box is only slightly larger than the STB itself.

Figure 4-2: Packaging for a typical complex STB (left) and an STB with HDD (right)

It is worth noticing that even STBs with hard-disk drives, which are typically sensitive to agitation come with a minimised packaging, where the packaging box only slightly exceeds the size of the STB (see Figure 4-2; on the right photo: left compartment for STB, right compartment for remote control).

4.3. USE PHASE (PRODUCT)

The statistics on complex STB power consumption in on and standby modes are based on:

- Catalogue data published on www.digitalfernsehen.de
- Eric Bush et al.[154]: measurements
- Stiftung Warentest: measurements of tested STBs in 2007 and 2008, published in the "test" magazine

[154] E. Bush, M. Schalcher, P. Kühne, S. Kammermann, S. Gasser, J. Nipkow, *Settop-Boxen: Bestimmung der energetischen Eigenschaften*, Final Report, May 7, 2007

For all three sources, the criterion "complex STB" has been verified. Almost all of these boxes are retail STBs, however, from a technical point of view they are similar to STBs provided by service providers. STBs for which conditional access capability has not been confirmed, were not taken into account.

The objective of this EuP Preparatory Study is not to initiate a broad measurement campaign of its own. Hence, all energy data has to be based on third party sources as stated above.

Catalogue data has to be tackled with caution as they rather refer to maximum specified data and rarely to actually measured data. Where both, catalogue and measured data is at hand the measured on mode consumption is typically 20-50% lower than catalogue values (see Bush et al.).

Based on the sources the following sections state typical power consumption values in on mode and standby[155]. The measurements for (active) standby and on mode documented by Bush et al. are based on DIN EN 62087. Instead of video and audio test signals, current TV pictures (Swiss Info Channel) were used, since no influence of the transmitted image content and accompanying audio signal on the power requirement of STBs was detected with the utilised power meter.

In data is based for a total of 208 complex STBs, and the STBs were numbered for better identification.

The following power consumption data is provided distinguishing

- Transmission platform
- Return path
- Second tuner
- Internal mass storage media (HDD / PVR)
- HD capability

This distinction has been made to reduce the complexity of the analysis and to focus on the most significant technical features contributing to power consumption, but it should be recognised that these five criteria are not the only performance features, which determine power consumption. Especially, the multitude of interfaces is not addressed in this analysis.

4.3.1. Complex DVB-C STBs

Catalogue values for on mode power consumption of complex DVB-C STBs without any additional features such as return path, second tuner, HDD or high-definition span a broad range of 7 to 35 W for on mode. Actually measured values for such STBs are all in the range of 6-7 W. Also, for standby, there are significantly higher values stated in product catalogues than actually measured.

For DVB-C STBs with HDD there is only catalogue data available.

155 "Typically" does not mean a minimum – maximum span, but power consumption values of a majority of STBs with similar features. Extremely high and low values are not taken into account.

For DVB-C STBs with high definition capability, measured power consumption data for two boxes show comparable high on mode and standby power levels. Actually, standby power is only slightly lower than on mode power consumption.

Table 4-9: Typical power consumption of complex DVB-C STB

STB No.	Features				typical power consumption (W)	
	return path	second tuner	HDD / PVR	HD	On mode	standby
1-24	-	-	-	-	6-25	3-6
25-31	-	-	+	-	10-15	3-6
32-33	-	-	-	+	14-18	13

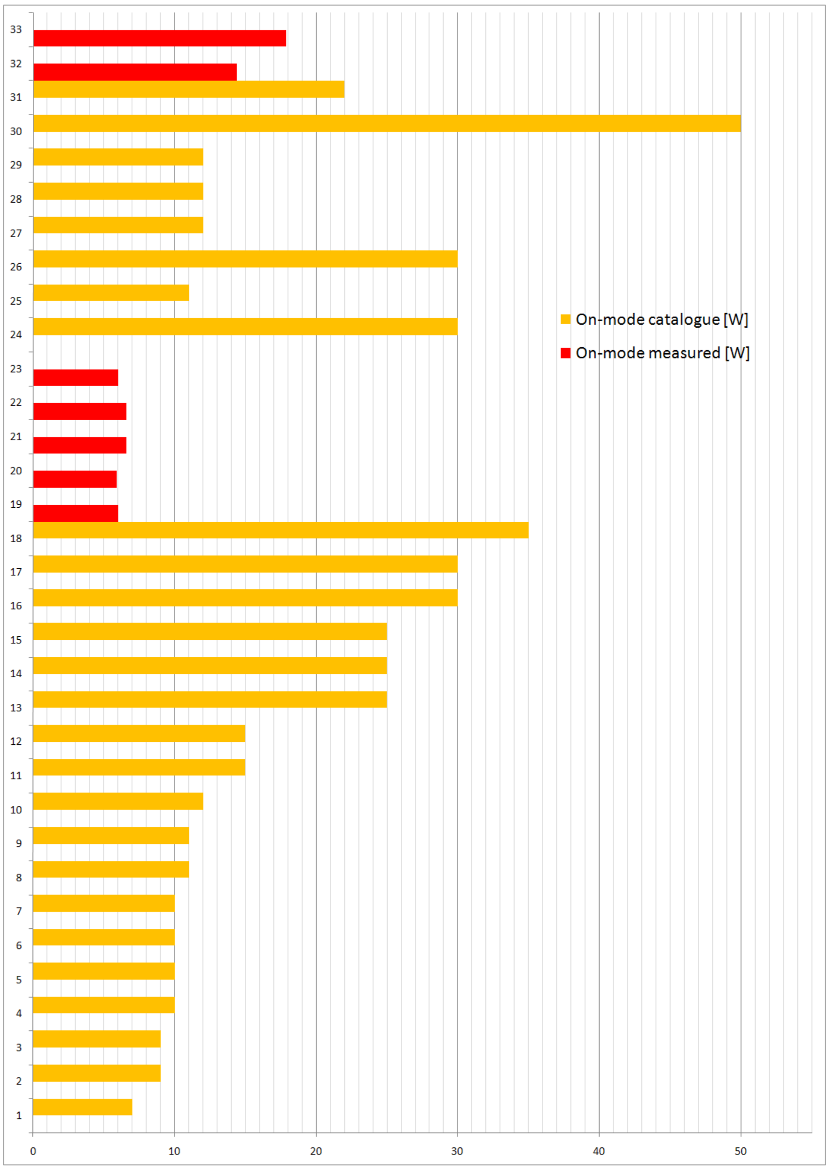


Figure 4-3: On mode power consumption (complex DVB-C STBs)

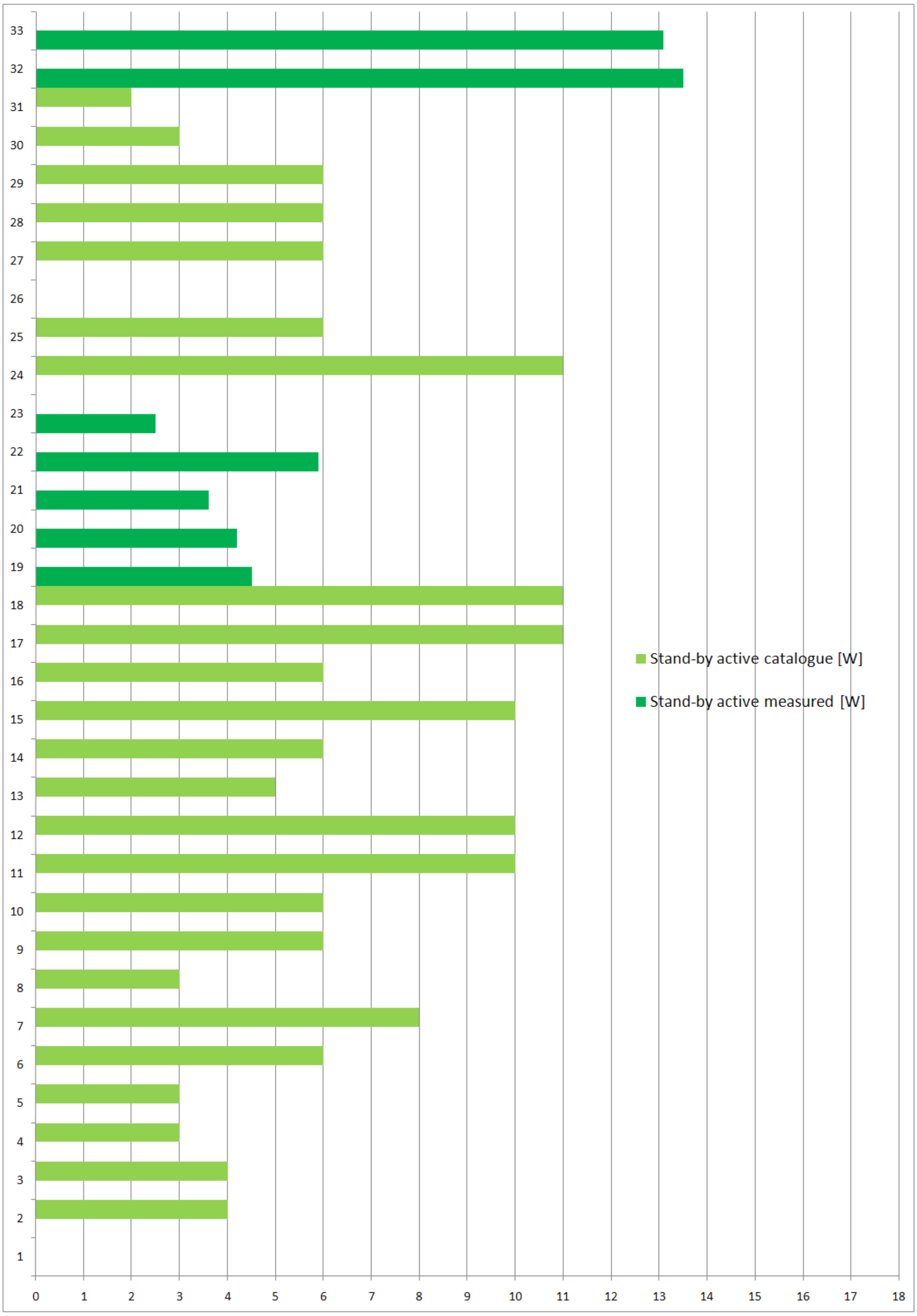


Figure 4-4: Stand-by power consumption (complex DVB-C STBs)

4.3.2. COMPLEX DVB-S STBS

There is data for more than 100 complex DVB-S STBs without additional features such as return path, second tuner, HDD, and HD capability. Also, for these STBs, measured values for on mode are rather at the lower end of published catalogue data for similar products. Among the measured DVB-S STBs are also those disassembled for the compilation of BOMs (see 4. 4.1.).

Table 4-10: Typical power consumption of complex DVB-S STB

STB No.	features				typical power consumption (W)	
	return path	second tuner	HDD / PVR	HD	On mode	standby
34-135	-	-	-	-	8-20	2-6
136-139	+	-	-	-	20-30	6
140-174	-	-	+	-	10-30	2-10
175-176	-	-	-	+	20	8-14
177-178	-	+	+	-	23	n.a.[156]

For complex DVB-S STBs with return path, only catalogue data are available, indicating a typical on mode power consumption of 20-30 W and standby levels of 6 W.

Also, the data on STBs with high definition capability is limited, which corresponds to the current market share of HD appliances. Measured data indicate typical on mode power consumption of 20 W and typical standby consumption in the range of 8-14 W.

To enhance the readability, the figures for on mode and standby power consumption for DVB-S STBs have been split in two (Figure 4-5 and Figure 4-6 showing on mode and standby for STBs listed with numbers 34-135, Figure 4-7 and Figure 4-8 for STBs listed with numbers 136-178).

156 As there are only 2 products with a huge difference in standby power, a “typical” value cannot be stated

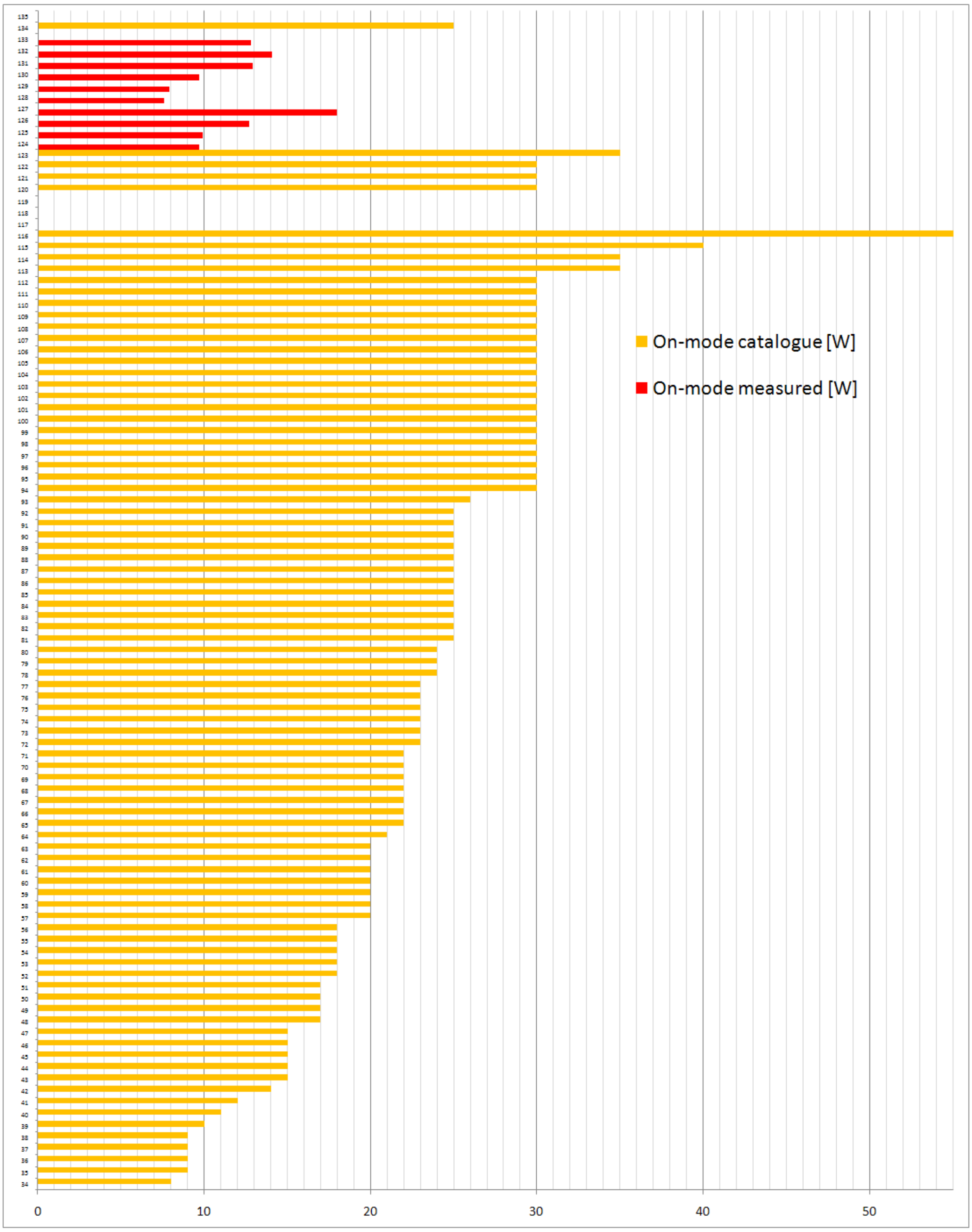


Figure 4-5: On mode power consumption (complex DVB-S STBs, no. 34-135)

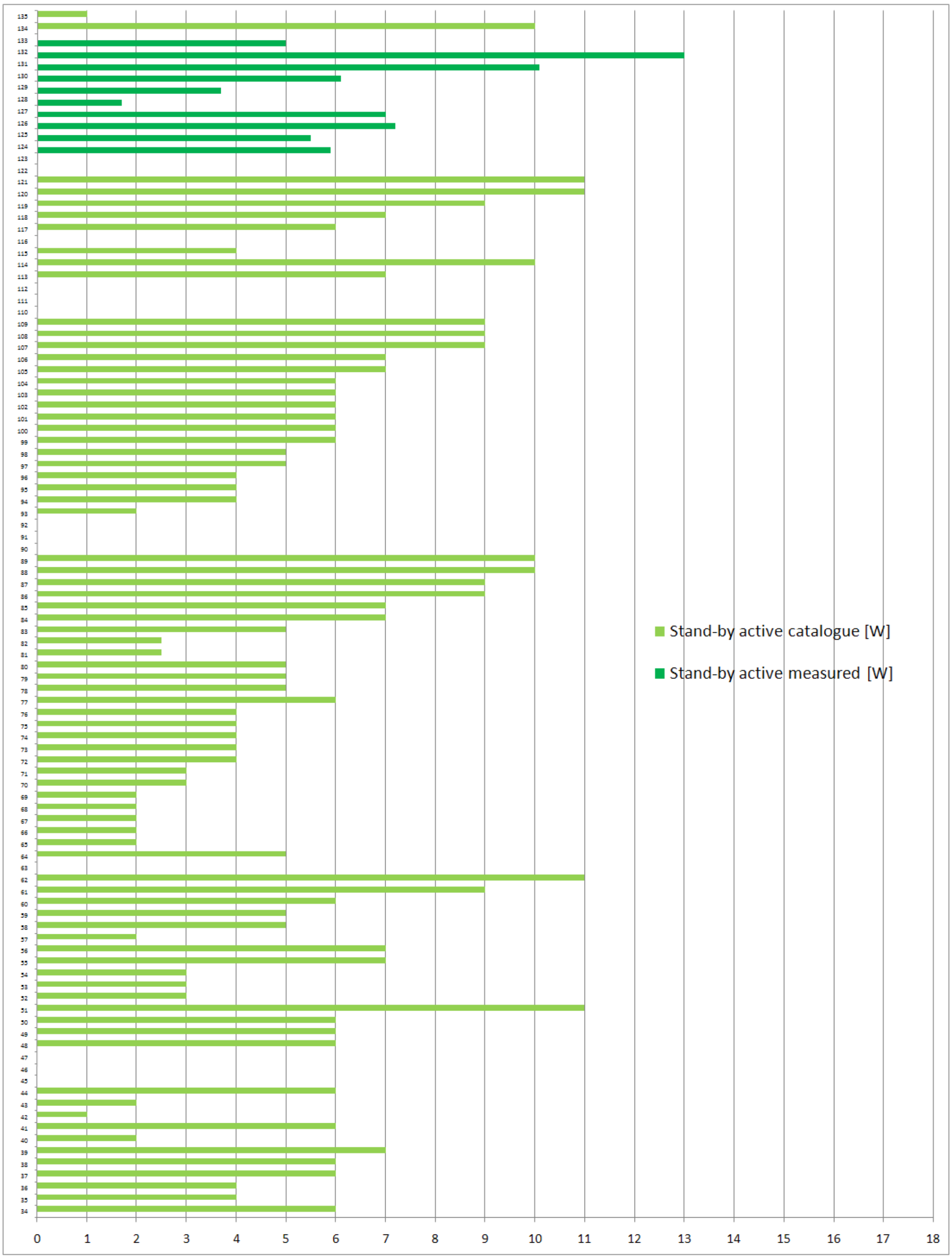


Figure 4-6: Standby power consumption (complex DVB-S STBs, no. 34-135)

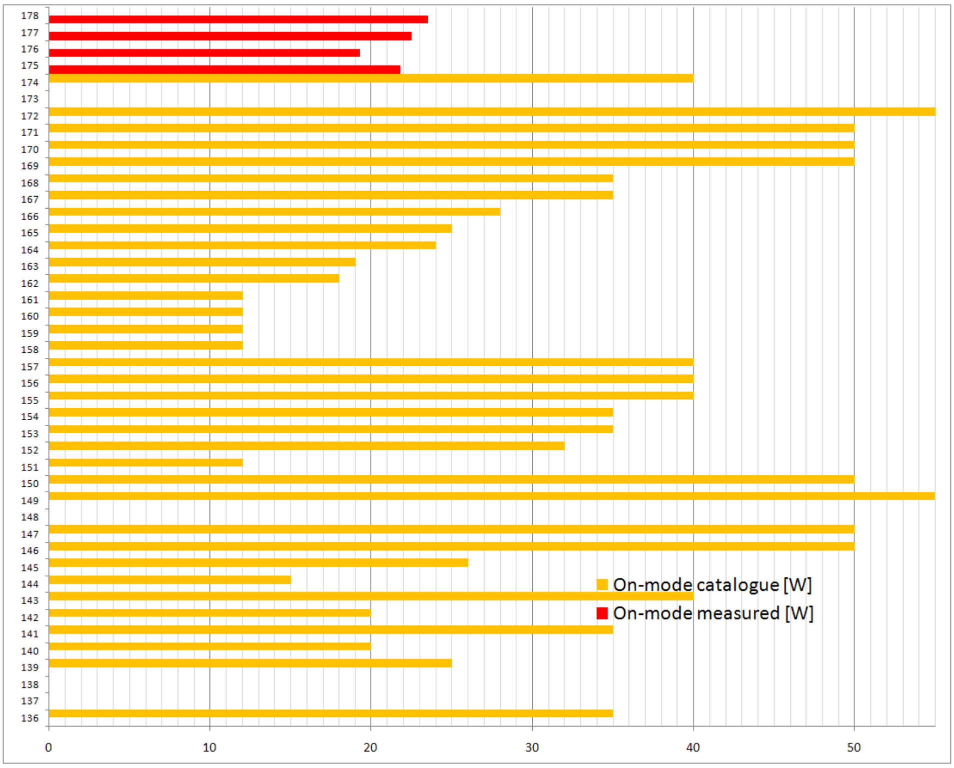


Figure 4-7: On mode power consumption (complex DVB-S STBs, no. 136-178)

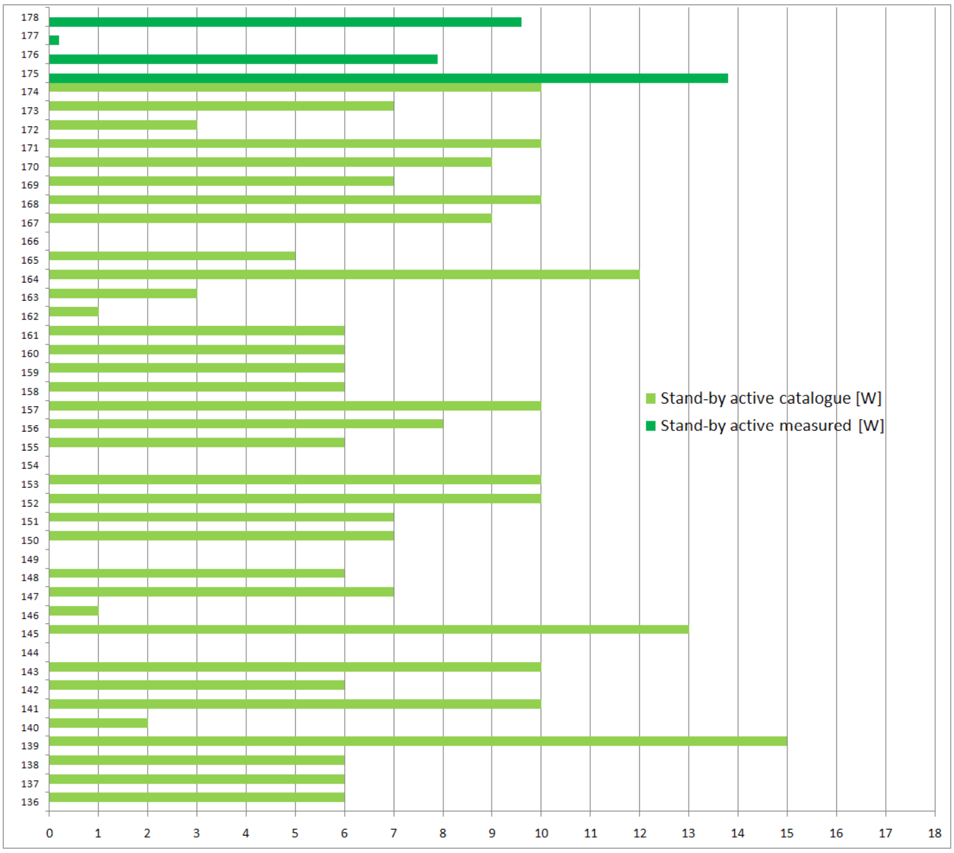


Figure 4-8: Standby power consumption (complex DVB-S STBs, no. 136-178)

4.3.3. Complex DVB-T STBs

For complex DVB-T STBs, the data is available only for a limited number of STB models, which corresponds to the low market share of DVB-T, especially in the pay TV segment. For complex DVB-T STBs without any additional features, such as return path, second tuner, HDD, and high definition, the catalogue and measured data indicate an on mode power consumption of 7-10 W and standby power consumption in the range of 2-6 W.

As for other transmission platforms, STBs with hard disc drive consume significantly more energy in on mode.

Table 4-11: Typical power consumption of complex DVB-T STBs

STB No.	Features				typical power consumption (W)	
	return path	second tuner	HDD / PVR	HD	On mode	standby
179-186	-	-	-	-	7-10	2-6
187-193	-	-	+	-	10-20	5-6

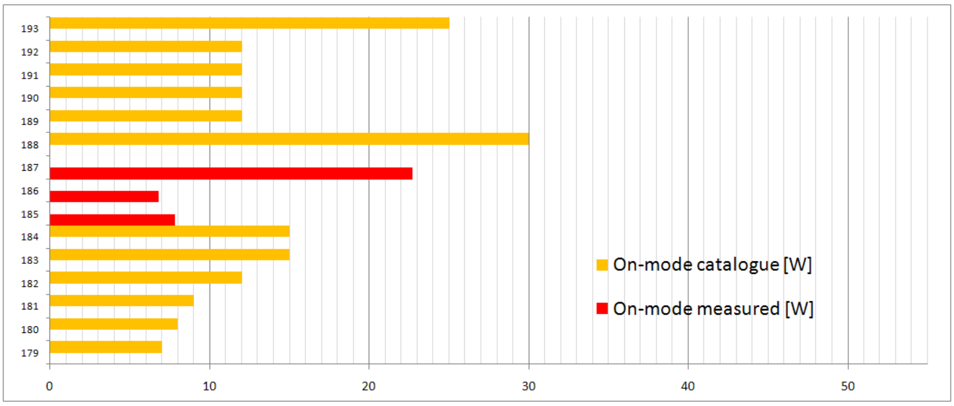


Figure 4-9: On mode power consumption (complex DVB-T STBs)

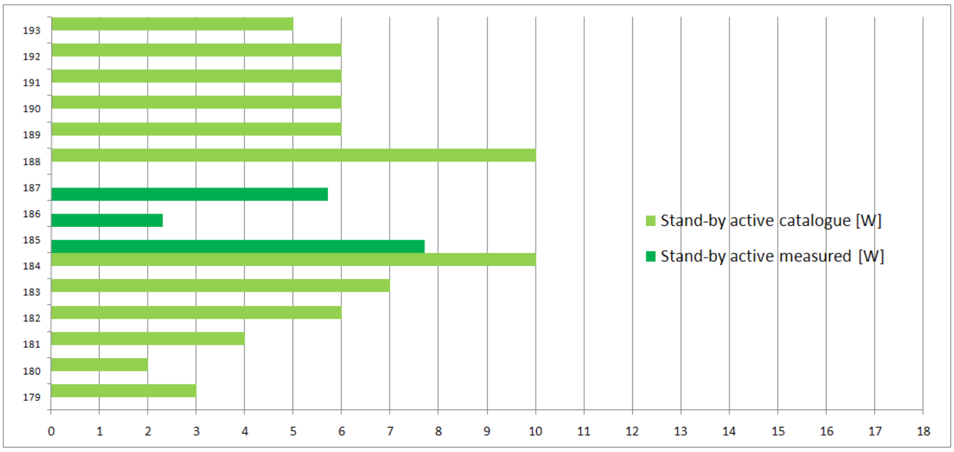


Figure 4-10: Standby power consumption (complex DVB-T STBs)

4.3.4. Complex Combo STBs

For complex combo STBs, which are compatible with more than one transmission platform, only catalogue data are available, which indicate on mode power consumption in the range of 15-20 W and standby power consumption of 3-6 W.

Table 4-12: Typical power consumption of complex Combo STBs

STB No.	Features				typical power consumption (W)	
	return path	second tuner	HDD / PVR	HD	On mode	standby
194-197	-	+	-	-	15-20	3-6
198-201	-	+	+	-	20	3-6

There is one complex combo STB with second tuner and HDD stating an extraordinary high on mode power level of 55 W.

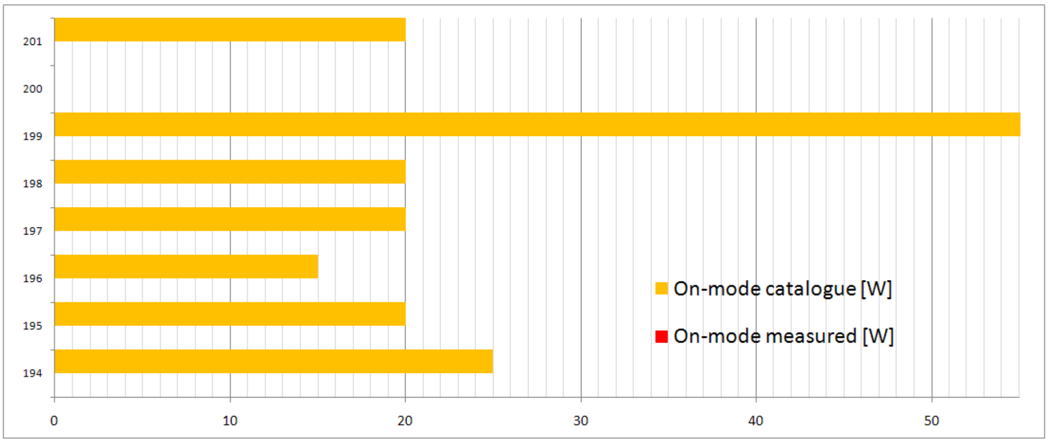


Figure 4-11: On mode power consumption (complex combo STBs)

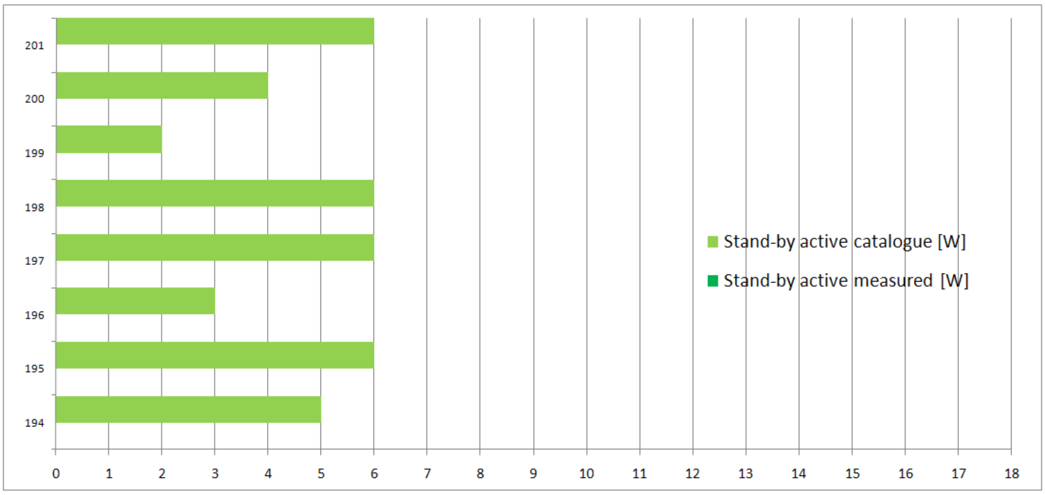


Figure 4-12: Standby power consumption (complex combo STBs)

4.3.5. COMPLEX DVB-C, -S, -T STBS WITH RETURN PATH

The data provided above include only a very limited number of STBs with return path, although it is assumed that STBs with return path have a highly significant market share today and even more in the near future as they are the key enabler for enhanced interactivity.

Estimates on typical power consumption values are presented in Table 4-13.[157]

Table 4-13: Typical power consumption of complex STBs with return path

STB	Features				typical power consumption (W)	
	return path	second tuner	HDD / PVR	HD	On mode	standby
I	+	-	-	-	8-16	6-14
II	+	+	-	-	12-20	10-16
III	+	+	+	-	20-35	15-30
IV	+	+	+	+	20-50	15-35

4.3.6. COMPLEX IPTV STBS

For IPTV STBs, the Triple play boxes no. 203-208 were measured by "*60 millions de consommateurs*"[158] and a testing laboratory respectively. **These values include both the modem and TV decoder parts** (typically power consumption in both, on mode and standby of the modem is 30-60%) of the total power consumption of the modem decoder combo (see Table 4-14).

On mode power consumption has been measured under heavy load, i.e. maximum data traffic (downloading a file while listening to music / streaming and watching a video / streaming).

Table 4-14: Typical power consumption of complex IPTV STBs

STB No.	Features				typical power consumption (W)	
	return path	second tuner	HDD / PVR	HD	On mode	standby
202-206	+	-	-	-	19-25	16-22
207-208	+	-	+	-	n.a.	n.a.[159]

157 R. Turner, *EuP and the set top box - Technology V power consumption*; Power point presentation
158 Internet: *Et si vous changiez de fournisseur?* 60 millions de consommateurs, n° 420 - octobre 2007
159 As there are only 2 products with a huge difference in both, on mode and standby power, a "typical" value cannot be stated. However, data for STB no. 207 shows, that an IPTV STB with HDD can have the same power consumption than IPTV STBs without HDD – or even less

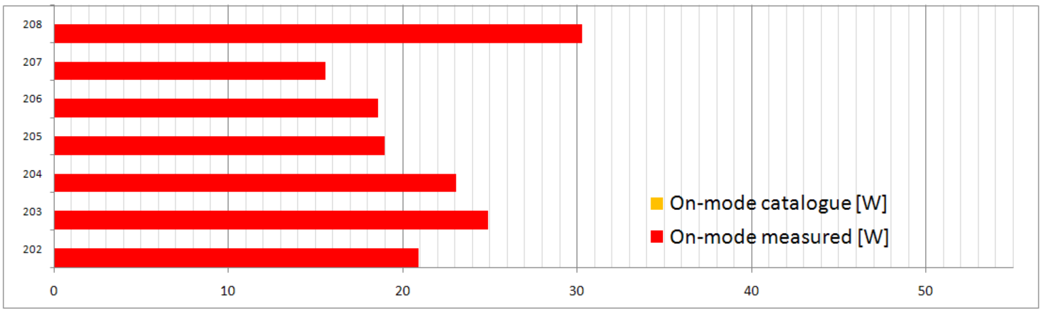


Figure 4-13: On mode power consumption (complex IPTV STBs)

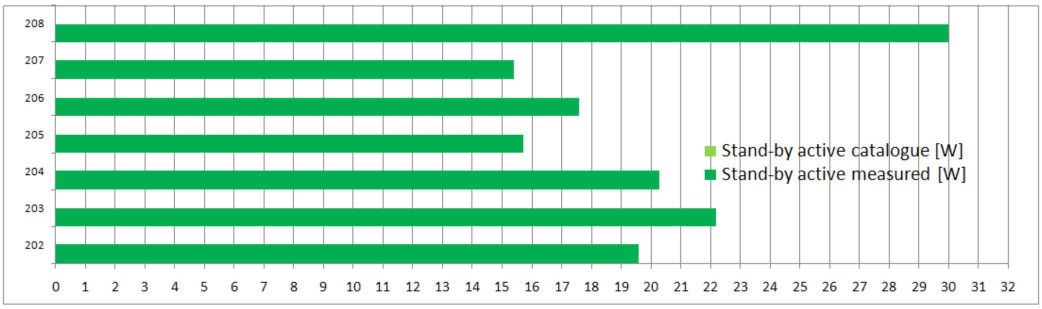


Figure 4-14: Standby mode power consumption (complex IPTV STBs)

4.3.7. Power Consumption per functionality

The above data shows the broad span of power consumption data for various configurations of complex STBs. The allocation of power consumption per "functionality" is complicated by the fact that there are interdependencies between the different functionalities, more functionalities typically also mean a design for a high-end market with additional features. Nevertheless, from the available market and product data, typical power consumption values can be estimated. To ensure the robustness of this data and ascertain that the data is applicable to all complex STBs (and not limited to retail STBs only), stakeholders were consulted (see ANNEX B for more details). The resulting typical power consumption levels are presented in Table 4-15.

Table 4-15: Typical on mode and active standby power consumption of complex STBs per functionality

STB (DVB-C, -S, -T, IPTV)	Typical power consumption (W)	
	On mode	Active standby
Basic "complex" STB, including all typical interfaces, digit display, CI and/or CAM, etc.	10	5
Additional power consumption for		
• Hard disk drive	+ 8	+ 2
• Second tuner / multiple tuners	+ 5	+ 1
• High definition capability	+ 8	+ 8
• Return path	+ 10	+10

Example: For a complex STB with HDD and HD capability a typical power consumption is 26 W in on mode and 15 W in (active) standby (including all additional features, that are common for complex STBs with HDD, HD).

Major functionalities not taken into account with this distinction, but with a potential significant contribution to power consumption are:

- Wireless connectivity
- Integrated DVD-, CD-ROM-, Blue-Ray disk player, etc.

All other major functionalities of complex STBs (mid-term perspective) are intended to be covered by this distinction.

"Typical" means, a majority of the STBs on the market have got approximately this power consumption (easily with a range of +/- 50%, see individual data above).

4.3.8. Annual Power Consumption

Based on the complex STB use patterns stated in task 3[160] (table 3-1) the typical annual power consumption is calculated, taking into account the typical on mode and standby power consumption levels listed above.

Data from the tables above is summarised in Table 4-16, including calculated annual power consumption. The additional estimates for STBs with return path (see 4.3.5.) have not been taken into account for this summary.

For the various configurations of complex STBs the following conclusions can be drawn:

- **Complex STBs without any additional features**, such as return path, second tuner, HDD/PVR or high definition capability typically consume **35-115 kWh** per year.
- **Complex STBs with high definition capability** are in the range of **110-140 kWh** power consumption per year.

160 9 hours in on mode daily for STBs without internal mass storage media and 10.5 hours for STBs with mass storage media, remaining time mainly in standby and a minor share in off mode / disconnected

- **IPTV STBs** clearly exceed 100 kWh power consumption per year and are rather in the range of **150-200 kWh** typically.
- **Complex STBs with internal mass storage media (HDD)** span a broad range of annual power consumption due to the large differences among DVB-S STBs with HDD. Neglecting the upper and lower end of the typical range for DVB-S STBs with HDD the typical annual power consumption of complex STBs with internal mass storage media can be stated to be **roughly 100 kWh**.

The typical power consumption values show that a distinction of transmission platforms cable, satellite, and terrestrial as such is not necessary. IPTV STBs are a different case.

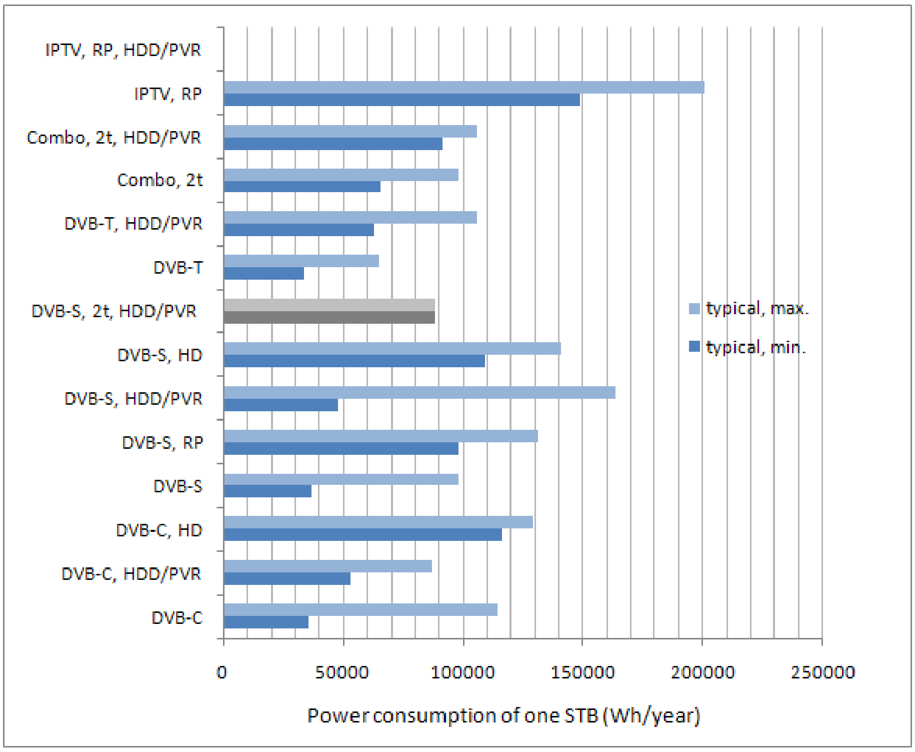
Table 4-16: Typical annual power consumption of complex STBs of various configurations

STB	Features				Typical power consumption (W) [161]		Typical power consumption (annual) (kWh)	
	Return path	Second tuner	HDD / PVR	HD	On mode	Standby	Range	
DVB-C	-	-	-	-	6-25	3-6	36 -	114
DVB-C	-	-	+	-	10-15	3-6	53 -	87
DVB-C	-	-	-	+	14-18	13	116 -	129
DVB-S	-	-	-	-	8-20	2-6	37 -	98
DVB-S	+	-	-	-	20-30	6	98 -	131
DVB-S	-	-	+	-	10-30	2-10	48 -	164
DVB-S	-	-	-	+	20	8-14	109 -	141
DVB-S	-	+	+	-	23	n.a.	88	(plus standby)
DVB-T	-	-	-	-	7-10	2-6	34 -	65
DVB-T	-	-	+	-	10-20	5-6	63 -	106
Combo	-	+	-	-	15-20	3-6	65 -	98
Combo	-	+	+	-	20	3-6	91 -	106
IPTV	+	-	-	-	19-25	16-22	149 -	201
IPTV	+	-	+	-	n.a.	n.a.	n.a.	

n.a. = not available

The annual power consumption in standby mode roughly equals the annual power consumption in on mode for almost all configurations. The only exemptions are STBs with high definition capability, where in total power consumed in standby is significantly higher than in on mode.

161 According to statistical data



Legend: RP = return path, 2t = second tuner, HDD/PVR = hard disc drive, HD = high definition capability

Figure 4-15: Typical annual power consumption of complex STBs

4.4. USE PHASE (SYSTEM)

During the use phase, complex STBs interact with other appliances: TVs, computers, etc. The first objective of this section is to identify and describe the functional system in which STBs operate. The second objective is to assess how the system influences the STB's performance, and how product features can improve not only the product itself, but also the system's overall environmental performance.

4.4.1. DESCRIPTION OF THE FUNCTIONAL SYSTEM

Complex STBs are in interaction with several devices and networks that impact the energy consumption of the box during its use phase. This section requires that the system is well defined. The scope of the study, as defined in Task 1 (and as studied in subtask 4.3), comprises the complex STB itself along with the three following external components:

- External power supply (for the STB)
- Remote control
- Modem (e.g. external ADSL modem for IPTV; including external power supplies for these modems, if applicable)

Following external components are considered for system interaction aspects:

- (External) conditional access module (to be connected to the CI-slot), Smartcard
- (External) mass storage media
- TV or monitor screen, Amplifier and loudspeaker
- For satellite platform: satellite dish, LNB (low noise block converter), power supply for antenna, DiSEqC (Digital Satellite Equipment Control) switch
- For IPTV-STBs : Personal Computer
- For IPTV-STBs : External router

Complex STBs are therefore included in a system composed of the STB itself and seven other items: 6 external components to which the STB can be connected (as mentioned above) and the service provider who provides the signal via the external network which can be satellite, cable, IPTV, or terrestrial.

The functional system of complex STBs is illustrated in the figure below (Figure 4-16):

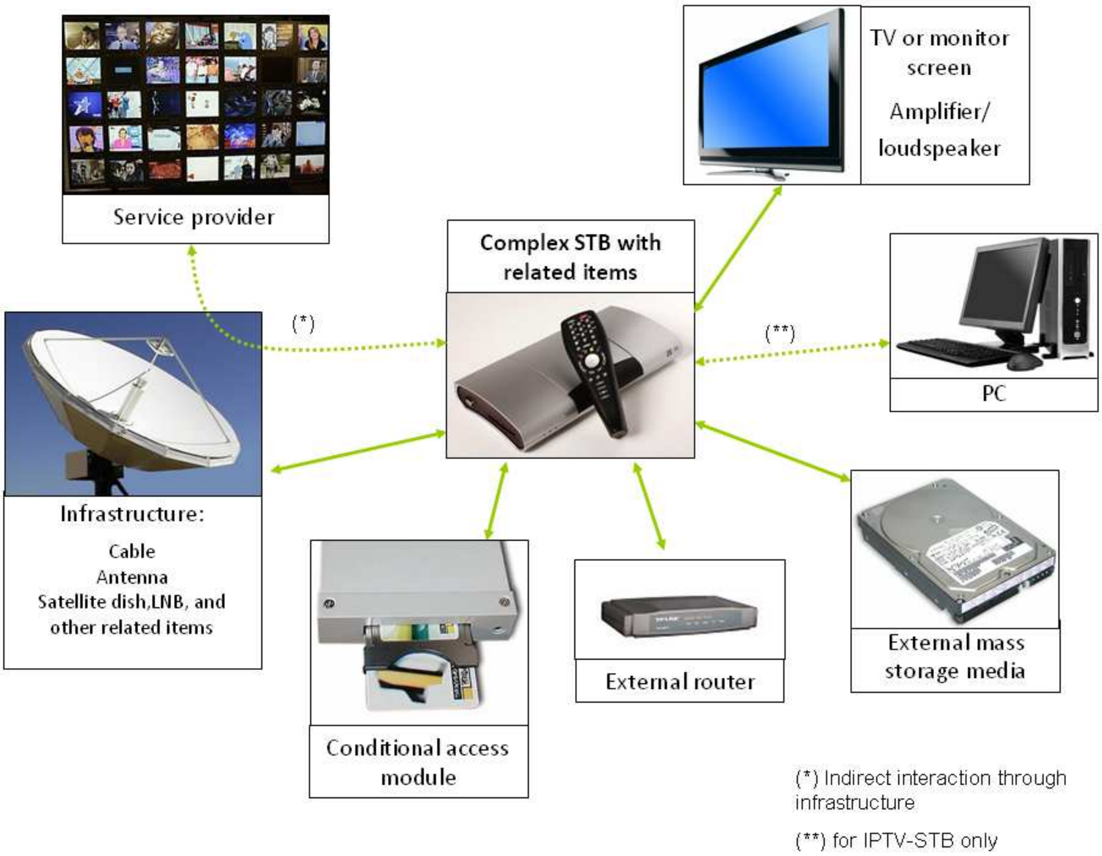


Figure 4-16: Functional system of complex STBs

4.4.2. DESCRIPTION OF THE INTERACTIONS WITHIN THE SYSTEM

- **Interactions between the complex STB and the service provider**

The service provider is the system component that mostly influences the energy consumption of the complex STB. The STB has to remain connected because of the reception of program guides and software updates. This is the main reason why the energy consumption of the STB is so high during its use phase, since the STB needs to remain in standby active mode in order to be able to respond to the service provider's signals. Interactions between the service provider and the STB occur for different reasons:

- To implement new functionalities or fix problems with the STB software/middleware/firmware which are often scheduled for nights.
- To update the entitlements which are periodically downloaded.
- To interact with the STB since it can also give the instruction to automatically power down a variety of hardware components[162].

More particularly, STBs with internal mass storage enable advanced features that lead to even more interactions between the service provider and the STB, requiring always-on technology.

Below are some typical examples of these features:

- If a program's start-time changes, the service provider can automatically adjust the recording schedule. This action can be made at any moment as long as a recording is demanded by the end-user.
- Consumers can set their STB to make recordings remotely via the internet or mobile phone. The STB needs therefore to be ready at any moment to receive a signal from the end-user.
- Some providers allow TV-series recording enabling the box to record automatically occurrences of the series, keeping track of schedule changes.

As a consequence, for all these advanced features, the STB needs to remain in a mode which allows receiving and processing a minimum level of data, i.e. either in on or standby active modes.

As already mentioned in Task 3, setting a limited timeframe for interactions between the service provider and the complex STB could enable users to turn off their STB without risk of missing any updates. However, as discussed above, some advanced functionalities are tailor-made for the user to remotely control his STB and would not exist if such timeframe was implemented (e.g. functionalities linked to recording). Moreover, these advanced functionalities are often the features that are promoted by service providers to enlarge their offers and attract new customers and they are considered essential for service providers to remain competitive.

The ADSL2 and ADSL2+ standards define power management modes for broadband network equipment network, which are L0, L2 and L3. At L0 the ADSL link is fully

[162] That is what British Sky Broadcasting is currently doing

functional. L2 is a low power mode, actually defined to reduce the power consumption of the network equipment, which is entered, when there is only reduced data traffic. End-devices, such as modems for STBs receive this signal from the network and might or might not enter also a power saving mode. In the L3 mode, no signal is transmitted on the line, and thus no transmission of information is possible. Vice versa, an ADSL2/2+ modem might or might not support L2 and L3 modes, i.e. Power Cut Back (PWB) function of the network equipment depending on capability and settings of the modem, and thus might or might not have a role to play to reduce power consumption of the network.

For the VDSL2 standard, there is only a L3 mode under consideration, as L2 turned out to be impractical for technical reasons[163].

- **Interactions between the complex STB and external components**

The **TV or monitor screen** connected to the STB actually does not send information to the STB. The flow of information only goes from the STB to the TV or monitor screen. As there is no return signal from the TV to the STB, the STB cannot get the information that the TV or monitor connected to the STB is in on, standby, or off mode. The STB continues to decode even if the TV is in off mode or in standby mode. There is therefore no influence of the TV or monitor screen on the energy consumption of the STB. The trend towards even larger TVs pushes also the demand for high definition capability of STBs and thus influences STB design (and power consumption), but also power consumption of network equipment as data rates increase significantly with high definition. The **external mass storage media**, as long as it has separate power supply, does not influence the energy consumption of the STB which perceives it as an output similar to TV. If the external mass storage media does not have a separate power supply, it gets power from the STB (up to 2.5 W[164]) and therefore increases the STB power consumption.

In the case of triple play IPTV, a **computer** can be connected to the modem of the IPTV-STB. This requires the modem to be in on mode when the user wants to use the internet. When the internet connection is being used, the modem needs to operate in on mode, even if the user is not watching TV.

An **external router** can be connected to the modem of the IPTV-STB. It can be used in order to share an internet connection for example. However, this does not directly affect the electricity consumption of the STB. However, the connection load will affect the modem's electricity consumption.

Generally speaking, devices connected to the outputs of the STB and unable to send signals back to the STB do not influence its energy consumption. However, the more external devices are added, the higher the energy consumption of the system is, because there is no energy optimisation between the different devices which require more power and more material than a multifunctional device.

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163 "The short lines, for which VDSL2 is targeted, suffer from strong Far-End-Crosstalk (FEXT). In this case, the impact of time-varying crosstalk is expected to be very significant. For this reason, it was proposed to completely abandon L2 mode for VDSL2." (G. Ginis: Low-Power Modes for ADSL2 and ADSL2+, SPAA021—January 2005, White Paper)

164 The current going through a USB 2.0 cable is about 500mA, with a 5V voltage

A **conditional access module or a smartcard** is required for a pay-TV STB. There will be data exchanged between the STB and the card to enable the STB to decode the input signal. It does not influence the energy consumption of the STB. There are also TV sets on the market with CI slots and thus the TV might take over the pay-TV capability, making the "basic" complex STB obsolete, but might require having the TV set in active standby for updates of software and entitlements.

- **Home networking and client STBs**

STBs might provide TV signals to more than one device, i.e. TV or computer. There are different possibilities to set up such a home-STB-system:

- Each end-device is connected to a full functional, independent STB
- One main STB with multiple connectivity is connected to multiple end-devices
- One STB serves as master STB with client STBs for each end-device

The latter might result in higher systems efficiency (lower total power consumption), if especially the recording functionality can be centralised with the main STB, instead of having multiple STBs running in parallel recoding and playing, as this is one of the functions, which is rather high power consuming.

Such a system comparison looks as follows (see also the example configuration described by Entwistle[165]):

- *Scenario 1:* TVs in three rooms, each with a separate STB with hard disk drive and a second tuner for time shift recording[166]

  Taking the typical power consumption as introduced above as a basis, this means a typical on mode power consumption of 20 W per STB, i.e. 60 W when all TVs are running in parallel and in total 21 W when all three STBs are in active standby.

- *Scenario 2:* TVs in three rooms, one connected to a master STB, two to a client STB each. Client STBs do not have a tuner of their own as the master STB comes with multiple tuners, master STB comes also with a hard disk drive, which provides the recording and playing functionality for the other two STBs / TVs as well.

  Power consumption of all three STBs when in on mode typically would be lower than in scenario 1. However, if only a "client TV" is running, it is required that the main STB and the client STB are both in on mode, which means a higher power consumption than in scenario 1 under this condition.

The conclusion is that the use of networked STBs and client STBs respectively **might result in lower power consumption**, but this is not a general rule and depends on the individual use patterns and to a minor degree also the systems set-up. Another aspect is the way connectivity is provided, i.e. in case connectivity is realised through WLAN

165 P. Entwistle, *How to improve the efficiency of complex STB*, International Workshop on Energy Efficient Set-Top Boxes & Digital Networks, IEA, Paris, July 4-5, 2007

166 No high definition, no return path

(Wireless Local Area Network) instead of a wired network, additional power is consumed.

From a **materials / resource consumption and end-of-life** point of view, shared components (such as the HDD) are the **ecologically preferable** alternative.

4.5. END-OF-LIFE PHASE

The default end-of-life entries for the typical complex STBs without additional features (see 4.1.1.) are listed in Table 4-17.

These values are assumed to correspond largely with most likely end-of-life reality for STBs: Majority of recycled plastics will go to thermal recycling as almost all housing parts, which make the majority of plastics in STBs are coated. In principle, high-value ABS plastics are used but coating hinders a high level materials recycling.

In general, housing parts are easy to be removed. A high percentage of metal housing parts to be separated for steel recycling can be assumed.

Printed wired board assemblies are considered "easy to disassemble" in general as the housing is fixed typically only with one type of screws and so are the (various) PWBs inside the STB. Some of the PWBs in complex STBs have a gold finish, making it likely, that these boards are separated with priority at disassembly for PWB recycling. The same argumentation can be followed for hard disk drives, which contain platinum or ruthenium (see § 4.1.) and are attractive for materials recycling.

It should be noted that statements about real recycling of today's STBs remain highly speculative. Due to their size it might be the case that a remarkable number of STBs will end up in the municipal household waste. In 2005, 40% of WEEE arising in the EU 27 (consumer electronics only) has been collected and treated according to the WEEE Review Study[167]. It is not known, where the remaining 60% end up: some of the appliances will be stored at home (which just shifts disposal to a later point in time), some might go for second hand use in countries outside the EU 27. Assuming that the remaining 60% end up (sooner or later, inside EU 27 or outside) in the municipal household waste, results in a remarkable share to be landfilled: In the EU 27, about 47% of municipal household waste is landfilled[168]. The calculated landfill ratio as parameter for the EcoReport calculation consequently is 28%.

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167 Jaco Huisman et al., 2008 *Review of Directive 2002/96 on Waste Electrical and Electronic Equipment (WEEE) – Final Report*, 5 August 2007, United Nations University

168 European Environmental Agency (EEA): Better management of municipal waste will reduce greenhouse gas emissions, 1 January 2008, reports.eea.europa.eu/briefing_2008_1/en/EN_Briefing_01-2008.pdf

Table 4-17: End-of-Life scenario

Pos nr	DISPOSAL & RECYCLING Description		unit	Subtotals
	Substances released during Product Life and Landfill			
227	Refrigerant in the product (Click & select)	0	g	1-none
228	Percentage of fugitive & dumped refrigerant	0%		
229	Mercury (Hg) in the product	0	g Hg	
230	Percentage of fugitive & dumped mercury	0%		
	Disposal: Environmental Costs perkg final product			
231	Landfill (fraction products not recovered) in g en %	546	28%	88-fixed
232	Incineration (plastics & PWB not re-used/recycled)	371	g	91-fixed
233	Plastics: Re-use & Recycling ("cost"-side)	23	g	92-fixed
	Re-use, Recycling Benefit	in g	% of plastics fraction	
234	Plastics: Re-use, Closed Loop Recycling (please edit%)	2	1%	4
235	Plastics: Materials Recycling (please edit% only)	20	9%	4
236	Plastics: Thermal Recycling (please edit% only)	203	90%	72
237	Electronics: PWB Easy to Disassemble ? (Click&select)	168	YES	98
238	Metals & TV Glass & Misc. (95% Recycling)	1317		fixed

4.6. CONCLUSIONS FOR TASK 4

The real life products identified for the purpose of Task 4 will be used to define the Base Cases in Task 5. This task presented the diversity of existing products that can fall into lot 18 and also setup the input database for the environmental analysis to be conducted during the Task 5. It also analysed the products in a system context and illustrated how the external factors can affect their environmental and energy efficiency.

5. Task 5 - Definition Of Base Case

This task comprises of an assessment of average EU product(s), the so called Base Case(s) defined as “a conscious abstraction of reality”. The description of Base Case(s) is the synthesis of the results of Tasks 1 to 4. Most of the environmental and Life Cycle Cost (LCC) analysis are built on these Base Cases throughout the rest of the study and it serves as the point-of-reference for Task 6 (technical analysis of BAT), Task 7 (improvement potential), and Task 8 (policy analysis).

5.1. PRODUCT SPECIFIC INPUTS

MEEuP indicates the analysis of one or two Base Cases. However, in order to cover appropriately the broad range of technical specifications and functionalities of complex set-top boxes (STB), this study defined 6 Base Cases as summarised in Table 5-3. Base Cases 1 to 3 cover STBs for standard definition (SD) resolution, and Base Cases 4 to 6 similar products, but with high definition (HD) resolution.

Base cases 1 and 4 have a very “basic” configuration without any other major features besides conditional access. Base Cases 2 and 5 cover STBs with internal mass storage media, i.e. HDD as dominating medium. Base cases 3 and 6 represent abridged Base Case (no extended BOM) for high-end STBs with HDD, second tuner, and return path. These two Base Cases specifically illustrate the differences in power consumption of more sophisticated STBs.

Power consumption data is explicitly not taken from the disassembled STBs, but from the evaluation of statistical data provided in Task 4 (§ 4.3.7) – see Table 5-1.

Table 5-1: Typical on mode and active standby power consumption of complex STBs per functionality

STB (DVB-C, -S, -T, IPTV)	Typical power consumption (W)	
	On mode	Active standby
Basic “complex” STB, including all typical interfaces, digit display, CI and/or CAM, etc.	10	5
Additional power consumption for		
• Hard disk drive	+ 8	+ 2
• Second tuner / multiple tuners	+ 5	+ 1
• High definition capability	+ 8	+ 8
• Return path	+ 10	+10

There is no robust market data available on the number of STBs with return paths. Therefore, in the case of STBs with HDD, a market split of 80% - 20% was assumed for STBs with or without return path respectively[169].

In order to properly cover the important market segment of triple play STBs, a Product Case for triple play boxes is analysed as well. However, as it does not include the functionality of transmitting TV signal, but requires an additional IPTV STB for this purpose, it is named as a "Product Case" and not a Base Case. Actually, such a triple play box will be combined with a STB similar to any of the 6 Base Cases. There exist integrated triple play / receiver boxes, but they do not represent the majority of the triple play market.

It should be noted that the six Base Cases and the Product Case actually are intended to cover 80 different theoretical combinations[170] and hence this methodological approach inevitably leads to some simplifications.

Some parameters are common to all or several Base Cases and are presented here:

- Product economic lifetime: assumed to be 4 years (Task 3, § 3.2.1).
- The data related to distribution is assumed to be already optimised and is therefore not included in the analysis (see Task 4, § 4.2)
- End-of-Life is assumed as defined in Task 4 (§ 4.5), see Table 5-2.

Table 5-2: End-of-life scenario

Pos nr	DISPOSAL & RECYCLING Description		unit	Subtotals
	Substances released during Product Life and Landfill			
227	Refrigerant in the product (Click & select)	0	g	1-none
228	Percentage of fugitive & dumped refrigerant	0%		
229	Mercury (Hg) in the product	0	g Hg	
230	Percentage of fugitive & dumped mercury	0%		
	Disposal: Environmental Costs perkg final product			
231	Landfill (fraction products not recovered) in g en %	546	28%	88-fixed
232	Incineration (plastics & PWB not re-used/recycled)	371	g	91-fixed
233	Plastics: Re-use & Recycling ("cost"-side)	23	g	92-fixed
	Re-use, Recycling Benefit	in g	% of plastics fraction	
234	Plastics: Re-use, Closed Loop Recycling (please edit%)	2	1%	4
235	Plastics: Materials Recycling (please edit% only)	20	9%	4
236	Plastics: Thermal Recycling (please edit% only)	203	90%	72
237	Electronics: PWB Easy to Disassemble ? (Click&select)	168	YES	98
238	Metals & TV Glass & Misc. (95% Recycling)	1317		fixed

169 According to discussions during the final stakeholder meeting, where it was pointed out, that explicitly a second tuner is a very common feature among STBs specified by pay-TV providers

170 Four possible transmission platforms plus combos, SD or HD, with or w/o internal mass storage media, with one or multiple tuners, with or w/o return path: 5 x 2 x 2 x 2 x 2 = 80 theoretical configurations, of which some are unlikely (e.g. IPTV w/o return path)

Table 5-3: Base Cases – Overview

Base cases / Product Case	Data source		Market data (2007)	
	BOM	Power consumption	Sales (Million units)	Stock (Million units)
(1) "basic" complex STB with SD	Typical DVB-S STB (4.1.1)	Table 4-15	18.2	54.2
(2) complex STB with SD, HDD	Typical DVB-S STB (4.1.3)	Table 4-15	2.8 assumed split: (2) – 20%, (3) – 80%	8.2 assumed split: (2) – 20%, (3) – 80%
(3) complex STB with SD, HDD, second tuner, return path	Typical DVB-S STB (4.1.3); second tuner and return path not accounted for in the BOM	Table 4-15		
(4) "basic" complex STB with HD	Sample DVB-S STB (4.1.5)	Table 4-15	0.6	1.6
(5) complex STB with HD, HDD	Sample DVB-S STB (4.1.5) plus HDD from (4.1.3), additional housing "overhead" etc. not accounted for in the BOM	Table 4-15	0.6 assumed split: (5) – 20%, (6) – 80%	1.6 assumed split: (5) – 20%, (6) – 80%
(6) complex STB with HD, HDD, second tuner, return path	Sample DVB-S STB (4.1.5) plus HDD from (4.1.3), additional housing "overhead" etc., second tuner and return path not accounted for in the BOM	Table 4-15		
(7) triple play box	Sample triple play box (4.1.2)	Table 4-15: Additional power consumption for return path only	2.0 (IPTV)	6.0 (IPTV)

Finally, for all Base Cases and for the Product case, the daily usage time in the various operating modes are as listed in Table 5-4, based on the results of Task 3, § 3.1.1.

Table 5-4: Complex STBs Base Case/Product case use pattern

Complex STB Base Case/Product Case	On mode (hours/day)	Standby active mode (hours/day)	Off mode (hours/day)	Disconnected mode (hours/day)
without internal mass storage media	9	14.76	0.12	0.12
with internal mass storage media	10.5	13.38	0.06[171]	0.06[172]

5.1.1. Base Case 1: "basic" complex STB with SD

Base case 1 represents a complex STB with basic set of features. In terms of BOM it relates to the model Wisi OR 41 DVB-S-CI STB described in Task 4. The detailed BOM for this STB is presented in 4.1.1 and Table 4-2 shows the aggregated BOM for this Base Case.

Table 5-5: Base Case 1 – BOM summary

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 1: "basic" complex STB with SD	0	KSchi

Nr	Life Cycle phases --> / Resources Use and Emissions	unit	PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE* Disposal	END-OF-LIFE* Recycl.	END-OF-LIFE* Total	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**199**			179	20	**199**	**0**
2	TecPlastics	g			**27**			24	3	**27**	**0**
3	Ferro	g			**864**			242	622	**864**	**0**
4	Non-ferro	g			**73**			20	52	**73**	**0**
5	Coating	g			**13**			4	10	**13**	**0**
6	Electronics	g			**341**			172	168	**341**	**0**
7	Misc.	g			**428**			120	308	**428**	**0**
	Total weight	g			**1944**			761	1183	**1944**	**0**

Energy data for on mode and active standby mode are derived from the statistical analyses presented in Task 4 (see § 4.3.7).

Typical power consumption for Base Case 1 is

- On mode: 10 W
- Active standby mode: 5 W
- Off mode: 1 W (assumed to be soft-off typically)

171 10% of end-users turn off or disconnect heir STBs in the evening after watching TV (at night)1% x 12 hours in off-mode or disconnected mode (="night") among which 50% use the off-mode: 1% x 50% x 12 hours in disconnected mode

172 10% of end-users turn off or disconnect heir STBs in the evening after watching TV (at night) 1% x 12 hours in off-mode or disconnected mode (="night") among which 50% use the disconnected-mode: 1% x 50% x 12 hours in disconnected mode

5.1.2. BASE CASE 2: COMPLEX STB WITH SD AND HDD

Base case 2 represents a complex STB with standard definition (SD) resolution and including a HDD. In terms of BOM, it relates to the Skymaster DVR 7500 STB described in Task 4. The detailed BOM for this STB is presented in § 4.1.3 and Table 5-6 shows the aggregated BOM for this Base Case.

Table 5-6: Base Case 2 – BOM summary

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 2: complex STB with SD, HDD	0	KSchi

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**421**			379	42	**421**	**0**
2	TecPlastics	g			**30**			27	3	**30**	**0**
3	Ferro	g			**1313**			368	945	**1313**	**0**
4	Non-ferro	g			**560**			157	403	**560**	**0**
5	Coating	g			**20**			6	14	**20**	**0**
6	Electronics	g			**477**			245	232	**477**	**0**
7	Misc.	g			**521**			146	375	**521**	**0**
	Total weight	g			**3341**			1327	2014	**3341**	**0**

Energy data for on mode and active standby mode are derived from the statistical analyses presented in Task 4 (see § 4.3.7).

Typical power consumption for Base Case 2 is

- On mode: 18 W
- Active standby mode: 7 W
- Off mode: 1 W (assumed to be soft-off typically)

5.1.3. BASE CASE 3: COMPLEX STB WITH SD, HDD, SECOND TUNER, RETURN PATH

Base Case 3 represents a complex STB with SD resolution, including a HDD, second tuner, and return path. As this Base Case intends to cover all major functionalities of a complex STB[173] with SD, and related power consumption, the same BOM as Base Case 2 is used for simplification.

Energy data for on mode and active standby mode are derived from the statistical analyses presented in Task 4 (see § 4.3.7).

Typical power consumption for Base Case 3 is

- On mode: 33 W
- Active standby: 18 W
- Off mode: 1 W (assumed to be soft-off typically)

173 Except WLAN and removable media player

5.1.4. Base Case 4: "basic" complex STB with HD

Base Case 4 represents a basic complex STB, but with HD capability. In terms of BOM, it relates to the Philips DSR 9005/02 STB described in Task 4. The detailed BOM for this STB is presented in § 4.1.5 and Table 5-7 shows the aggregated BOM for this Base Case.

Table 5-7: Base Case 4 – BOM summary

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 4: "basic" complex STB with HD	0	KSchi

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**409**			368	41	**409**	**0**
2	TecPlastics	g			**44**			40	4	**44**	**0**
3	Ferro	g			**1205**			337	867	**1205**	**0**
4	Non-ferro	g			**357**			100	257	**357**	**0**
5	Coating	g			**17**			5	13	**17**	**0**
6	Electronics	g			**577**			294	283	**577**	**0**
7	Misc.	g			**701**			196	505	**701**	**0**
	Total weight	g			**3310**			1340	1970	**3310**	**0**

Energy data for on mode and active standby mode are derived from the statistical analyses presented in Task 4 (see § 4.3.7).

Typical power consumption for Base Case 4 is:

- On-mode: 18 W
- Active standby mode: 13 W
- Off-mode: 1 W (assumed to be soft-off typically)

5.1.5. Base Case 5: complex STB with HD and HDD

Base Case 5 represents a complex STB with HD capability and including a HDD. The BOM for this Base Case is derived from Base Case 4 plus a typical HDD[174]. Table 5-8 shows the aggregated BOM for this Base Case.

Table 5-8: Base Case 5 – BOM summary

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 5: complex STB with HD, HDD	0	KSchi

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	**unit**									
1	Bulk Plastics	g			**411**			370	41	**411**	**0**
2	TecPlastics	g			**51**			46	5	**51**	**0**
3	Ferro	g			**1224**			343	881	**1224**	**0**
4	Non-ferro	g			**775**			217	558	**775**	**0**
5	Coating	g			**17**			5	13	**17**	**0**
6	Electronics	g			**603**			307	296	**603**	**0**
7	Misc.	g			**724**			203	521	**724**	**0**
	Total weight	g			**3805**			1490	2315	**3805**	**0**

Energy data for on mode and active standby mode are derived from the statistical analyses presented in Task 4 (see § 4.3.7).

174 Meaning, Base Case 5 is not based on a real-world product, but a theoretical combination of BOMs. With an HDD included a real-world product might need a larger housing, slightly different power circuitry and might come with additional buttons on the front panel etc. – all these "overheads" for integrating a HDD are not accounted for in the BOM for the Base Case 5, and are assumed to be negligible.

Typical power consumption for Base Case 5 is:

- On-mode: 26 W
- Active standby mode: 15 W
- Off-mode: 1 W (assumed to be soft-off typically)

5.1.6. Base Case 6: complex STB with HD, HDD, second tuner, return path

Base Case 6 represents a complex STB with HD resolution, HDD, second tuner and return path. As this Base Case intends to cover all major functionalities of a complex STB[175] with HD, and related power consumption, the same BOM as Base Case 5 is used for simplification.

Energy data for on mode and active standby mode are derived from the statistical analyses presented in Task 4 (see § 4.3.7).

Typical power consumption for Base Case 6 is

- On-mode: 41 W
- Active standby mode: 26 W
- Off-mode: 1 W (assumed to be soft-off typically)

5.1.7. Product Case 7: Triple Play Box

Product Case 7 represents a triple play box, i.e. a broadband (xDSL) modem for PC internet access, VoIP, and means to connect to a TV via a separate STB (the latter not included in this product case but could be a basic STB). BOM data for this product case is derived from the sample triple play box analysed in 4.1.2. Table 5-9 shows the aggregated BOM for this Product Case.

Table 5-9: Product Case 7 – BOM summary

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Materials	unit									
1	Bulk Plastics	g			467			420	47	467	0
2	TecPlastics	g			79			71	8	79	0
3	Ferro	g			4			1	3	4	0
4	Non-ferro	g			22			6	16	22	0
5	Coating	g			0			0	0	0	0
6	Electronics	g			278			144	133	278	0
7	Misc.	g			519			145	373	519	0
	Total weight	g			1368			788	580	1368	0

Energy data for on mode and active standby mode are derived from the statistical analyses presented in Task 4 (see § 4.3.7).

Typical power consumption for Product Case 7 is (return path functionality only):

- On-mode: 10 W
- Active standby: 10 W
- Off-mode: 1 W (assumed to be soft-off typically)

175 Except WLAN and removable media player

Daily usage time in various operating modes are assumed to be similar to that of a "complex STB with internal mass storage media" as discussed in Task 3, (§ 3.1.1), although an STB with or without mass storage media might be connected to the triple play box. On the other hand a computer connected to the PC will require the triple play box to have longer on mode times.

5.2. BASE CASE ENVIRONMENTAL IMPACT ASSESSMENT

5.2.1. BASE CASE 1: "BASIC" COMPLEX STB WITH SD

The total environmental impacts for Base Case 1 according to EcoReport calculations are listed in Table 5-10.

Table 5-10: Base Case 1 – Life Cycle Impact

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 1: "basic" complex STB with SD	0	KSchi

Nr	Life Cycle phases --> Resources Use and Emissions		PRODUCTION			DISTRI-BUTION	USE	END-OF-LIFE*			TOTAL
			Material	Manuf.	Total			Disposal	Recycl.	Total	
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	239	68	307	77	2518	62	47	16	2918
9	of which, electricity (in primary MJ)	MJ	88	16	103	0	2516	0	20	-20	2599
10	Water (process)	ltr	147	4	151	0	169	0	18	-18	302
11	Water (cooling)	ltr	86	18	104	0	6707	0	4	-4	6807
12	Waste, non-haz./ landfill	g	6067	145	6212	64	2978	669	57	612	9866
13	Waste, hazardous/ incinerated	g	276	1	277	1	61	371	22	349	689
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	15	4	19	6	110	5	3	1	137
15	Ozone Depletion, emissions	mg R-11 eq.				negligible					
16	Acidification, emissions	g SO2 eq.	154	23	176	19	649	9	17	-7	837
17	Volatile Organic Compounds (VOC)	g	1	1	2	0	1	0	0	0	3
18	Persistent Organic Pollutants (POP)	ng i-Teq	9	2	12	0	17	5	0	4	33
19	Heavy Metals	mg Ni eq.	138	6	144	3	45	18	2	15	207
	PAHs	mg Ni eq.	20	1	21	3	5	0	2	-2	27
20	Particulate Matter (PM, dust)	g	13	6	19	8	14	81	1	80	122
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	113	0	113	0	17	5	11	-6	124
22	Eutrophication	g PO4	4	0	4	0	0	0	0	0	4
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

Figure 4-2 illustrates the contribution of different life cycle phases to each of the impact categories for Base Case 1. To understand such respective contribution, the total impact of a category is shown as 100%, but it does not mean that each category has equal amount of impact and the categories are not comparable. Negative impacts at end-of-life, i.e. recycling credits outweighing disposal impacts, are shown in this graph as a negative percentage.

Materials acquisition is clearly dominating the total environmental impacts (more than 60%) for the following categories:

- Waste, non-hazardous / landfill (mainly from gold coatings of connectors / CI-slot)
- Heavy metals emissions to air and to water (mainly from steel housing, heavy metals to water also from large ICs)
- PAH emissions to air (mainly from batteries)
- Eutrophication (mainly from steel housing and connectors)

Manufacturing according to the EcoReport calculations[176] is not dominating any of the categories, but contributes roughly one third of the total impacts for the category:

- Volatile Organic Compounds (VOC) to air (mainly from printed circuit boards)

Distribution does not dominate either in any of the categories. The most relevant categories are VOC and PAH emissions to air, where distribution is correlated with roughly 10% of the total life cycle impacts.

The **use phase** is dominating (more than 70%) in the case of:

- Total Energy and electricity
- Greenhouse Gases
- Acidification

The use phase impacts on total energy, electricity, and Greenhouse Gases for different modes are as follows:

- On mode: 55%
- Active standby mode: 45%
- Off mode: <0.15%

End-of-life impacts are dominating (more than 50%) in the following categories:

- Waste, hazardous / incinerated
- Particulate Matter emissions to air

These results do not allow making a robust assessment regarding which life cycle phase is the most relevant because comparison across categories is not feasible. However, it can be observed that **materials acquisition, use,** and **end-of-life** phases are of relevancy and will be analysed in Task 7 when assessing the improvement potential for different options. Regarding the use modes, both on mode and active standby need further consideration, whereas off-mode is of minor relevancy.

176 Note: The EcoReport spreadsheet covers manufacturing impacts of electronic components under "materials" and not "manufacturing"

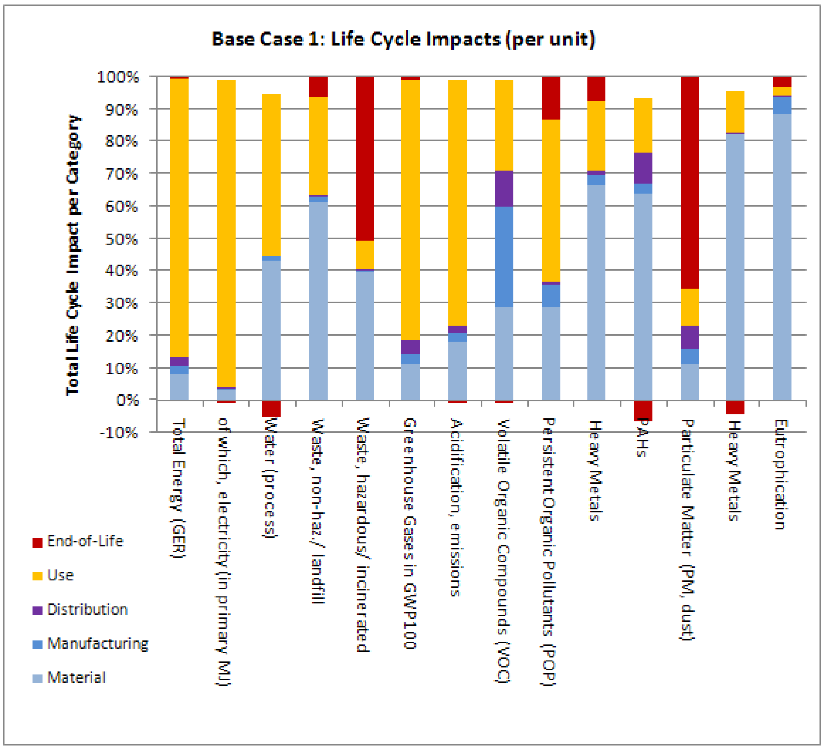

Figure 5-1: Base Case 1 – Life Cycle Impact

5.2.2. BASE CASE 2: COMPLEX STB WITH SD AND HDD

The total environmental impacts for Base Case 2 according to EcoReport calculations are listed in Table 5-11.

Table 5-11: Base Case 2 – Life Cycle Impact

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 2: complex STB with SD, HDD	0	KSchi

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	412	107	**519**	**114**	**4340**	107	71	**36**	**5010**
9	of which, electricity (in primary MJ)	MJ	130	29	**159**	**0**	**4337**	0	27	**-27**	**4469**
10	Water (process)	ltr	218	6	**224**	**0**	**291**	0	24	**-24**	**491**
11	Water (cooling)	ltr	137	29	**165**	**0**	**11562**	0	6	**-6**	**11721**
12	Waste, non-haz./ landfill	g	15700	253	**15953**	**82**	**5186**	1147	79	**1069**	**22289**
13	Waste, hazardous/ incinerated	g	467	2	**469**	**2**	**105**	638	30	**607**	**1183**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	25	7	**32**	**9**	**189**	8	5	**3**	**234**
15	Ozone Depletion, emissions	mg R-11 eq	negligible								
16	Acidification, emissions	g SO2 eq.	252	34	**287**	**28**	**1119**	16	23	**-8**	**1426**
17	Volatile Organic Compounds (VOC)	g	1	1	**3**	**1**	**2**	0	0	**0**	**5**
18	Persistent Organic Pollutants (POP)	ng i-Teq	22	4	**26**	**0**	**29**	8	0	**8**	**63**
19	Heavy Metals	mg Ni eq.	214	10	**224**	**4**	**77**	30	3	**27**	**332**
	PAHs	mg Ni eq.	60	1	**62**	**4**	**9**	0	3	**-3**	**72**
20	Particulate Matter (PM, dust)	g	24	9	**33**	**20**	**24**	139	1	**138**	**215**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	171	0	**171**	**0**	**30**	9	15	**-7**	**194**
22	Eutrophication	g PO4	6	0	**6**	**0**	**0**	1	0	**0**	**7**
23	Persistent Organic Pollutants (POP)	ng i-Teq	negligible								

Figure 5-2 illustrates the contribution of different life cycle phases to each of the impact categories for Base Case 2. Although the power consumption is more than 50%

higher for Base Case 2 compared to Base Case 1, the distribution of the impacts per life cycle phase is nearly the same for both Base Cases, obviously due to the fact that the more power consuming configuration comes with more components and weight.

With respect to the **materials acquisition**, the HDD contributes significantly to two impact categories:

- Waste, non-hazardous / landfill: precious metal coating of the platter
- Heavy metals emissions to air: massive steel housing of the HDD

The use phase impacts on total energy, electricity, and Greenhouse Gases for different modes are as follows:

- On mode: 67%
- Active standby mode: 33%
- Off mode: <0.1%

Results show that the conclusions are the same as for Base Case 1: **materials acquisition, use,** and **end-of-life** phases are all of relevancy. Regarding the use modes, both on mode and active standby need further consideration, whereas off-mode is of minor relevancy.

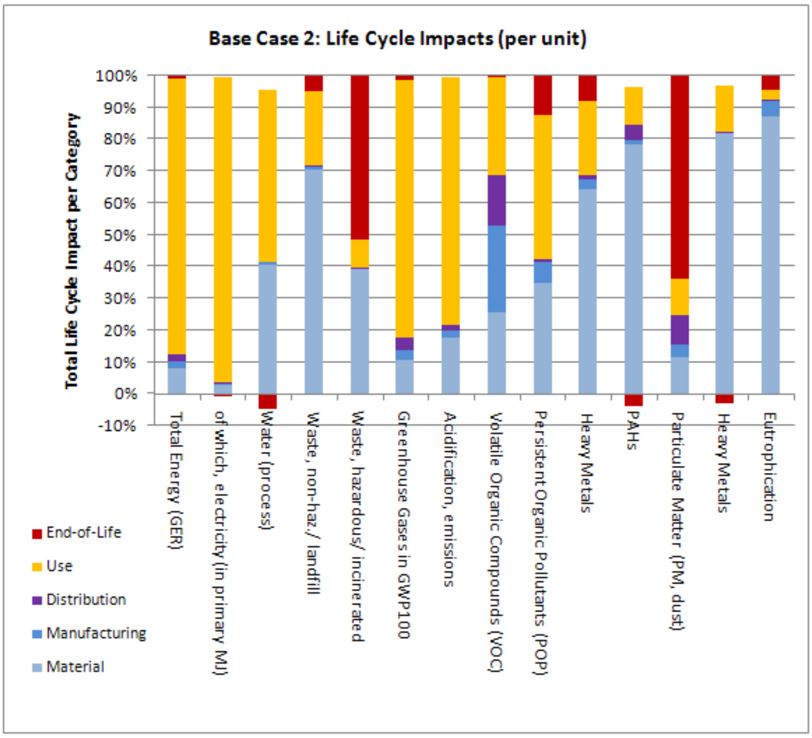

Figure 5-2: Base Case 2 – Life Cycle Impact

5.2.3. BASE CASE 3: COMPLEX STB WITH SD, HDD, SECOND TUNER, RETURN PATH

The total environmental impacts for Base Case 3 according to EcoReport calculations are listed in Table 5-12.

Table 5-12: Base Case 3 – Life Cycle Impact

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 3: complex STB with SD, HDD, 2nd tuner, return path	0	KSchi

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	412	107	**519**	**114**	**9011**	107	71	**36**	**9680**
9	of which, electricity (in primary MJ)	MJ	130	29	**159**	**0**	**9007**	0	27	**-27**	**9140**
10	Water (process)	ltr	218	6	**224**	**0**	**603**	0	24	**-24**	**802**
11	Water (cooling)	ltr	137	29	**165**	**0**	**24017**	0	6	**-6**	**24177**
12	Waste, non-haz./ landfill	g	15700	253	**15953**	**82**	**10601**	1147	79	**1069**	**27704**
13	Waste, hazardous/ incinerated	g	467	2	**469**	**2**	**212**	638	30	**607**	**1291**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	25	7	**32**	**9**	**393**	8	5	**3**	**438**
15	Ozone Depletion, emissions	mg R-11 eq				negligible					
16	Acidification, emissions	g SO2 eq.	252	34	**287**	**28**	**2322**	16	23	**-8**	**2629**
17	Volatile Organic Compounds (VOC)	g	1	1	**3**	**1**	**3**	0	0	**0**	**7**
18	Persistent Organic Pollutants (POP)	ng i-Teq	22	4	**26**	**0**	**59**	8	0	**8**	**93**
19	Heavy Metals	mg Ni eq.	214	10	**224**	**4**	**157**	30	3	**27**	**412**
	PAHs	mg Ni eq.	60	1	**62**	**4**	**18**	0	3	**-3**	**81**
20	Particulate Matter (PM, dust)	g	24	9	**33**	**20**	**50**	139	1	**138**	**241**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	171	0	**171**	**0**	**60**	9	15	**-7**	**225**
22	Eutrophication	g PO4	6	0	**6**	**0**	**0**	1	0	**0**	**7**
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

The contributions of each life cycle phases to the different impact categories are actually are very similar to Base Cases 1 and 2. The absolute values per STB are higher, e.g. for Greenhouse Gases 438 kg CO_2 eq. over the full life cycle compared to 137 and 234 kg respectively for Base Case 1 and 2.

The use phase impacts on total energy, electricity, and Greenhouse Gases for different modes are as follows:

- On mode: 59%
- Active standby mode: 41%
- Off mode: <0.1%

The assessment shows that conclusions are the same as for Base Case 1 and 2: **materials acquisition, use,** and **end-of-life** are all of relevancy. Regarding the modes both, on mode and active standby need further consideration, whereas off mode is of minor relevancy.

5.2.4. BASE CASE 4: "BASIC" COMPLEX STB WITH HD

The total environmental impacts for Base Case 4 according to EcoReport calculations are listed in Table 5-12.

Table 5-13: Base Case 4 – Life Cycle Impact

Nr	Life cycle Impact per product:								Date	Author
0	Base Case 4: “basic” complex STB with HD								0	KSchi

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	441	115	**556**	**109**	**5434**	110	78	**32**	**6133**
9	of which, electricity (in primary MJ)	MJ	133	27	**160**	**0**	**5430**	0	33	**-33**	**5557**
10	Water (process)	ltr	272	7	**279**	**0**	**365**	0	30	**-30**	**614**
11	Water (cooling)	ltr	126	31	**157**	**0**	**14478**	0	7	**-7**	**14628**
12	Waste, non-haz./ landfill	g	9311	242	**9553**	**79**	**6390**	1136	96	**1040**	**17062**
13	Waste, hazardous/ incinerated	g	515	2	**518**	**2**	**130**	691	37	**654**	**1303**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	27	7	**34**	**9**	**237**	8	5	**3**	**283**
15	Ozone Depletion, emissions	mg R-11 eq.				negligible					
16	Acidification, emissions	g SO2 eq.	317	38	**355**	**27**	**1401**	16	28	**-12**	**1772**
17	Volatile Organic Compounds (VOC)	g	1	2	**3**	**1**	**2**	0	0	**0**	**6**
18	Persistent Organic Pollutants (POP)	ng i-Teq	14	4	**18**	**0**	**36**	8	0	**7**	**62**
19	Heavy Metals	mg Ni eq.	212	9	**221**	**4**	**95**	31	4	**27**	**347**
	PAHs	mg Ni eq.	58	1	**60**	**3**	**11**	0	3	**-3**	**71**
20	Particulate Matter (PM, dust)	g	30	10	**40**	**19**	**30**	142	1	**141**	**230**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	204	0	**204**	**0**	**37**	9	19	**-10**	**232**
22	Eutrophication	g PO4	5	0	**5**	**0**	**0**	1	0	**0**	**6**
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

Figure 5-3 illustrates the contribution of different life cycle phases to each of the impact categories for Base Case 4. Once again, the relative relevancy of the individual life cycle phases for the various impact categories remains the same as for the other Base Cases.

The use phase impacts on total energy, electricity, and Greenhouse Gases for different modes are as follows:

- On mode: 46%
- Active standby: 54%
- Off mode: <0.1%

Once again, the **materials acquisition, use,** and **end-of-life** phases are all of relevancy. Regarding the modes both, on mode and active standby need further consideration, whereas off mode is of minor relevancy.

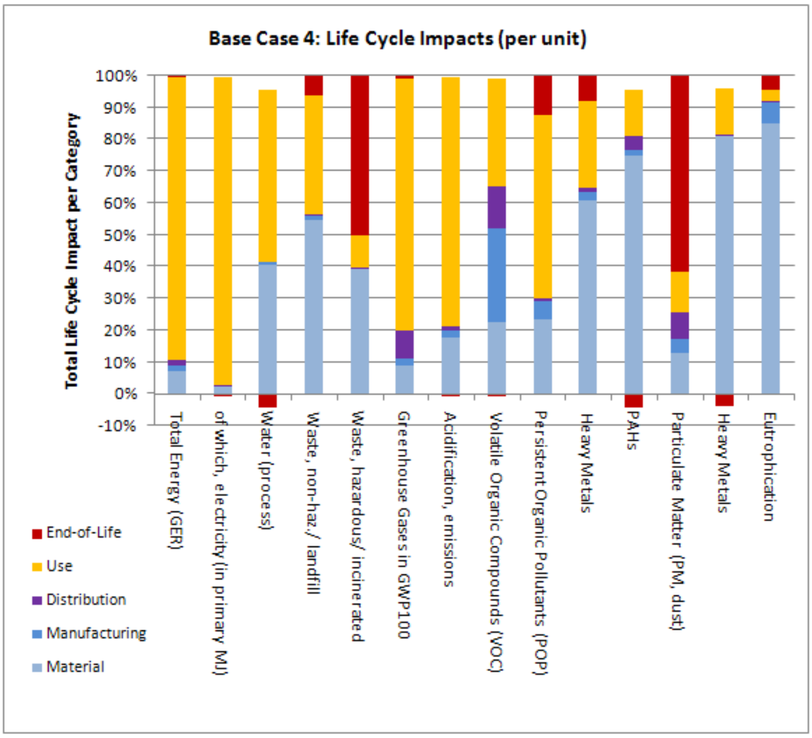

Figure 5-3: Base Case 4 – Life Cycle Impact

5.2.5. BASE CASE 5: COMPLEX STB WITH HD AND HDD

The total environmental impacts for Base Case 5 according to EcoReport calculations are listed in Table 5-14.

Table 5-14: Base Case 5 – Life Cycle Impact

Nr	Life cycle Impact per product:									Date	Author
0	Base Case 5: complex STB with HD, HDD									0	KSchi
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	519	124	**643**	**109**	**7270**	121	80	**41**	**8064**
9	of which, electricity (in primary MJ)	MJ	154	30	**184**	**0**	**7266**	0	35	**-35**	**7415**
10	Water (process)	ltr	289	7	**296**	**0**	**487**	0	31	**-31**	**752**
11	Water (cooling)	ltr	131	34	**165**	**0**	**19371**	0	7	**-7**	**19529**
12	Waste, non-haz./ landfill	g	17778	268	**18046**	**79**	**8602**	1306	100	**1206**	**27934**
13	Waste, hazardous/ incinerated	g	538	3	**541**	**2**	**173**	712	39	**673**	**1388**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	31	8	**39**	**9**	**317**	9	5	**4**	**369**
15	Ozone Depletion, emissions	mg R-11 ec					negligible				
16	Acidification, emissions	g SO2 eq.	349	41	**389**	**27**	**1874**	18	29	**-11**	**2280**
17	Volatile Organic Compounds (VOC)	g	2	2	**3**	**1**	**3**	0	0	**0**	**7**
18	Persistent Organic Pollutants (POP)	ng i-Teq	23	4	**28**	**0**	**48**	9	0	**9**	**84**
19	Heavy Metals	mg Ni eq.	216	10	**226**	**4**	**127**	34	4	**30**	**386**
	PAHs	mg Ni eq.	81	2	**82**	**3**	**15**	0	4	**-4**	**97**
20	Particulate Matter (PM, dust)	g	35	11	**45**	**19**	**40**	156	1	**155**	**259**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	222	0	**222**	**0**	**49**	10	20	**-10**	**261**
22	Eutrophication	g PO4	5	0	**6**	**0**	**0**	1	0	**0**	**6**
23	Persistent Organic Pollutants (POP)	ng i-Teq					negligible				

The correlations between life cycle phases and impact categories actually are very similar to what was observed for the other Base Cases.

The use phase impacts on total energy, electricity, and Greenhouse Gases for different modes are as follows:

- On mode: 58%
- Active standby mode: 42%
- Off mode: <0.1%

Materials acquisition, use, and **end-of-life** are all of relevancy. Regarding the modes both, on mode and active standby need further consideration, whereas off mode is of minor relevancy.

5.2.6. Base Case 6: complex STB with HD, HDD, second tuner, return path

The total environmental impacts for Base Case 6 according to EcoReport calculations are listed in Table 5-15.

Table 5-15: Base Case 6 – Life Cycle Impact

Nr	Life cycle Impact per product:	Date	Author
0	Base Case 6: complex STB with HD, HDD, 2nd tuner, return path	0	KSchi

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	519	124	**643**	**109**	**11941**	121	80	**41**	**12735**
9	of which, electricity (in primary MJ)	MJ	154	30	**184**	**0**	**11936**	0	35	**-35**	**12086**
10	Water (process)	ltr	289	7	**296**	**0**	**799**	0	31	**-31**	**1063**
11	Water (cooling)	ltr	131	34	**165**	**0**	**31827**	0	7	**-7**	**31985**
12	Waste, non-haz./ landfill	g	17778	268	**18046**	**79**	**14018**	1306	100	**1206**	**33349**
13	Waste, hazardous/ incinerated	g	538	3	**541**	**2**	**280**	712	39	**673**	**1496**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	31	8	**39**	**9**	**521**	9	5	**4**	**573**
15	Ozone Depletion, emissions	mg R-11 eq.					negligible				
16	Acidification, emissions	g SO2 eq.	349	41	**389**	**27**	**3077**	18	29	**-11**	**3482**
17	Volatile Organic Compounds (VOC)	g	2	2	**3**	**1**	**5**	0	0	**0**	**9**
18	Persistent Organic Pollutants (POP)	ng i-Teq	23	4	**28**	**0**	**79**	9	0	**9**	**115**
19	Heavy Metals	mg Ni eq.	216	10	**226**	**4**	**207**	34	4	**30**	**467**
	PAHs	mg Ni eq.	81	2	**82**	**3**	**24**	0	4	**-4**	**107**
20	Particulate Matter (PM, dust)	g	35	11	**45**	**19**	**66**	156	1	**155**	**285**
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	222	0	**222**	**0**	**79**	10	20	**-10**	**292**
22	Eutrophication	g PO4	5	0	**6**	**0**	**0**	1	0	**0**	**6**
23	Persistent Organic Pollutants (POP)	ng i-Teq					negligible				

The use phase impacts on total energy, electricity, and Greenhouse Gases for different modes are as follows:

- On mode: 55%
- Active standby mode: 45%
- Off mode: <0.1%

Materials acquisition, use, and **end-of-life** are all of relevancy. Regarding the modes both, on mode and active standby need further consideration, whereas off mode is of minor relevancy.

5.2.7. PRODUCT CASE 7: TRIPLE PLAY BOX

The total environmental impacts for Product Case 7 according to EcoReport calculations are listed in Table 5-16.

Table 5-16: Product Case 7 – Life Cycle Impact

Nr	Life cycle Impact per product:	Date	Author
0	Product Case 7: Triple Play Box	0	KSchi

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Total	
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	MJ	222	57	279	76	3665	69	55	13	4034
9	of which, electricity (in primary MJ)	MJ	92	14	106	0	3664	0	16	-16	3754
10	Water (process)	ltr	132	3	135	0	246	0	14	-14	366
11	Water (cooling)	ltr	110	16	125	0	9768	0	4	-4	9890
12	Waste, non-haz./ landfill	g	5857	99	5956	63	4306	470	46	424	10749
13	Waste, hazardous/ incinerated	g	291	1	292	1	87	625	18	607	988
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	11	4	15	6	160	5	4	1	182
15	Ozone Depletion, emissions	mg R-11 eq				negligible					
16	Acidification, emissions	g SO2 eq.	121	18	140	18	945	10	15	-5	1098
17	Volatile Organic Compounds (VOC)	g	1	1	2	0	1	0	0	0	3
18	Persistent Organic Pollutants (POP)	ng i-Teq	2	0	2	0	24	3	0	3	29
19	Heavy Metals	mg Ni eq.	19	0	20	3	63	19	2	17	103
	PAHs	mg Ni eq.	16	1	17	3	7	0	2	-2	25
20	Particulate Matter (PM, dust)	g	11	5	16	8	20	89	1	88	132
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	50	0	50	0	24	6	9	-3	71
22	Eutrophication	g PO4	2	0	2	0	0	0	0	0	3
23	Persistent Organic Pollutants (POP)	ng i-Teq				negligible					

Figure 5-4 illustrates the contribution of the different life cycle phases to each of the impact categories for Product Case 7.

Materials acquisition is clearly dominating the total environmental impacts for the following categories:

- Waste, non-hazardous / landfill (mainly from gold contained in printed circuit board assemblies)
- PAH emissions to air (mainly from large capacitors and coils)
- Heavy metals emissions to water (mainly from large ICs[177])
- Eutrophication (various components)

Manufacturing according to the EcoReport calculations is not dominating any of the categories, but contributes roughly to 30% of the total impacts for the category:

- Volatile Organic Compounds (VOC) to air (mainly from printed circuit boards)

Distribution does not dominate either in any of the impact categories.

The **use phase** is dominating (more than 80%) the total environmental impacts for the following categories:

- Total Energy, and electricity
- Greenhouse Gases

177 Note: IC processing (i.e. "manufacturing") in the methodology is covered under "materials"

- Acidification
- Persistent Organic Pollutants

The use phase impacts on total energy, electricity, and Greenhouse Gases for different modes are as follows:

- On mode: 44%
- Active standby mode: 56%
- Off mode: <0.1%

The use phase contributes to 50-70% of all impacts for the categories:

- Water (process)
- Heavy metals emissions to water

End-of-life impacts are dominating (more than 60%) for the following categories:

- Waste, hazardous / incinerated
- Particulate Matter emissions to air

These results do not allow making a robust assessment regarding which life cycle phase is the most relevant because a comparison across categories is not feasible. However, it can be observed that the use phase dominates in more categories than with the Base Cases 1-6. The conclusion is that **materials acquisition, use,** and **end-of-life** are all of relevancy and will be analysed in following tasks regarding improvement potentials. Regarding the modes, both on mode and active standby mode need further consideration, whereas off mode is of minor relevancy.

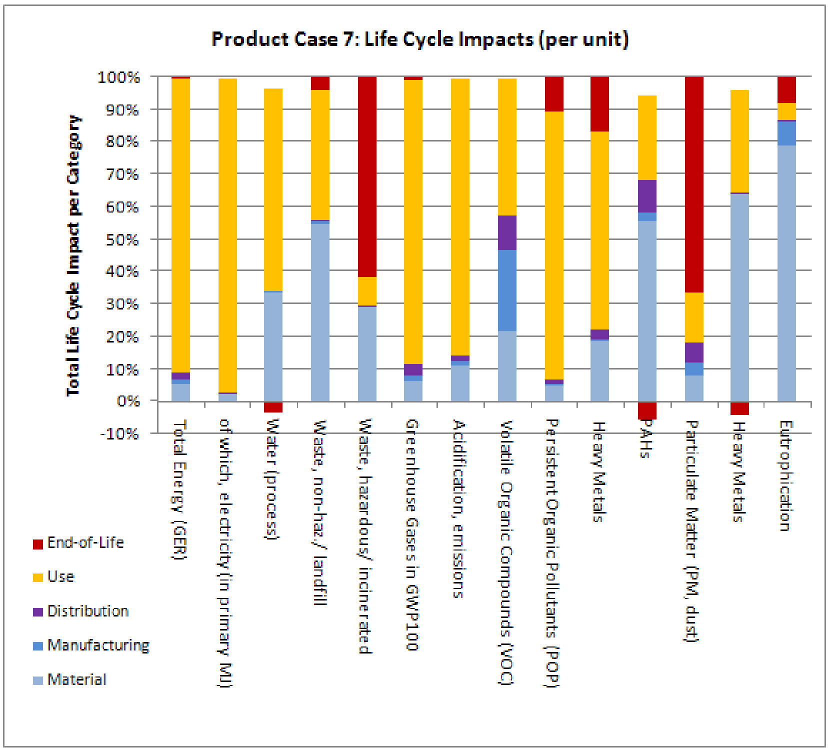

Figure 5-4: Product Case 7 – Life Cycle Impact

5.3. BASE CASE LIFE CYCLE COSTS

The life cycle costs refer to **2007 data** (see Task 2, table 2-19: "Full price (rare)").

5.3.1. BASE CASE 1: "BASIC" COMPLEX STB WITH SD

The life cycle costs for Base Case 1 according to EcoReport calculations are listed in Table 5-17. The electricity cost is about 21% of the total life cycle cost.

Table 5-17: Base Case 1 – Life Cycle Costs

	Base Case 1: "basic" complex STB with SD *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	100	€	1820	mln.€
E	Installation/ acquisition costs (if any)	0	€	0	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	35	€	496	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	0	€	0	mln.€
	Total	**135**	€	**2316**	mln.€

5.3.2. BASE CASE 2: COMPLEX STB WITH SD AND HDD

The life cycle costs for Base Case 2 according to EcoReport calculations are listed in Table 5-18. The electricity cost is about 16% of the total life cycle cost.

Table 5-18: Base Case 2 – Life Cycle Costs

	Base Case 2: complex STB with SD, HDD *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	250	€	140	mln.€
E	Installation/ acquisition costs (if any)	0	€	0	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	60	€	26	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	0	€	0	mln.€
	Total	**310**	€	**166**	mln.€

5.3.3. Base Case 3: complex STB with SD, HDD, second tuner, return path

The life cycle costs for Base Case 3 according to EcoReport calculations are listed in Table 5-19. No distinction is made for the purchase price between Base Case 2 and 3. The electricity cost is about 28% of the total life cycle cost.

Table 5-19: Base Case 3 – Life Cycle Costs

	Base Case 3: complex STB with SD, HDD, 2nd tuner, return path *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	250	€	560	mln.€
E	Installation/ acquisition costs (if any)	0	€	0	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	125	€	215	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	0	€	0	mln.€
	Total	**375**	€	**775**	mln.€

5.3.4. Base Case 4: "basic" complex STB with HD

The life cycle costs for Base Case 4 according to EcoReport calculations are listed in Table 5-20. The electricity cost is about 17% of the total life cycle cost.

Table 5-20: Base Case 4 – Life Cycle Costs

	Base Case 4: "basic" complex STB with HD *Item*	LCC new product		total annual consumer expenditure in EU25	
D	Product price	250	€	150	mln.€
E	Installation/ acquisition costs (if any)	0	€	0	mln.€
F	Fuel (gas, oil, wood)	0	€	0	mln.€
F	Electricity	75	€	32	mln.€
G	Water	0	€	0	mln.€
H	Aux. 1: None	0	€	0	mln.€
I	Aux. 2 :None	0	€	0	mln.€
J	Aux. 3: None	0	€	0	mln.€
K	Repair & maintenance costs	0	€	0	mln.€
	Total	**325**	€	**182**	mln.€

5.3.5. Base Case 5: complex STB with HD and HDD

The life cycle costs for Base Case 5 according to EcoReport calculations are listed in Table 5-21. The electricity cost is about 17% of the total life cycle cost.

Table 5-21: Base Case 5 – Life Cycle Costs

	Base Case 5: complex STB with HD, HDD *Item*	LCC new product	total annual consumer expenditure in EU25
D	Product price	350 €	42 mln.€
E	Installation/ acquisition costs (if any)	0 €	0 mln.€
F	Fuel (gas, oil, wood)	0 €	0 mln.€
F	Electricity	101 €	8 mln.€
G	Water	0 €	0 mln.€
H	Aux. 1: None	0 €	0 mln.€
I	Aux. 2 :None	0 €	0 mln.€
J	Aux. 3: None	0 €	0 mln.€
K	Repair & maintenance costs	0 €	0 mln.€
	Total	**451** €	**50** mln.€

5.3.6. Base Case 6: complex STB with HD, HDD, second tuner, return path

The life cycle costs for Base Case 6 according to EcoReport calculations are listed in Table 5-22. No distinction is made for the purchase price between Base Case 5 and 6. The electricity cost is about 25% of the total life cycle cost.

Table 5-22: Base Case 6 – Life Cycle Costs

	Base Case 6: complex STB with HD, HDD, 2nd tuner, return path *Item*	LCC new product	total annual consumer expenditure in EU25
D	Product price	350 €	168 mln.€
E	Installation/ acquisition costs (if any)	0 €	0 mln.€
F	Fuel (gas, oil, wood)	0 €	0 mln.€
F	Electricity	166 €	56 mln.€
G	Water	0 €	0 mln.€
H	Aux. 1: None	0 €	0 mln.€
I	Aux. 2 :None	0 €	0 mln.€
J	Aux. 3: None	0 €	0 mln.€
K	Repair & maintenance costs	0 €	0 mln.€
	Total	**516** €	**224** mln.€

5.3.7. Product Case 7: Triple Play Box

The life cycle costs for Product Case 7 according to EcoReport calculations are listed in Table 5-22.

Table 5-23: Product Case 7 – Life Cycle Costs

	Product Case 7: Triple Play Box *Item*	LCC new product	total annual consumer expenditure in EU25
D	Product price	50 €	100 mln.€
E	Installation/ acquisition costs (if any)	0 €	0 mln.€
F	Fuel (gas, oil, wood)	0 €	0 mln.€
F	Electricity	51 €	80 mln.€
G	Water	0 €	0 mln.€
H	Aux. 1: None	0 €	0 mln.€
I	Aux. 2 :None	0 €	0 mln.€
J	Aux. 3: None	0 €	0 mln.€
K	Repair & maintenance costs	0 €	0 mln.€
	Total	**101** €	**180** mln.€

5.4. EU TOTALS

5.4.1. LIFE CYCLE ENVIRONMENTAL IMPACTS

The total life cycle impacts for Base Cases 1 – 6 and Product Case 7 are summarised in Table 5-24 (reference year: 2007). Total Energy (GER) consumption of the EU stock (produced, in use, discarded) for the reference year 2007 is 74 PJ, of which electricity is 6.2 TWh. The EuP Preparatory Study on simple STBs calculated a use phase electricity consumption of 6.2 TWh (business-as-usual scenario for 2010)[178] as well, but one can observe the differences regarding market dynamics. Whereas the market for complex STBs sees significant growth rates and consequently the potential for rising total electricity consumption, the market segment of simple STBs is likely to grow at much lower rates beyond 2010.

Table 5-24: Lifecycle indicators – totals for complex STBs (2007)

main life cycle indicators	unit	value							
		Base Case 1	Base Case 2	Base Case 3	Base Case 4	Base Case 5	Base Case 6	Product Case 7	Totals
Total Energy (GER)	PJ	41,40	2,15	16,28	2,59	0,68	4,20	6,23	73,54
of which, electricity	TWh	3,39	0,18	1,44	0,21	0,06	0,37	0,54	6,19
Water (process)*	mln.m3	4,72	0,23	1,44	0,30	0,07	0,38	0,61	7,74
Waste, non-haz./ landfill*	kton	165,71	11,70	55,70	8,96	3,01	13,76	19,35	278,19
Waste, hazardous/ incinerated*	kton	12,25	0,65	2,76	0,76	0,16	0,67	1,93	19,19
Emissions (Air)									
Greenhouse Gases in GWP100	mt CO2eq.	1,99	0,10	0,74	0,12	0,03	0,19	0,28	3,46
Acidifying agents (AP)	kt SO2eq.	12,21	0,63	4,50	0,78	0,20	1,18	1,72	21,22
Volatile Org. Compounds (VOC)	kt	0,06	0,00	0,014	0,003	0,001	0,003	0,01	0,09
Persistent Org. Pollutants (POP)	g i-Teq.	0,53	0,03	0,17	0,03	0,01	0,04	0,05	0,86
Heavy Metals (HM)	ton Ni eq.	3,55	0,17	0,83	0,19	0,04	0,19	0,17	5,15
PAHs	ton Ni eq.	0,46	0,04	0,17	0,04	0,01	0,05	0,05	0,82
Particulate Matter (PM, dust)	kt	2,15	0,12	0,51	0,13	0,03	0,13	0,25	3,32
Emissions (Water)									
Heavy Metals (HM)	ton Hg/20	2,18	0,10	0,47	0,13	0,03	0,13	0,13	3,17
Eutrophication (EP)	kt PO4	0,08	0,00	0,015	0,004	0,001	0,003	0,005	0,11

178 Final report EuP Preparatory Study Simple Digital TV Converters (Simple Set Top Boxes) p. 113

Base Case 1 represents roughly 60% of environmental impacts of all complex STBs in 2007.

For all Base Cases and the Product Case, it has been confirmed by Ecoreport analysis that **material acquisition, use phase** and **end-of-life,** each dominate at least two of the environmental impact indicators. **On-mode** and **active standby** power consumption are equally important. Components and materials with a high contribution to certain life cycle indicators are identified to be:

- Steel / Aluminium housing parts (STB and HDD)
- Large ICs
- Large capacitors and coils (batteries)
- Printed circuit boards (manufacturing)
- Gold / precious metal content in printed circuit board assemblies, connectors and in HDD platters

5.4.2. LIFE CYCLE COSTS

Table 5-25 compares the Life Cycle Costs for complex STBs, i.e. total annual consumer expenditure for new products (reference year 2007). In total, life cycle costs are 3.9 billion Euros, thereof 912 million Euros electricity costs in EU 27 (23% of total life cycle costs).

Table 5-25: Life Cycle Costs – totals for complex STBs

Life Cycle Costs: total annual consumer expenditure in EU 25/27 (new products)	unit	value							
		Base Case 1	Base Case 2	Base Case 3	Base Case 4	Base Case 5	Base Case 6	Product Case 7	Totals
Product price	mln. EUR	1820	140	560	150	42	168	100	2980
Electricity	mln. EUR	496	26	215	32	8	56	80	912
Totals	mln. EUR	2316	166	775	182	50	224	180	3892

5.5. EU-25 TOTAL SYSTEM IMPACT

One of the largest pay-TV providers, BSkyB, states in its “The Bigger Picture Report”[179] a CO_2 footprint of their operations as 45,555 tonnes CO_2 equivalents for the year 2006/07[180] (including data centres and offices, but excluding the STBs themselves and third party services). Further, it has about 8.5 million customers meaning an “overhead” of **5.4 kg CO_2 eq. per pay-TV STB per year**. No data for other pay-TV service providers is available, and for triple-play services the impact allocation per service is difficult because of a wider range of serviced provided (internet, telephony, etc.).

179 British Sky Broadcasting Group plc, *The Bigger Picture Review 2007* p. 16, 17, media.corporate-ir.net/media_files/irol/10/104016/csr/The_Bigger_Picture_07.pdf

180 Actually, BSkyB claims to be carbon neutral as they set off their emissions; furthermore, they use (partly) renewable energy sources

Multiplying this "service provider overhead" with the stock of 65.7 million complex STBs results in annual additional EU-27 Greenhouse Gas emissions of **0.35 Mt CO_2 eq.** compared to 3.46 Mt CO_2 eq. for the complex STBs.

According to the lot 5 EuP Preparatory Study[181], a TV causes Greenhouse Gas emissions of **128.1 kg CO_2 eq. / year.** The total EU-27 impact of the **TV sets** (calculation basis: 32" LCD Base Case) connected to complex STBs (i.e. 65.7 million units as per 2007) is **8.4 Mt CO_2-eq**. Figure 5-5 illustrates the relations of Greenhouse Gas emissions for the system pay-TV provider / complex STB / TV set as per unit.

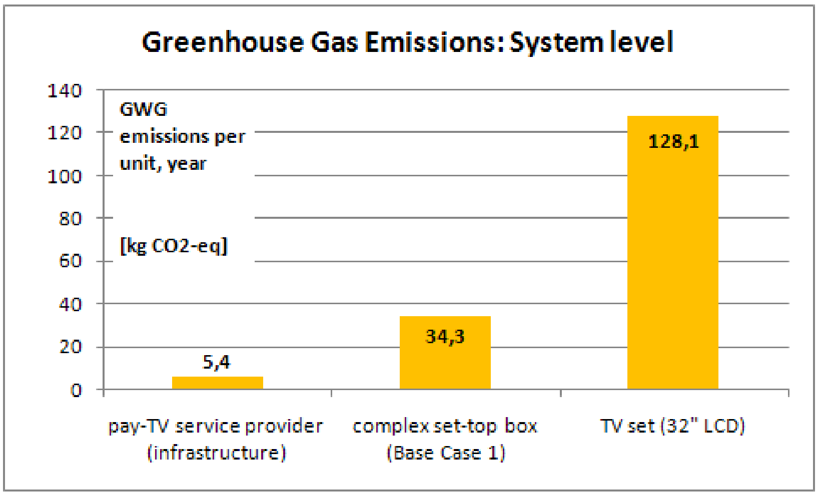

Figure 5-5: Greenhouse gas emissions per unit – service provider, complex STB, and TV

Broadband equipment, an important system component for IPTV is forecasted to consume 50 TWh of electricity in 2015[182], which equals for today's EU electricity mix **23 Mt CO_2-eq**. However, only a minor share of today's broadband power consumption can be allocated to internet TV, but the share might increase significantly in the mid-term future (2010-2015).

5.6. CONCLUSIONS FOR TASK 5

The Base Cases will serve as point of reference when evaluating the improvement potential (Task 7) of various design options identified in Task 6.

The **materials acquisition, use,** and **end-of-life phases** are all of relevancy when analysing the environmental impacts of complex STBs, and will be in focus during the subsequent tasks when evaluating the improvement potential of different options. Regarding the use modes, both on and active standby need further attention, whereas off mode is of minor relevancy.

181 Base Case for a 32" LCD TV, full life cycle

182 Introduction to Code of Conduct for Broadband Equipment - version 2 – 17 July 2007; end-use and network equipment, but STBs as such excluded from this figure

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6. Task 6 - Technical Analysis BAT

Task 6 entails a description and technical analysis of Best Available Technologies (BATs) and Best Not yet Available Technologies (BNATs), both at product and component levels.

BAT is a technology already available on the market, or at least whose feasibility has already been demonstrated in minimising environmental impacts and is expected to be introduced within 1 to 3 years. BNAT refers to technology, which has the potential to lead to further (environmental) performance improvements, but is still under research and development and can be considered as a future option / trend.

The assessment of the BAT and BNAT provides input for the identification of the improvement options in Task 7. Intellectual property, technical feasibility, and availability on market in a strict sense may not be judged here, as the objective of this task is to illustrate various technically feasible (and potentially available) options. However, the Task 7 will take these issues into account when suggesting possible improvement options applicable to complex set-top boxes (STBs).

6.1. SUBTASK 6.1 - STATE-OF-THE-ART IN APPLIED RESEARCH FOR THE PRODUCT

6.1.1. PRODUCTS ON THE MARKET

6.1.1.1 Slim design

An example of very **slim design** of a complex STB is the Personal Video Recorder STB (PVR) Dreambox 600 PVR S. The circuitry is miniaturised compared to STBs with similar functionality (but without a display, just LED indicator lights), line spaces[183] of the Printed Circuit Boards (PCBs) are much smaller and also the hard disk drive is of a slim design. The small volume of the STB is achieved also by having an external power supply unit for the Dreambox. The environmental impacts of different life cycle phases compared to a non-miniatursed STB of similar functionality (i.e. Base Case 2) are shown in Figure 6-1. Use phase power consumption is not accounted for to compare only the material and mechanical design related differences[184]: The slim design is slightly less materials consuming regarding technical plastics and miscellaneous materials, but has a much higher non-hazardous waste generation (+ 59%). However, for all other environmental impact categories, the sum of impacts in production, distribution and

183 Distance between from one copper line to the next

184 Actually, the power consumption of the slim design Dreambox 600 PVR S is lower than for the Base Case 2 in on mode and only slightly higher in standby, i.e. slim design does not mean a general conflict with energy efficiency

end-of-life is smaller compared to the environmental profile of Base-Case 2 (see Task 5, § 5.2.2), e.g.:

- Total Energy (GER): - 49%
- Hazardous waste / incinerated: - 47%
- Greenhouse Gas emissions (GWP): - 51%
- Acidification (emissions to air): - 52%
- Heavy metals (emissions to air): - 67%
- Particulate Matter (emissions to air): - 73%

It is often assumed that a compact design might have a negative impact on end-of-life (lower material separation efficiency, loss of valuable materials, higher concentration of critical materials, etc.). Contrary to this assumption, the EcoReport assessment results also show positive end-of-life trends for the slim design in almost all impact categories.

However, a slim design usually comes with a price premium, which is also the case for the Dreambox 600 PVR S, sold at about € 400.

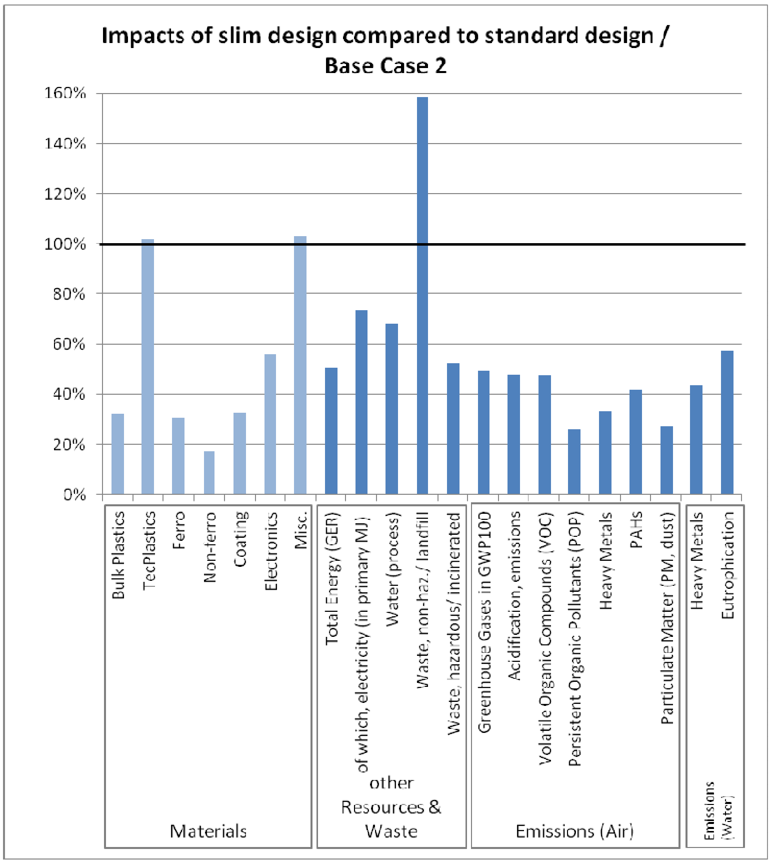

Figure 6-1: Environmental impacts of a STB with a slim design compared to Base Case

A key element of a slim design for STBs with Hard Disk Drive (HDD) is the size of the HDD. Figure 2-6 shows the comparison of two HDDs (upper case removed, both Parallel ATA) found in STBs. The left HDD is the one used in the Dreambox 600 PVR S with a storage capacity of 160 GB (2.5”), the right HDD is taken from another STB and has a lower capacity of 80 GB – but is much more bulky (3.5”), thicker, and has more weight.

Figure 6-2: HDD for STBs (standard 3.5” –right; compact 2.5” –left)

In general, there are even smaller HDD form factors on the market (down to 0.85”), but not known to be used in STBs.

6.1.1.2 Design for Recyclability

An example for a “recycling friendly” STB is the Technisat DigitSim S2: The **housing is fixed solely by clip-connectors**, no screws are used to fix the housing. Just one screw fixes the 12 V plug as otherwise repeated plugging might weaken the solder interconnection. Also the one **PCB** of the STB is **clipped in**. Manual separation of housing plastics and PCB is done within seconds. Plastics of the housing are **not coated** (only full-body coloured), which enables high level plastics recycling.

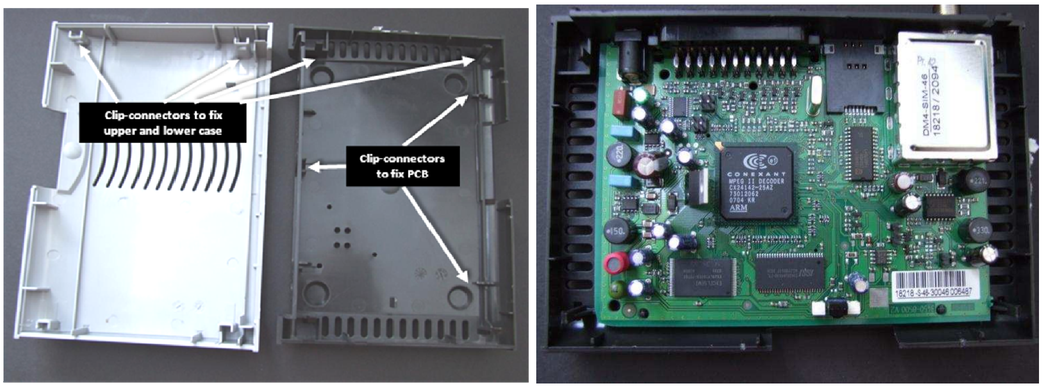

Figure 6-3: Housing parts with connectors (left) and PCB clipped in to bottom case (right) – Technisat DigitSim S2

The typical design of STBs is a housing fixed with a couple of screws (although usually screws of the same type) and coated front panels.

The Technisat DigitSim S2, however, is an STB with limited functionality compared to many other complex STBs, which is a reason, why this one has only one PCB which is favourable for a recycling-friendly mechanical design.

The price of this STB is at the lower end of complex STBs.

The use of connectors and non-coated plastics is assumed to lead to a significantly high share of plastics for material recovery and reduced thermal recovery. For example, in the cas of DigitSim S2 STB above, the standard recycling scenario (plastics: 9% material recycling, 90% thermal recycling, which is the scenario for all Base Cases in Task 5) is calculated and compared with a scenario, where better materials separation suitability is assumed to result in 90% plastics materials recycling and 9% thermal recycling. In both cases, as for the Base Cases in general, the "PWB easy to disassemble?" settings are "yes"[185]. The resulting impact reductions and additional recycling credits significantly change with the *high plastics recovery scenario* as listed in Table 4-2:

- Total Energy (GER) changes from 10 MJ consumption to 2 MJ credits
- Waste (hazardous / incinerated) is reduced from 320 g to 88 g
- Particulate Matter (emissions to air) is reduced from 49 g to 36 g
- Heavy metals (emissions to water) shows credits increased from 1.6 mg to 2,9 mg Hg/20

Note that in categories waste (hazardous / incinerated) and particulate matter, the impacts of end-of-life dominate the total life cycle impacts (see Base Case assessments in Task 5, §5.2.).

Table 6-1: End-of-Life impacts of enhanced recyclability (per unit)

			Standard scenario: plastics 9% material recovery, 90% thermal	**High plastics recovery scenario:** plastics 90% material recovery, 9% thermal
	Life Cycle phases -->		End-of-Life	End-of-Life
	Other Resources & Waste			
8	Total Energy (GER)	MJ	10	-2
9	of which, electricity (in primary MJ)	MJ	-8	-9
10	Water (process)	ltr	-8	-8
11	Water (cooling)	ltr		
12	Waste, non-haz./ landfill	g	258	255
13	Waste, hazardous/ incinerated	g	320	88
	Emissions (Air)			
14	Greenhouse Gases in GWP100	kg CO2 eq.	0.9	0.7
16	Acidification, emissions	g SO2 eq.	-2.2	-3.4
17	Volatile Organic Compounds (VOC)	g	0.0	0.0
18	Persistent Organic Pollutants (POP)	ng i-Teq	1.9	1.9
19	Heavy Metals	mg Ni eq.	10	6
	PAHs	mg Ni eq.	-0.9	-0.9
20	Particulate Matter (PM, dust)	g	49	36
	Emissions (Water)			
21	Heavy Metals	mg Hg/20	-1.6	-2.9
22	Eutrophication	g PO4	0.1	0.0

185 Although for the DigitSim S2 the answer more clearly would be "yes" than for the ones with screw fixed printed circuit boards, but the methodology does not allow for such distinction.

6.1.1.3 Low power consumption STBs

Among the complex STBs available on the market, following are some of the models with lowest power consumption:

- Pace DC245: A complex DVB-C186 STB, which was introduced in 2007. According to Pace, this STB with return path consumes 4 W on mode and 3.7 W in active standby mode. These low power consumption values, however, are also due to the fact that this box has very basic functionality.
- Technisat Digicorder S2: A complex DVB-S187 STB, which features a 160 GB HDD, display, 2 Common Interface (CI) slots and 2 tuners. Whereas the power consumption in on mode is in a typical range for such kind of configuration (22.5 W, according to Bush et al.188), the passive standby power consumption is extremely low: Bush et al. measured a consumption of 0.2 W, although the Technisat catalogue states 1 W for passive standby189.
- Besides the Digicorder S2, there are a couple of other complex DVB-S with a measured passive standby power consumption below 1 W, namely Boca DSL 221 CI (0.9 W) and Comag SL 35 1 CI (0.7 W), according to Stiftung Warentest measurements190.

Table 6-2 lists the lowest (independently measured) power consumption values for various complex STB configurations. Base data is outlined more in detail in Task 4 (§4.3.), this now are the best performing STBs, but note, that the total number of independently measured STBs is only 32 (e.g. for DVB-S with second tuner and HDD/PVR the stated value is the better performing product out of two).

Table 6-2: Lowest measured power consumption of complex STBs

Transmission platform	Features				Lowest measured power consumption (W)	
	Return path	Second tuner	HDD / PVR	HD	On mode	(Passive) standby
DVB-C	-	-	-	-	6	2.5
DVB-S	-	-	-	-	7.6	1.7
DVB-T[191]	-	-	-	-	6.3	2.3
DVB-S	-	+	+	-	22.5	0.2
IPTV[192]	+	-	+	-	15.6	n.a.

186 DVB-C: Cable transmission platform

187 DVB-S: Satellite transmission platform

188 E. Bush, M. Schalcher, P. Kühne, S. Kammermann, S. Gasser, J. Nipkow: Settop-Boxen: Bestimmung der energetischen Eigenschaften, Final Report, May 7, 2007

189 Technisat stated, that 0.2 W might not be a correct value; however introduction of an additional power supply for low power makes the TechniSat product range to consume now 300-600 mW in standby (indication of standby with an illuminated button; 2W in standby when display active)

190 Vom Himmel geholt - Digitale Sat-Empfänger, test, 11/2007, p. 55-59; 15 tested in total, thereof 13 complex ones acquired for reverse engineering

191 DVB-T: Terrestrial transmission platform

6.1.2. Low Power Standby Mode

Industry experts were asked to comment on whether a 1-W-standby-mode is implementable and the majority of them agreed that such mode could comprise of the following set of functionalities[193]:

- Front-panel button reactivation
- Remote control reactivation
- Automatic wake-up at pre-determined times and intervals, including automatic wake-up for scheduled recordings

Note: One leading STB manufacturer opposed this by replying that a 1-W-standby mode is not feasible for cable and satellite STBs as "the security and network requirements of current conditional access systems requires some level of 'always-on'. (...) Wake up time will become equivalent to a 'cold boot' which, depending on product complexity can be from 1-5 minutes".

The complex STB has to wake up from such a low power standby mode (passive standby) to allow for remote programming (via internet), software updates, entitlements updates, and Electronic Program Guide (EPG) updates. BSkyB, for example, allows for a remote programming of recordings up to 30 minutes before the beginning of a recorded programme, and to allow this short-notice programming the STB has to wake up at least every 30 minutes to update the scheduled recordings. Such active periods for remote programming need only a few minutes, but for other updates longer daily periods are required. ANGA[194] states a need of minimum 1 hour minimum wake-up time daily for entitlement messages data. However, fixed or predictable times for software updates might lead to higher security risk.

According to industry sources[193], the additional circuitry for a 1-W-standby mode probably increases the price of a set-top box by € 2.5 to € 5.

A 1-W standby mode according to stakeholder feedback is not possible for STBs while they are intended to provide router or networking functionality, i.e. act as (active) routers, switches, ADSL / DOCSIS modems, VoIP adapters, etc.

6.1.2.1 "Cold standby" concept by UPC / Liberty Global

Following requirements by digital cable TV provider UPC / Liberty Global will be applicable for future cable TV hardware platforms[195]:

- The STB shall be able to enter a state of cold standby, where it shall consume a maximum of 1 W of power in total, all components considered (i.e. cable modem, mainboard, etc).
- The STB shall also support a lukewarm standby mode (approx. 5 W) where the cable modem remains active (for customers that are subscribed to internet access for their PC).

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192 IPTV: Internet transmission platform
193 Based on the second stakeholder questionnaire published at the lot 18 project website
194 Association of German Cable Operators
195 Eric Peeters / Michael Bryan-Brown, UPC, December 6, 2007

- The STB shall also still have a hot standby mode, which can be enabled in the menu.
- When in cold standby, the unit shall be able to be awoken by either the keys on the front-panel or by the Remote Control Unit. It shall not be awoken by IR signals intended for other devices.
- When in cold standby, the unit shall be able to wake itself at certain pre-determined times and at certain intervals. This should be configurable via an API.

With this functionality spectrum, the “cold standby” confirms the possible functionality of a “low power standby mode” as outlined above. The following functionality may be compromised because of the cold standby requirements, according to UPC / Liberty Global:

- RF bypass[196] – Liberty Global considers to remove this functionality completely (will have customer impact)
- SCART[197] loop-through – Liberty Global considers to remove the VCR SCART
- Remote Digital Video Recorder (DVR) programming – Liberty Global considers to use the automatic wake-up functionality in combination with a central database for this purpose
- Event based series linking – for this functionality, the user needs to enable the hot standby mode in the menu
- In-home distribution of DVR content – for this functionality, the user needs to enable the hot standby mode in the menu

6.1.2.2 Further obstacles for a low power standby mode

A low power standby mode also means an impact on the convenience as delay times to full operational mode increase (boot times)[198]. This is even more relevant for **high definition** boxes as these have more complex features. In order to support the enhanced set of functionalities, which comes with HD STBs, there has been a move towards the Linux Operating System (OS) which is much more complex and takes longer to load than previous OS. Hence, nowadays typically in HD boxes, major parts remain active in standby (according to one industry source, this is the reason, why standby power consumption of HD STBs in the market mostly is similar to the on mode power consumption). Implementation of a low power standby mode for these STBs would mean significant delay times.[199]

196 Enables the cable signal to bypass the STB and go directly to a cable-ready TV or recorder

197 A SCART connector is a physical and electrical interconnection between two pieces of audio-visual equipment

198 One stakeholder mentioned that service providers also require a high level of software security in order to prevent hackers accessing their media content. Such features further increase the time to boot.

199 Stiftung Warentest tested delay times from off mode/disconnected of complex DVB-S STBs, the only tested HD box (Philips DSR9005/02, on mode: 15,0 W, standby: 14,5 W) has a delay time from disconnected to full operation of 36 seconds, see also table 4-1.

In satellite STBs, the Low Noise Block (LNB) generally remains permanently powered for reasons of stability and long lifetime. A 1-W-standby-mode could hamper the proper operation of the LNB.

6.1.2.3 Low power standby scenario

Figure 6-4 compares the 24-hour power consumption profile for a complex STB in standard configuration and a STB with an implemented low power standby mode. It is assumed, that the STB is running in on mode for 9 hours daily, for example recording a programme at 12 p.m. for 90 minutes, remaining switched on for another 3 hours thereafter, and watching live TV or playing the recorded programme from 7 to 11.30 p.m. During the rest of the day, the STB is switched into active standby[200], awaiting updates of channels, EPG, software and entitlements, and remote programming (a). With low power standby implemented (b) the STB is assumed to enter this mode after watching or recording (upon user interaction typically) and to wake-up every 30 min for remote programming - if any - and minor updates for a couple of minutes. One major daily update is scheduled to happen at night (in this scenario: 1 a.m.) for one hour (software, entitlements, channel updates, etc.).

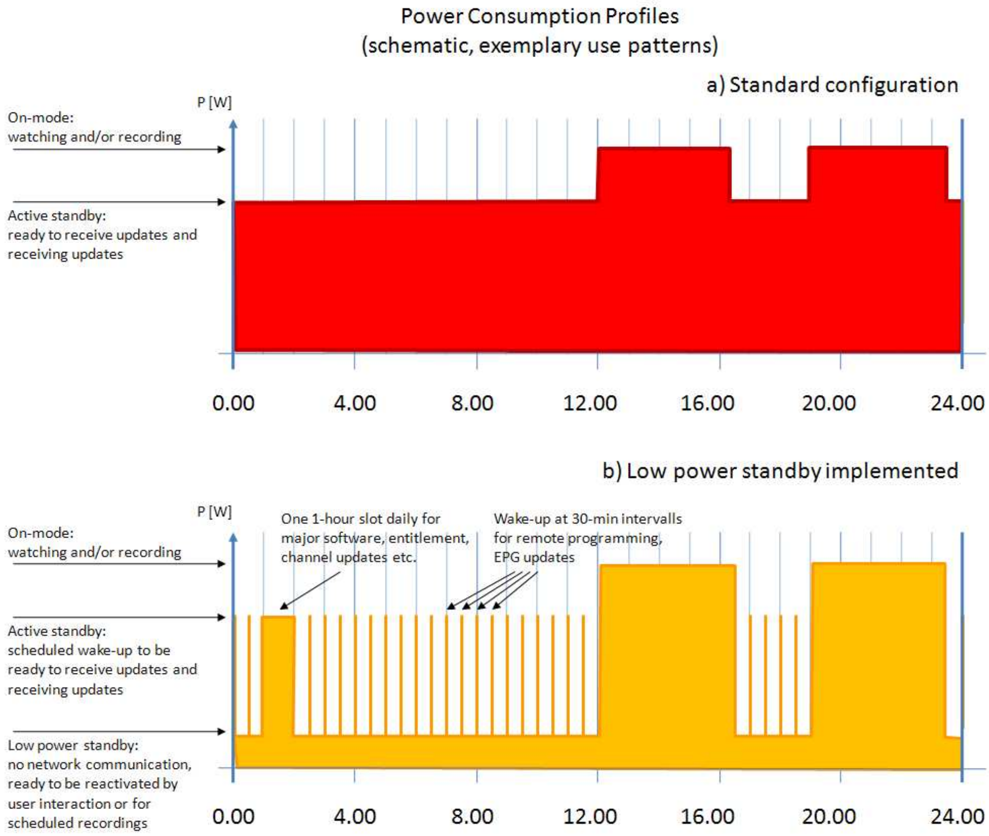

Figure 6-4: Comparison of normal and low standby power consumption profiles

200 Here a typical use case is assumed with 0h/day both in off mode and in disconnected mode. Usage times in off mode and disconnected modes are not taken into account here, as this low power standby scenario is not meant to represent an abstract average (as in Task 3), but a theoretical typical real use case.

It is not clear yet, how long the wake-up periods for the 30-min intervals have to be, as it depends on the actual middleware (to be developed), boot times, and data to be transferred. For this scenario, it is estimated that 5 minutes might be sufficient to allow proper operation. The resulting times in the various modes according to this scenario are outlined in Table 3-1[201].

As an alternative scenario, the table also lists the mode times for a 2 h wake-up interval, which still allows to reduce active standby times, but clearly the major improvement step is the implementation of an automatic low power standby mode with 30 min wake-up intervals, compared to no such automatic mode at all.

Table 6-3: Complex STBs use pattern (hours/day)

Appliance / configuration	On mode	Standby active mode[202]	Low power standby mode	Off mode	Disconnected mode
Complex STB without internal mass storage media					
standard[203]	9	14.76	-	0.12	0.12
low power standby implemented; wake-up interval 30 min	9	3.25	11.5	0.12	0.12
low power standby implemented; wake-up interval 2 hours	9	1.5	13.26	0.12	0.12
Complex STB with internal mass storage media					
standard[204]	10.5	13.38	-	0.06	0.06
low power standby implemented; wake-up interval 30 min	10.5	3.1	10.28	0.06	0.06
low power standby implemented; wake-up interval 2 hours	10.5	1.5	11.84	0.06	0.06

Essential requirements to enable such a scenario are:

201 Off mode and disconnected mode times now mathematically taken into consideration; scenario also calculated for STB without mass storage media, although programmed recording is no option for these anyhow, but other updates are

202 For 30-min-wake-up-interval: $t_{\text{low power standby mode}}$ [h] = $t_{\text{standby active, standard}}$ [h] / 0,5 h * 1/12 h + 1 h; with 5 min ("1/12 h") standby active time every 30 min, and 1 h for major daily updates

203 Corresponding to task 3 results, see table 3-1

204 Corresponding to task 3 results, see table 3-1

- Middleware developments to allow for such an operation
- Coordination with service providers / operators to upload updates at pre-defined intervals
- Boot time significantly reduced so that users do not find start up delays unacceptable

6.2. SUBTASK 6.2 - STATE-OF-THE-ART AT COMPONENT LEVEL

The analysis on the component level includes material, circuitry layout aspects and software issues. Main input for this subtask is derived from a survey among manufacturers.

6.2.1. ALTERNATIVES TO PVC[205]

The environmental pros and cons of PVC are heavily debated. This EuP Preparatory Study does not intend to analyse, whether getting PVC out of electronics is per se environmentally benign[206], but as there are voices claiming PVC free to be "green" – even brandname ICT and CE manufacturers are doing so – a brief summary shall be provided here:

Sabic, a plastics manufacturer offers **Noryl modified polyphenylene ether resins** for flexible wire-coatings: "Non-halogenated, flame-retardant flexible Noryl resin for wire coating is non-brominated, meets heavy metal free requirements and has the potential to be recycled. The material has certifications under UL1581 specification for 80°, 90° and 105°C." Dell actually showcased a business PC at the Electronics Goes Green conference in Berlin, September 8-10, 2008, without any PVC, and cable coatings made of these Noryl resins. T. Arbogast, Dell, stated at this conference that the costs for this alternative are twice that of PVC, but he expects, that if such alternatives are used broadly by the electronics industry, costs will drop down significantly due to economies of scale.

Another alternative to PVC is **cross-linked polyethylene (XLPE)**: In late 2007, Samsung announced that all their LCD panels will go PVC free by making use of polyethylene instead.

Further material suppliers of alternatives to PVC for cables and wiring comprise:

- Dow Wire & Cable (polyolefin compounds)
- AlphaGary
- Teknor Apex (vinyl compounds)
- GE Advanced Materials (Noryl resins)

205 Polyvinyl chloride
206 Note: the MEEuP EcoReport tool does not allow for such a comparison

Apple, for example, plans to eliminate completely the use of PVC and brominated flame retardants in its products by the end of 2008[207]. Consequently, there would be a PVC free IPTV STB on the market latest by next year, namely the Apple TV box.

6.2.2. New PCB Materials: HTT Boards

These new PCB material, i.e. high temperature-resistant thermoplastics (HTT) allow for higher recycling performance and avoidance of use of flame retardants. For more details, see EuP Preparatory Study on Simple Set-top Boxes[208].

6.2.3. Hard-off switch

Many pay TV STBs come with a **hard-off switch**, most of them with the switch on the backside, but at least one model known with a hard-off switch **on the front panel** (Kathrein UFS 710). This front-side hard-off switch is realised through a plastics link, which connects the front-side button internally with the power circuitry in the rear part of the STB (next to the plug).

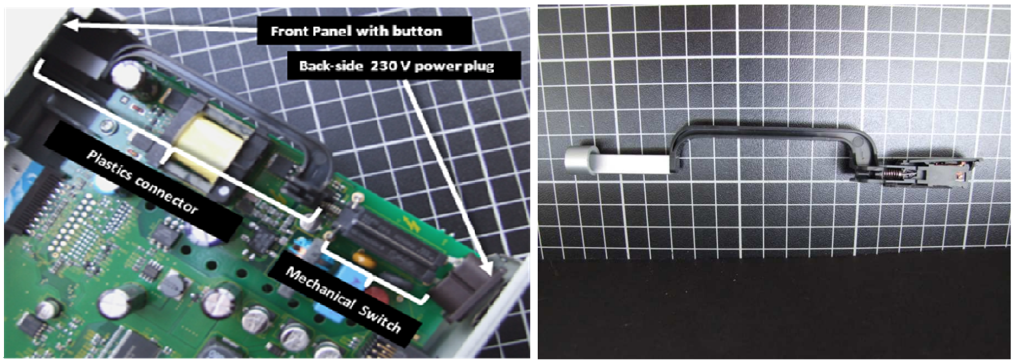

Figure 6-5: Hard-off switch assembly with PCB (left) and separated (right) – Kathrein UFS 710

The weight of the hard-off switch is 0.5% of the total STB weight, but in terms of environmental impacts (regarding materials and production only) it is even minor:

- Total Energy (GER): 0.4% (or 1.3 MJ)
- Waste (both categories): 0.03% each
- Greenhouse Gas emissions: 0.3%

For comparison, the Total Energy of 1.3 MJ corresponds to 0.12 kWh electricity consumption, i.e. 60 hours in 5 W standby.

6.2.4. Hard disk drive and solid state disk

HDD might be **turned down** when not in use, but this does not refer to parallel recording while watching a programme in case the possibility for replay is intended.

207 A Greener Apple: www.apple.com/hotnews/agreenerapple

208 *Final Report EuP Preparatory Study Simple Digital TV converters* (Simple Set-top Boxes), 2007

However, to switch off a HDD by user interaction, i.e. to disable the replay option, is possible in principle, but has to be supported by the software. As long as there is no scheduled recording, back-up recording for replay or time-shift, or replay, an automatic turn-down of the HDD is already implemented in a majority of STBs. According to an industry expert, it is possible to connect the motor driver in a hard disk to the host microcontroller at nearly no cost, and the power savings are remarkable (in the range of 3 W).

Latest state-of-the-art 3.5" HDDs for consumer electronics applications have a power consumption of 4.7 W in on mode (read/write)[209] and 3 W in idle mode.

Smaller 2.5" HDDs need even less power[210], due to the smaller form factor (less mechanical energy required). There are such 2.5" HDDs on the market, which consume 1.8 W in operational mode (read/write) and 1.7 W in idle mode – but prices for 2.5" drives are significantly higher than for 3.5" drives (however, the prices are declining rapidly).

Solid state disks (SSDs), as an alternative to HDDs, have just entered the high-price computer segment, see for example Apple's MacBook Air, which comes optional with a solid state disk, but at a price premium of 1,000 US$. This indicates that this is far from being a viable alternative for the mass STB market. Some industry experts expect a power savings potential from solid state disks of 3 W and more in on mode and minor savings in standby. However, there are also constraints regarding the suitability of solid state disks as replacement of hard disk drives: the number of possible read / write cycles to high density NAND Flash memory is limited with current technology[211].

Hybrid HDD / SSD concepts are under consideration currently: The SDD / flash memory (limited memory capacity) provides a buffer function for review, which allows the HDD to turn down as long as no permanent recordings are intended. This would allow for HDD power savings (see above) which are not over-compensated by the memory power consumption, but at higher costs and extended BOM. However, for such hybrid approaches, the counter-argument of limited number of read / write cycles seems to hold true.

6.2.5. SYSTEM ON CHIP / SILICON IMPROVEMENTS

System on Chip (SoC) improvements are frequently mentioned to be a key area for efficiency gains. Actually, STB power consumption improvements in the past are to a large extent due to better semiconductor devices, and further improvements are under development. General approaches comprise[212]:

- Move to low power silicon process option similar to mobile devices (cell phone, PDA, etc.)

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209 See for example Seagate's Pipeline HD™ for DVRs (320 GB – 1 TB); note: start-up power consumption typically is higher than power consumption during read or write

210 See for example Hitachi's CinemaStar™ C5K320 (120-320 GB)

211 Industry source: "for a box offering instant rewind or a user making constant use of pause, the flash could easily start to fail in under 1 year"

212 D. Clark, *How to improve the efficiency of complex STB*, International Workshop on Energy Efficient Set-Top Boxes & Digital Networks, IEA, Paris, July 4-5, 2007

- Voltage islands – Provides lower standby power consumption
- Dynamic voltage scaling – Voltage is adjusted up or down based on processing load

SoC based future power savings require a close coordination with middleware changes and conditional access / service provider requirements: changed silicon design might allow to switch-off circuitry blocks, which are not in direct use, but this might interfere with the service provider's security strategy.

The following list of exemplary semiconductor solutions launched recently by a couple of leading component providers illustrates SoC approaches, but is not meant to be exhaustive.

- **Infineon: Tuner ICs for 3.3 V**

Infineon recently launched a product line of HF tuner ICs[213], which operate at lower voltage levels of 3.3 V whereas typically the tuner in TVs and STBs runs on 5 V. This lower voltage level comes with a power saving of 170 mW, according to Infineon claims – at similar performance.

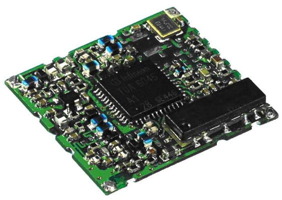

Figure 6-6: HF tuner with Infineon components –reference design

- **Fairchild: Green FPS Series for power supply designs**

Fairchild's Green FPS™ e-Series™ are suited for power supply designs below 25W e.g. for STBs. Based on Fairchild's proprietary valley switching technique, these Green FPS products increase power conversion efficiency by 1% and reduce EMI up to 5dB, when compared to conventional hard-switching topologies, according to Fairchild: "Utilising an advanced burst mode operation, the Green FPS e-Series devices meet standby power regulations by reducing standby power consumption to below 0.2W at no load conditions (below 1W at 0.5W load)."

- **ST Microelectronics (STM): Latest generation chip for HD STBs**

In September 2008, STM launched the STi7105 chip for HD STBs, including IPTV, DVB-S, hybrid DVB-T/broadband boxes with WiFi home network, and DVB-C boxes with DOCSIS modem, all with PVR. STM claims that this chip allows for an implementation of a 1-W standby (i.e. "enhanced power management further extends the STi7105's low-

213 Giuseppe Calarco, *Stromsparender HF-Tuner für Fernseher und Settop-Boxen,* www.elektroniknet.de/home/bauelemente/fachwissen/uebersicht/aktive-bauelemente/konsumelektronik-ics/stromsparender-hf-tuner-fuer-fernseher-und-settop-boxen/

power credentials, helping end products to meet power-saving initiatives such as the International Energy Authority's 1W Plan")[214].

Already in January 2008, ST Microelectronics announced a chip (STi7111) with an implemented power management system which monitors the activity of the SoC and dynamically configures the system clocks to run at reduced rates, i.e. lowering power consumption while maintaining system performance[215].

6.2.6. Modem ASICs

Cable modem ASICs[216] are likely to merge with the main STB processor for next generation silicon. This will be relevant for the STB mass market only after 2012. This will lead to a leaner BOM, i.e. eliminate additional memory and some of the passive components. One industry expert estimated resulting power savings in the range of up to 0.5 W in on mode and active standby – at decreasing manufacturing costs.

6.2.7. Modem standby

A strategy for "low power at low traffic" or automatic turn down, when no information is exchanged through the network, could remarkably lower power consumption of STBs with return paths, as the modems are among the most energy consuming components in STBs in standby (5 W and more per unit).

Implementation of such power saving modes for the modem essentially needs a support by the communication standards used for the network interaction, i.e. DOCSIS / EURODOCSIS in the case of cable modems[217] and DSL / ADSL typically for triple play boxes / IPTV.

- EURODOCSIS: Currently, this standard (developed by the US-based Cable Labs) does not support reduction in clock speeds or to turn of unused channels, i.e. an amendment of the standard would be needed, which essentially takes at least 3 years. .
- DSL / ADSL: The ADSL2 and ADSL2+ standards do support power saving modes L2 and L3 (see Table 6-4), and all ADSL terminal units (ATU) shall support these modes, according to the ITU-T recommendation G.992.3. However, these are meant to allow for a power management of the ATU at central office and related servers / routers. ADSL modems might or might not turn into power savings modes in L2 and L3 states as well. There are ADSL modems on the market (e.g. Fritz!Box), which turn into a power saving mode with reduced data transfer in L2 state as well – in case this feature is enabled by the user. The Eco-Mode of the Fritz!Box according to AVM saves approx. 1 W.

214 STMicroelectronics Boosts Performance and Value for High-Definition Set-Top Boxes, with Next-Generation Decoder IC, Geneva, September 12, 2008 www.st.com/stonline/stappl/cms/press/news/year2008/p2319.htm

215 STMicroelectronics Announces High-Definition Set-Top-Box Decoder with Integrated Demodulator, January 22, 2008, www.ferret.com.au

216 ASIC: Application Specific Integrated Circuit

217 Currently power management is not supported by (EURO)DOCSIS

Table 6-4: ADSL power management states (ITU-T Rec. G.992.3, 01/2005)

State	Name	Description
L0	Full On	The ADSL link is fully functional.
L2	Low Power	The ADSL link is active, but a low-power signal conveying background data is sent from the ATU-C (ADSL terminal unit at central office end) to the ATU-R (ADSL terminal unit at remote terminal end). A normal data carrying signal is transmitted from the ATU-R to the ATU-C.
L3	Idle	There is no signal transmitted on the line. The ATU may be powered or unpowered in L3.

6.2.8. Power circuitry

Improved power designs, feature:

- (Internal or external) Power supplies with efficiencies above 80%,
- Reduction of voltage levels,
- Internal switch mode DC/DC instead of linear regulation for DC/DC conversion.

According to industry experts, these are already implemented in the majority of STBs.

6.2.8.1 High efficiency switch mode power supplies

Until a couple of years ago, power supply units for STBs were typically of linear design. In the meantime, for cost and performance reasons, switch mode power supplies gained ground and have become standard technology.

EPCOS published a power supply reference design for STBs for Century do Brasil, based on a joint development of EPCOS and ST Microelectronics, which achieves approximately 80% efficiency[218] (rated output power 11 W), see Figure 6-7.

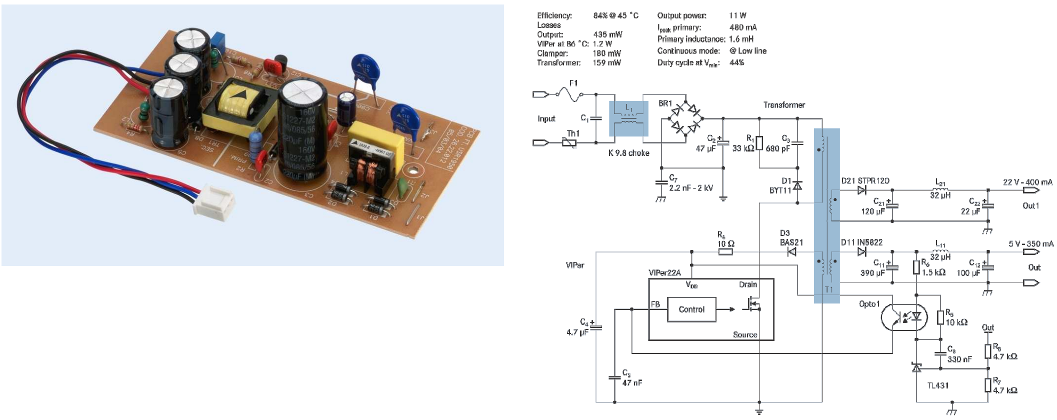

Figure 6-7: Switch mode power supply (reference design by EPCOS, STM)

218 Epcos, *Referenzdesign für SMPS, Set-Top-Box ohne Blackout in Brasilien,* January 2007, www.epcos.de/web/generator/Web/Sections/Components/Page,locale=nn,r=263282,a=372582.html

Table 6-5 lists external AC-DC power supplies (EPS), which have the highest average efficiencies in their power range, based on the Energy Star database. Efficiencies significantly above 80% and partly even above 85%[219] are achievable with BATs, at low no-load losses, which are of minor relevancy for STBs.

Table 6-5: Selected EPS with high efficiency and low no-load losses[220]

Company Name	Model	Nameplate DC Output Power (W)	No Load Input Power (W)	Average Active Efficiency (%)
Acbel Polytech Inc.	WA8077	4.2	0.09	73%
Leader Electronics, Inc.	MV12-4120050-C5	6	0.11	79%
Hitron Electronics Corporation	HEG06-S120050	6	0.156	81%
Leader Electronics, Inc.	MV12-Y090100-C5	9	0.12	84%
Total Power International	TPLG10-090110-1	9.9	0.1	86%
Hitron Electronics Corporation	HEG10-900110-1	9.9	0.15	88%
Leader Electronics, Inc.	MV12-D120100-C5	12	0.11	85%
Leader Electronics, Inc.	MU17-1180090-A1	16.2	0.24	87%
Leader Electronics, Inc.	MV18-4150120-C5	18	0.14	85%
XP Power	AEL20US30	20	0.40	86%

Modern switch-mode power supplies for STBs use quasi-resonant switching circuitries, improving the efficiency as well as reduced input filtering efforts.

One of the leading semiconductor manufacturers in the STB power segment stated: "In the given range of 8...38 W, it is relatively easy to achieve 85% [average efficiency]. At low load (or no load) the power supply will go into 'Pulse Frequency Mode'[...] where the supply will wake up for a short time, load the output capacitor, and go back to sleep. The average consumption is low, but when the capacitor is being charged the power supply works at good efficiency."

219 85% efficiency refers to the power circuitry, i.e. is the relevant figure for internal power supplies; with external power supplies the additional losses of the 12 V cable have to be taken into account, which might reduce efficiency by 2% (depending on cable length and diameter)

220 At 230 V, 50 Hz, source: Energy Star database, August 27, 2008

According to a retail STB manufacturer, their STBs already achieve a total energy efficiency of the power circuitry of more than 90%, at higher production costs, which, due to fierce competition, does not result in higher product prices.

One of the pay-TV providers stated, that today they specify power supplies at 80%efficiency as a minimum.

6.2.8.2 3.3 Volts architecture

Lowering the supply voltage for certain components of the STBs means power savings, see for example the tuner IC above. Similarly there is a change currently from 5 V to 3.3 V supply voltage for the smart cards. However, as the smart cards' power consumption is in the range of milliwatts only, the resulting savings are minor, but current system architectures require the smart card to be powered constantly (for receiving broadcast entitlement management messages and system service requests). Power savings might be in the range of 20mW for the smart card when comparing to a 5 V architecture with 3.3 V supply voltage, meaning 175 Wh per year for a constantly powered smart card.

6.2.9. Low Energy LNB Solutions

Some low LNB solutions exist for DVB-S STBs. For more details, please see the EuP Preparatory Study on Simple Set-top Boxes[221] - § 6.5.5

6.2.10. Power management

6.2.10.1 Power down components

Approaches to limit power consumption of components, which are not in use, comprise[222]:

- Powering down tuners when not in use
- Powering down home connectivity when not in use
- Powering down blocks within SoC when not in use
- Powering down advanced codecs processing blocks on silicon, when only standard definition broadcasts are received / viewed

Such features go hand-in-hand with silicon improvements (see above), which are in the pipeline. Actually, implementation results in a split of the on mode in various power levels, depending on which components remain active and which are powered down. These effects can hardly be quantified as this depends on a very distinct use pattern profile.

Implementation of a power management actually requires a joint undertaking of the STB hardware supplier, silicon supplier, middleware and application software provider, and the conditional access / service provider.

221 *Final Report EuP Preparatory Study Simple Digital TV converters* (Simple Set-top Boxes), 2007

222 D. Clark, *How to improve the efficiency of complex STB*, International Workshop on Energy Efficient Set-Top Boxes & Digital Networks, IEA, Paris, July 4-5, 2007

6.2.10.2 Middleware

Middleware is one of the key components to enable power management: whatever is implemented in the silicon as options to power down segments and components when not in use needs to be supported by the middleware.

Middleware provider NDS announced as a feedback to the experts' survey, that the NDS Mediahighway Ultra middleware, available in 2009, will support a couple of more sophisticated power management options without detrimental impacts on manufacturing costs, at least by 2012. According to NDS claims, these power management features might result in active standby power consumption reduction of 3 W or more.

However, one pay-TV provider pointed out, that middleware adaptations to support sophisticated power management come with significant investment throughout the design, development, manufacturing and testing chain.

There are also companies working on proprietary middleware solutions to implement power management features.

6.2.10.3 Automatic Power Down

There are complex STBs on the market, which automatically drop from on mode into standby under certain conditions: introduced in March 2007, most Sky+ PVR STB's and all HD boxes have implemented this feature. Complex STBs specified by BSkyB drop into standby after 11 p.m. (feature is active until 3:30 a.m.) if there is no user activity for 2 hours (see message, which is displayed on the screen, in Figure 6-8), until the customer turns it back on.

Figure 6-8: Sky+ auto-standby screen message

BSkyB claims that with more than 4 million STBs equipped with this power-down feature UK customers save 12 million GBP annually[223], which equals roughly € 3.80, and 30 kWh[224] per STB per year. According to BSkyB, this feature does not affect the manufacturing cost but requires a significant investment in development and testing.

223 BSkyB www.jointhebiggerpicture.com/EnvironmentHome/Environment/WhatsSkydoing/SkyProducts/SkyAutoStandby.aspx

224 Average UK electricity costs: 13,16 Euro/100 kWh, see Task 2

6.3. SUBTASK 6.3 - STATE-OF-THE-ART OF BEST EXISTING PRODUCT TECHNOLOGY OUTSIDE THE EU

As the consumer electronics business is a global market, there are rarely any additional BAT technologies available outside the EU, which are not already covered by the above analysis.

- **Prototype IPTV set-top box with a standby passive mode of approx. 3 Watts**

At the April 2008 Code of Conduct meeting, Motorola and Swisscom presented the plan to develop a prototype of an IPTV STB with a standby passive mode of approximately 3 Watts.[225] This concept is based on the perception that the components needed for networking (internet connection remains and software – SOC, memory, etc. – keep running) use approximately 3 Watts. Motorola and Swisscom see possibilities to drastically reduce the power consumption of the other components in the STB by 2009. A detailed evaluation of the required hardware and software changes and impacts for the customer still needs to be done. This project, supported by the Swiss Federal Office of Energy, will also investigate the possibility of a Wake-on-LAN-function which would allow a standby active mode.

According to Motorola and Swisscom, to achieve 2 Watts for an IPTV STB by 2012, a basic redesign of the chipsets will be needed.

- **CableLabs (US): CableCARD**

CableLabs defined a Conditional Access System device (CableCARD™) that removes the security component of a system from digital STBs and sets it into an external Personal Computer Memory Card (PCMCIA)[226,227]. In case a complex STB, it is intended *only* to provide the decryption / entitlement system, this box could be fully replaced by such a card, if the TV set has a PCMCIA slot. Consequently, there would be no STB power consumption, but the TV set might need to remain in a networked standby to allow for a constant integrity monitoring. The most likely use scenario however, is that such a CableCard is used with a STB nevertheless, due to additional STB features.

Two types of Cable Cards are specified:

- S-Card: single stream; typically used in unidirectional devices, supports the FCC Plug and Play mandate
- M-Card: multi stream; bi-directional device

The power consumption is stated to be:

- 2.5 W maximum average power consumption for combination S-Card / M-Card device
- 1.5 W maximum average power consumption for M-Card only device

225 R. Brueniger: Common position of Swisscom and Motorola towards Draft 8 of the Code of Conduct on Digital TV Services, April 29, 2008, Ispra

226 C. Stone, *How to improve the efficiency of complex STB*, International Workshop on Energy Efficient Set-Top Boxes & Digital Networks, IEA, Paris, July 4-5, 2007

227 CableLabs: OpenCable™ — CableCARD™ Primer, www.opencable.com/primer/cablecard_primer.html

CableCom (CH): 1-W-standby

Swiss CableCom announced for 2009 the introduction of power saving complex STBs with the following features[228]:

- Automatic power down from on mode to standby
- Maximum 1 W power consumption in standby
- Hard-off switch

As CableCom is a UPC / Liberty Global company this announcement largely corresponds with the planning of a "cold standby" as outlined in 6.1.2.1.

Astound Broadband (US): Power Save Mode

Astound, a US triple play service provider implemented a user-customisable power save mode and gives customer instructions as follows[229]**:**

*"To maximise the life of your DVR, you should power-down the DVR when it is not in use. Simply press **CLB** and then press **Power** on your remote control, or press **Power** on the front panel of the DVR. The power light turns off, but because the DVR is still plugged in, your scheduled recordings still occur.*

Between 1:00 a.m. and 6:00 a.m. every day, your DVR will automatically enter Power-Save mode. In Power-Save mode, the cable box is powered down, but all scheduled recordings still occur. When the DVR enters Power-Save mode, your TV displays a black screen.

At approximately 1:10 a.m., the DVR displays a 5-minute warning banner, which states that the DVR is about to enter Power-Save mode. When the banner appears, do one of the following:

- *To allow the DVR to enter Power-Save mode, do nothing when the warning banner appears. The DVR will automatically power down. After your DVR powers down, you must press CBL and then press Power on your remote control, or press Power on the front panel of your DVR to start watching TV again.*
- *To stop the DVR from entering Power-Save mode, simply press any key on your remote control when the warning banner appears.*

From 1:10 a.m. until 6:00 a.m., the DVR presents the warning banner after every 2 hours of inactivity (no remote control presses)."

228 Cablecom: Cablecom lanciert Internetangebot mit über 100 Mbit/s Download und eine interaktive TV-Plattform - Neue energiesparende Set-Top-Boxen ab Anfang 2009 erwartet, press release, Zürich, August 26, 2008

229 astound.net/index.php?option=content&task=view&id=247

6.4. CONCLUSIONS FOR TASK 6

There are some technology developments, which have the potential to contribute to power savings of complex STBs in general. Being asked about the potential of certain measures, technology experts from industry gave the following answers[230].

- Question: In summary, where do you see the highest potential (technology progress, potential efficiency gains) for power savings in complex STBs? (mid-term future, i.e. coming 5 years) (Table 6-6)

Table 6-6: Improvement options for complex STBs

Option	Your statement: improvement potential[231]			
	high	moderate	low / no	don't know
(1) Improved HDD	●	●●●●●●	●	
(2) Solid state disk / Flash memory (instead of HDD)	●●		●●●●●	●
(3) System on Chip (SoC) improvements	●	●●●●●	●●	
(4) Silicon tuner		●●●	●●●●	●
(5) Improved modem technology (return path)		●●	●●●●	●●
(6) Improved power design	●●	●●	●●●●	
(7) Power management / middleware	●●●●●	●●●		
(8) Maximise use of passive standby / EPG with energy management option	●	●		
(9) Changes in broadcasters system / headend operation		●		
(10) Smart card: 3.3 V architecture			●	

It is evident that software aspects are assigned the highest improvement potential. Improved silicon (SoC) is assumed to have at least a moderate potential.

Modem technology and solid state disks are rather not likely to result in significant power savings, mainly due to the time frame of the question (SSD for STBs rather not available at reasonable costs within coming 5 years, DOCSIS modems power savings in standby would require a fundamental revision of the DOCSIS standard).

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230 Based on the public stakeholder questionnaire, published at the EuP lot 18 project website; in total 6 experts / companies replied to this question

231 Every dot represents an answer, in total 8 companies replied to this question. Entries (9) to (11) are free field entries by individual experts.

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7. Task 7 - Improvement Potential

Task 7 consists of identifying the design improvement options, quantifying the influence they can have on reducing environmental impacts, and monetising them in terms of Life Cycle Costs (LCC) for the consumer. Finally, one or more solutions of Best Available Technology (BAT) and with Least Life Cycle Cost (LLCC) are identified.

Key technical improvement options are identified on the basis of technology development and research presented under Task 6. Such options discussed, listing their environmental improvement potential, feasibility for different types of set-top boxes (STBs), and associated costs.

7.1. SUBTASK 7.1 – OPTIONS

The following general improvement options are derived from the technical analysis presented in Task 6. Assumptions for calculating improvements are also discussed for each option.

7.1.1. Power Management Options

7.1.1.1 Low Power Standby Mode

Implementation of a low power standby mode as outlined in § 6.1.2 could lead to significant power savings in standby mode, but also with an impact on convenience for the user: such low power standby mode may not be suitable for all users and therefore typically can be disabled by the consumer. This fact makes actual use of this feature hardly predictable – and depends on:

- Acceptance of loss of functionalities while in off mode
- Delay / boot times from low power standby to full operational mode
- Menu support for changing settings

This option is defined as follows:

- 1 W power consumption in this low power standby mode
    - Variant 1:
        - 30 min wake-up interval
        - 80% of all users do not disable this default mode (estimate only), i.e. 80% of STBs are in low power standby for 11.5 h/day (w/o internal mass storage media) and 10.28 h/day (with internal mass storage media) respectively (see 6.1.2.3)
    - Variant 2:
        - 2 hours wake-up interval

  - 80% of all users d-o not disable this default mode (estimate only), i.e. 80% of STBs are for 13.26 h/day (w/o internal mass storage media) and 11.84 h/day (with internal mass storage media) respectively in low power standby (see 6.1.2.3)
- € 5 product price adder (upper limit of industry estimates)

7.1.1.2 Disabling functions

There exist some hypothetical possibilities to disable certain functions to save energy, for example:

- Disable rewind functionality
- Disable instant pause232
- Disable automatic recording of frequently watched programmes

Disabling the rewind functionality by the user allows the HDD to be turned off and to save HDD power in on mode. Potential use of such a power savings feature by the user is highly unpredictable as in the case of other power management features discussed above.

For the analysis purpose, this option is evaluated separately as it is different from the other, more technical options: disabling certain functions may inevitably hamper a functionality of the STB, which, according to discussions at the stakeholder meeting, should not be tackled by regulation. However, for users who want to have a PVR STB but are sure never to use rewind or pause, this optional setting might be useful. It is worth noticing that there are retail STB PVR manufacturers, which do not provide a default rewind and instant pause functionality.

This option is defined as follows:

- 3 W power consumption reduction in on mode for Base Cases (BC) with internal mass storage media (i.e. 2, 3, 5, and 6).
- HDD disabled (any of the above functionalities disabled) for 20% of on mode times233
- € 1 product price adder (HDD / middleware adaption only, not for e.g. a hybrid solution with SSD for short-term recordings)

7.1.1.3 Automatic Power Down

The Automatic Power Down (APD) as implemented by BSkyB (see Task 6, § 6.2.11.3) means an average power consumption reduction of 82 Wh per STB and day[234].

This option is defined as follows:

232 Instant pause requires an always active hard disk drive (if not a hybrid solution), but to interrupt / pause a programme with a delay of a couple of seconds is possible, if the HDD has to be activated first

233 20% are only an estimate, not based on any further evidence as no data on possible user acceptance is available

234 30 kWh/a stated savings per box divided by 365 days; obviously the 30 kWh/a savings statement is based on much longer on mode times than used for this study

- On mode times down from 9 to 4.5 h/d for complex STBs w/o internal mass storage media
- On mode times down from 10.5 to 6 h/d for complex STBs with internal mass storage media
- For combination of options with an implemented low power standby mode, it is assumed that times deducted from on mode will be spent in this low power standby mode
- Negligible changes in STB price

7.1.1.4 Modem standby

Modems might enter a networked standby mode at low traffic, if supported by the communication standards, which is currently the case for ADSL but not for EURODOCSIS. Consequently, as a horizontal option for STBs with return path, this is an option has a potential only mid-term (> 3 years from initiating an adaptation of DOCSIS).

This option is defined as follows:

- "Return path functionality STBs" power consumption +6 W instead of +10 W in active standby for 80% of the active standby times (20% allowance for transition phases)
- This results in 3.2 W lower standby power consumption for the "modem standby only option" and 3.0 W lower standby power consumption for the combined option with high efficiency power supply (see below), as this reduces the effect of a modem standby
- Negligible product price change

7.1.1.5 Power down components

Some measures are under discussion to reduce power consumption in on mode by switching off unused components, circuitry blocks, interfaces (see Task 6, § 6.2.11.1), and a dynamic voltage scaling and adjustment of system clocks (see Task 6, § 6.2.5). The actual effect of such measures is highly dependent on the distinct use patterns (i.e. which parts of the STB are in use and for how long). The effect is larger for more complex STBs: the more features are provided; the higher is the likelihood that not all of them used. Explicitly, this does not include powering down the HDD (which is assumed to be already the status-quo) nor the return path.

Cost implications are assumed to be minor as such features are likely to become standard with next generation silicon.

This option is defined with the following assumptions:

- Reduction of average power consumption in on mode between 1 and 3 W, depending on the configuration: - 1 W in on mode for Base Case 1 and 2; - 2 W in on mode for Base Cases 3, 4, and 5; - 3 W in on mode for Base Case 6
- € 1 product price adder

- In the light of possible minimum requirements, the on mode values adopted for the calculation of this option are not maximum values, but an assumed average of various distinct on mode levels.

7.1.2. Modem ASICs

Deriving from industry sources, this option is defined as follows:

- Power savings of 0.5 W in on mode and standby for all return path STBs
- Negligible product price changes

7.1.3. Front Panel Hard-off switch

The actual effect of implementing a zero-Watt hard-off switch depends on following factors:

- User awareness
- User acceptance, which depends on:
    - loss of functionalities while in off mode
    - risk of damage (e.g. to a hard disk drive)
    - convenience, i.e. delay / boot times from hard-off to full operational mode

There is no evidence regarding the likeliness to which extend users might use a hard-off switch: for STBs with HDD to be used for scheduled recordings, the use of a hard-off switch is less likely; same is the case for STBs providing additional "always-on" functionalities, such as VoIP. In such cases, the STB might be switched-off during holiday absence (unless answering machine functionality is provided). This option is defined as follows:

- Same off mode times assumed as with the Base Cases, but at 0 W
- Hard-off switch BOM added
- € 2 product price adder

7.1.4. High Efficiency Power Supply

State-of-the-art power supply units and circuitries for the power range of STBs might achieve 85% efficiency, which means a 6% power consumption reduction in on mode and standby compared to 80% efficiency units[235].

Although a manufacturer stated that such efficiency is "relatively easy to achieve", this option is defined with a conservative estimate of € 2 product price adder, which might

235 For STBs with external power supplies, an increase of the power circuitry efficiency from 80 to 85% taking into account actually additional power losses of the 12 V cable would mean an EPS efficiency increase from roughly 78% to 83% - but the relative power consumption savings of 6% are the same

hold true in the initial phase of introduction of such high efficient power supplies, but will see a significant price drop soon after due to economies of scale.

7.1.5. Good Design Practice: Next Generation Silicon

7.1.5.1 General

"Good design practice" comprises miscellaneous measures to reduce power consumption among them:

- High efficient components
- SoC improvements (beyond power management options)
- Low voltage architecture

Such measures are assumed to reduce (maximum) on mode and standby power consumption.

In addition, there already exist "basic" complex STBs on the market, which are measured 2 W and more below the Base Case 1 value of 10 W in on mode and 5 W in active standby mode (see values in Task 6, Table 6-2). These STBs are in the same price segment as others with higher power consumption, and have similar functionality. Consequently, it is assumed that these values are achievable at negligible cost changes.

This option is defined as follows:

- 2 W power reduction in on mode and standby mode for all Base Cases
- Negligible product price changes

7.1.5.2 High Definition / Advanced Codecs

Specifically for HD STBs, there is a higher improvement potential as observed power consumption in active standby of the HD functionality is the same as for on mode. Statements by industry experts regarding this aspect are as follows:

- "The HD increment in standby is likely to decrease with next generation silicon. (...) Currently available silicon does not support power reductions in standby, we would expect that future silicon will switch off more unused circuit blocks, including HD decoders. However it may be more complex to also switch off the associated extra memory."
- "No [there is no technical reason for an explicitly high power consumption of HD functionality STBs in standby], since in standby no comprehensive signal processing takes place. The only reason for such behaviour could be that for active mode HD, more processor power is required, so more powerful Digital Signal Processors (DSP) are used, and if they are also used for standby they will show higher consumption although their processing power is not needed."
- "In active standby it is possible to decrease energy by disabling audio video interfaces as well as internal video decoding. Unfortunately, due to the fact that the video decoding is generally embedded in the global architecture it is not possible to really electrically switch-off the not used part, and the

remaining energy losses are not negligible with existing new thin technologies (leakage currents). Better efficiency of the power management of SoC might be expected with the introduction of 'power islands' aiming to electrically switch-off some parts of the ICs, but this will not occur before 3-4 years."

- For a contrary statement see the remarks regarding the operating system explained under § 6.1.2.2

It is assumed, that for HD STBs, the added power consumption of +8 W in active standby can be reduced to +3 W by 2012 (i.e. relevant for Base Cases 4, 5, 6), if delay times for transition from standby to on mode can be realised on an acceptable level.

This option alone also requires a joint undertaking of silicon, middleware, service providers and STB manufacturers, but is assumed to be less comprehensive than implementation of a general low power standby mode for the whole STB. A conservative estimate is a € 3 product price increase for implementation of this option.

7.1.6. HARD DISK DRIVE

State-of-the-art 3.5" HDDs for consumer electronics achieve 4.7 W in on mode (read/write) today. Taking into account typical power supply losses this means a power consumption of 5.5 W. This option is calculated as follows:

- 2.5 W power reduction in on mode (down to "+5.5 W" from "+8 W" for the HDD feature)
- Negligible product price changes

State-of-the-art 2.5" HDDs (up to 320 GB) for consumer electronics achieve less than 2 W in on mode (read/write) today. Taking into account typical power supply losses this means a power consumption of 2.5 W. This option is defined as follows:

- 5.5 W power reduction in on mode (down to "+2.5 W" from "+8 W" for the HDD feature)[236]
- 15 € product price adder (perspective: 2010; 20 € as of today, compared to 3.5" HDDs of same – medium range - capacity)

7.1.7. SOLID STATE DISK

The SSD option is not expected to be a viable alternative to HDD in the short- to mid-term. As a long-term option (provided technical obstacles, such as the number of read/write cycles, are solved in the long run), this is defined as follows:

- 3 W power reduction in on mode for all Base Cases with internal mass storage media

[236] For the calculation of combination of improvement options, the implementation of a state-of-the-art 2.5" HDD is taken into account with a further power consumption reduction of 2 W in on mode on top of all previous improvements

- BOM: Platters and mechanics replaced by 5 g large ICs (memory) and 10 g printed circuit board substrate (additional footprint)
- € 100 product price adder (2015 outlook; high uncertainty; depends on storage capacity; only trend is relevant for this analysis – and the trend is clear: much higher than HDD and therefore in no way subject to possible minimum requirements)

7.1.8. Design for Recyclability

A Design for Recyclability as outlined in Task 6, § 6.1.1 ("no-screw-design") is only feasible for safety reasons for complex STBs with external power supplies. Although with reduced power consumption in the future, external power supplies might become an economic option for more STB market segments, as of today this is relevant only for Base Case 1 ("basic" complex STB with SD).

The main adverse effect of requiring a Design for Recyclability is that the appearance of the STB might be less attractive with non-coated front plastic parts.

As demonstrated by the (rather "low cost") sample STB analysed in § 6.1.1, such a Design for Recyclability can be assumed not to add to manufacturing costs, but rather vice versa as also the assembly becomes easier, and additional coatings for the plastics can be avoided.

This option is defined as follows:

- High plastics recovery scenario with 90% material recovery and 9% thermal for Base Case 1

In principle, this option can be combined with the hard-off switch option, but requires the hard-off switch to be placed on the primary side of the external power supply.

7.1.9. Slim Design

A highly miniaturised design currently is represented only in the upper market segment. The archetype of a slim STB as outlined in Task 6, § 6.1.1 is in principle an option for Base Cases 2, 3, 4, 5 and 6. For calculating the option, power consumption will remain unchanged, purchase price is estimated at € 400 for SD STBs and € 450 for HD STBs, which reflects the market situation as of today, and a significant drop in costs are expected mid-term (economy of scale), but will remain more costly than conventional design even within the next 5-8 years. Consequently this option does not qualify for lowering life cycle costs.

7.1.10. Overview of Improvement Options

An overview of the applicability of different Base Cases is provided in Table 7-1.The number of options per Base Case is between 7 and 12. In principle, a combination of all applicable options per Base Case is possible, but this means for e.g. Base Case 6 with 13 individual options several hundreds of possible combinations of options. An alternative approach is used: all options are calculated individually (1, 2, 3, etc.), plus an add-on scenario where consecutively – as required by the MEEuP methodology – options are added one by one (1, 1+3, 1+3+4, etc.[237]).

Table 7-1: Improvement options per Base Case

Base Cases / Product Case	Option															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Low power standby mode (1W): 30 min wake-up interval	Low power standby mode (1W): 2 h wake-up interval	APD	Power down components	3.5" State-of-the-art HDD	85% Power supply efficiency	Good design practice: General	Good design practice: General + HD	Modem ASICs	Modem standby	Hard-off switch	2.5" State-of-the-art HDD	Solid state disk	Design for Recyclability	Slim design	Disable functionalities
(1) "basic" complex STB with SD	•	•	•	•		•	•				•			•		
(2) complex STB with SD, HDD	•	•	•	•	•	•	•				•	•	•		•	•
(3) complex STB with SD, HDD, second tuner, return path	•	•	•	•	•	•	•		•	•	•	•	•		•	•
(4) "basic" complex STB with HD	•	•	•	•		•	•	•			•				•	
(5) complex STB with HD, HDD	•	•	•	•	•	•	•	•			•	•	•		•	•
(6) complex STB with HD, HDD, second tuner, return path	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•
(7) triple play box						•	•		•	•	•			•		

7.2. SUBTASK 7.2 – ENVIRONMENTAL IMPACTS

The reduction in the environmental impacts by implementing various improvement options (individual options) to average EU products (Base Case) are calculated using

[237] Note: 1+2 is not an option

the EcoReport tool and results are listed for each Base Case in the following sub-sections.

The analysis of the results is provided later in § 7.4.

For the triple play box, Task 5 analysed a Product Case (PC) (i.e. sample product) and in this section, the improvement potential is also analysed in comparison to this Product Case.

7.2.1. BASE CASE 1: "BASIC" COMPLEX STB WITH SD

Table 7-2 shows the results of the environmental impact calculation for Base Case 1 (without any improvement option) and for Base Case 1 to which each individual options 1, 2, 3, 4, 6, 7, 11, and 14 are implemented separately.

Table 7-2: Improvements for Base Case 1 (one product, full life cycle)

	Base Case 1		Option								
	Other Resources & Waste		BC	1	2	3	4	6	7	11	14
8	Total Energy (GER)	MJ	2918	2391	2283	2573	2780	2767	2190	2916	2915
9	of which, electricity (in primary MJ)	MJ	2599	2072	1964	2254	2461	2449	1871	2596	2599
10	Water (process)	ltr	302	267	260	279	293	292	254	302	302
11	Water (cooling)	ltr	6807	5401	5113	5887	6439	6405	4864	6799	6803
12	Waste, non-haz./ landfill	g	9866	9254	9129	9466	9706	9691	9021	9867	9864
13	Waste, hazardous/ incinerated	g	689	677	674	681	686	685	672	697	506
	Emissions (Air)										
14	Greenhouse Gases in GWP100	kg CO2 eq.	137	114	109	122	131	131	105	137	137
15	Ozone Depletion, emissions	mg R-11 eq.									
16	Acidification, emissions	g SO2 eq.	837	701	673	748	801	798	649	836	836
17	Volatile Organic Compounds (VOC)	g	3	3	3	3	3	3	3	3	3
18	Persistent Organic Pollutants (POP)	ng i-Teq	33	30	29	31	32	32	28	33	33
19	Heavy Metals	mg Ni eq.	207	198	196	201	204	204	194	207	204
	PAHs	mg Ni eq.	27	26	25	26	26	26	25	27	27
20	Particulate Matter (PM, dust)	g	122	119	118	120	121	121	118	123	112
	Emissions (Water)										
21	Heavy Metals	mg Hg/20	124	121	120	122	124	123	120	124	123
22	Eutrophication	g PO4	4	4	4	4	4	4	4	4	4
23	Persistent Organic Pollutants (POP)	ng i-Teq									

7.2.2. BASE CASE 2: COMPLEX STB WITH SD AND HDD

Table 7-3 shows the results of the environmental impact calculation for Base Case 2 (without any improvement option) and for Base Case 2 to which each individual options 1, 2, 3, 4, 5, 6, 7, 11, 12, 13, 15 and 16 are implemented separately.

Table 7-3: Improvements per Environmental Unit Indicator for Base Case 2 (one product, full life cycle)

	Base Case 2		Option												
	Other Resources & Waste		BC	1	2	3	4	5	6	7	11	12	13	15	16
8	Total Energy (GER)	MJ	5010	4266	4147	4251	4849	4607	4750	4277	5009	4052	4544	4686	4878
9	of which, electricity (in primary MJ)	MJ	4469	3726	3606	3710	4308	4067	4209	3737	4467	3568	4005	4434	4374
10	Water (process)	ltr	491	442	434	441	480	464	474	442	491	425	488	432	499
11	Water (cooling)	ltr	11721	9739	9421	9698	11292	10648	11028	9769	11718	9355	10433	11633	11466
12	Waste, non-haz./ landfill	g	22289	21427	21289	21409	22102	21822	21988	21440	22292	12772	14174	31906	21549
13	Waste, hazardous/ incinerated	g	1183	1166	1163	1165	1179	1174	1177	1166	1191	1144	1190	669	1181
	Emissions (Air)														
14	Greenhouse Gases in GWP100	kg CO2 eq.	234	201	196	201	227	216	222	202	234	191	214	212	228
15	Ozone Depletion, emissions	mg R-11 eq.													
16	Acidification, emissions	g SO2 eq.	1426	1235	1204	1231	1385	1323	1359	1238	1426	1175	1316	1265	1396
17	Volatile Organic Compounds (VOC)	g	5	5	5	5	5	5	5	5	5	5	6	4	5
18	Persistent Organic Pollutants (POP)	ng i-Teq	63	58	57	58	62	60	61	58	63	50	59	41	57
19	Heavy Metals	mg Ni eq.	332	319	317	319	329	325	327	319	332	311	325	168	357
	PAHs	mg Ni eq.	72	70	70	70	71	71	71	70	72	50	70	29	50
20	Particulate Matter (PM, dust)	g	215	211	210	211	214	213	214	211	216	196	212	107	215
	Emissions (Water)														
21	Heavy Metals	mg Hg/20	194	190	189	190	193	192	193	190	194	177	210	103	202
22	Eutrophication	g PO4	7	7	7	7	7	7	7	7	7	6	7	4	7
23	Persistent Organic Pollutants (POP)	ng i-Teq													

7.2.3. Base Case 3: complex STB with SD, HDD, second tuner, return path

Table 7-4 and Table 7-5 show the results of the environmental impact calculation for Base Case 3 (without any improvement option) and for Base Case 3 to which each individual options 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 15 and 16 are implemented separately.

Table 7-4: Improvements per Environmental Unit Indicator for Base Case 3 (one product, full life cycle) (Options 1, 2, 3, 4, 5, 6 and 7)

	Base Case 3		Option							
	Other Resources & Waste		BC	1	2	3	4	5	6	7
8	Total Energy (GER)	MJ	9680	7575	7236	8646	9358	9278	4646	8948
9	of which, electricity (in primary MJ)	MJ	9140	7034	6695	8105	8818	8737	4106	8408
10	Water (process)	ltr	802	662	640	733	781	776	467	754
11	Water (cooling)	ltr	24177	18561	17658	21417	23318	23103	10752	22224
12	Waste, non-haz./ landfill	g	27704	25263	24870	26505	27331	27238	21868	26856
13	Waste, hazardous/ incinerated	g	1291	1242	1234	1267	1283	1281	1175	1274
			0	0	0	0	0	0	0	0
	Emissions (Air)		0	0	0	0	0	0	0	0
14	Greenhouse Gases in GWP100	kg CO2 eq.	438	346	331	392	424	420	218	406
15	Ozone Depletion, emissions	mg R-11 eq.	0	0	0	0	0	0	0	0
16	Acidification, emissions	g SO2 eq.	2629	2087	2000	2363	2546	2526	1333	2441
17	Volatile Organic Compounds (VOC)	g	7	6	6	7	7	7	5	7
18	Persistent Organic Pollutants (POP)	ng i-Teq	93	80	77	87	91	91	60	89
19	Heavy Metals	mg Ni eq.	412	376	370	394	406	405	325	399
	PAHs	mg Ni eq.	81	77	76	79	80	80	71	79
20	Particulate Matter (PM, dust)	g	241	229	227	235	239	238	213	237
			0	0	0	0	0	0	0	0
	Emissions (Water)		0	0	0	0	0	0	0	0
21	Heavy Metals	mg Hg/20	225	211	209	218	222	222	192	220
22	Eutrophication	g PO4	7	7	7	7	7	7	7	7
23	Persistent Organic Pollutants (POP)	ng i-Teq								

Table 7-5: Improvements per Environmental Unit Indicator for Base Case 3 (one product, full life cycle) (Options 9, 10, 11, 12, 13, 15 and 16)

Base Case 3

	Other Resources & Waste		9	10	11	12	13	15	16
8	Total Energy (GER)	MJ	9497	9024	9680	8723	9215	9357	9548
9	of which, electricity (in primary MJ)	MJ	8957	8483	9138	8239	8676	9104	9044
10	Water (process)	ltr	790	759	802	737	799	744	810
11	Water (cooling)	ltr	23688	22426	24173	21810	22888	24088	23921
12	Waste, non-haz./ landfill	g	27492	26943	27708	18196	19589	37322	26964
13	Waste, hazardous/ incinerated	g	1286	1275	1299	1252	1298	777	1288
			0	0	0	0	0	0	0
	Emissions (Air)		0	0	0	0	0	0	0
14	Greenhouse Gases in GWP100	kg CO2 eq.	430	409	438	394	418	416	432
15	Ozone Depletion, emissions	mg R-11 eq.	0	0	0	0	0	0	0
16	Acidification, emissions	g SO2 eq.	2582	2460	2629	2377	2519	2468	2599
17	Volatile Organic Compounds (VOC)	g	7	7	7	7	7	5	7
18	Persistent Organic Pollutants (POP)	ng i-Teq	92	89	93	81	90	72	87
19	Heavy Metals	mg Ni eq.	409	401	412	391	405	248	437
	PAHs	mg Ni eq.	80	79	81	59	79	38	59
20	Particulate Matter (PM, dust)	g	240	237	242	222	238	132	241
			0	0	0	0	0	0	0
	Emissions (Water)		0	0	0	0	0	0	0
21	Heavy Metals	mg Hg/20	223	220	225	207	240	133	232
22	Eutrophication	g PO4	7	7	7	7	7	4	7
23	Persistent Organic Pollutants (POP)	ng i-Teq							

7.2.4. BASE CASE 4: "BASIC" COMPLEX STB WITH HD

Table 7-6 shows the results of the environmental impact calculation for Base Case 4 (without any improvement option) and for Base Case 4 to which each individual options 1, 2, 3, 4, 6, 7, 7+8, 11, and 15 are implemented separately.

Table 7-6: Improvements per Environmental Unit Indicator for Base Case 4 (one product, full life cycle)

Base Case 4

			Option									
	Other Resources & Waste		BC	1	2	3	4	6	7	7+8	11	15
8	Total Energy (GER)	MJ	6133	4550	4227	5788	5857	5807	5404	4725	6130	5757
9	of which, electricity (in primary MJ)	MJ	5557	3975	3651	5212	5281	5232	4829	4150	5554	5520
10	Water (process)	ltr	614	509	487	591	596	592	565	520	614	499
11	Water (cooling)	ltr	14628	10409	9546	13708	13892	13760	12685	10875	14620	14547
12	Waste, non-haz./ landfill	g	17062	15228	14852	16662	16742	16685	16218	15430	17063	32934
13	Waste, hazardous/ incinerated	g	1303	1267	1259	1295	1297	1296	1287	1271	1312	673
			0	0	0	0	0	0	0	0	0	0
	Emissions (Air)		0	0	0	0	0	0	0	0	0	0
14	Greenhouse Gases in GWP100	kg CO2 eq.	283	214	200	268	271	269	251	221	283	259
15	Ozone Depletion, emissions	mg R-11 eq.	0	0	0	0	0	0	0	0	0	0
16	Acidification, emissions	g SO2 eq.	1772	1365	1282	1683	1701	1688	1585	1410	1772	1538
17	Volatile Organic Compounds (VOC)	g	6	5	5	6	6	6	6	5	6	4
18	Persistent Organic Pollutants (POP)	ng i-Teq	62	51	49	59	60	60	57	52	62	45
19	Heavy Metals	mg Ni eq.	347	320	314	341	342	341	334	323	347	184
	PAHs	mg Ni eq.	71	68	67	70	70	70	70	68	71	28
20	Particulate Matter (PM, dust)	g	230	221	219	228	228	228	226	222	231	108
			0	0	0	0	0	0	0	0	0	0
	Emissions (Water)		0	0	0	0	0	0	0	0	0	0
21	Heavy Metals	mg Hg/20	232	222	220	230	230	230	227	223	232	105
22	Eutrophication	g PO4	6	6	6	6	6	6	6	6	6	4
23	Persistent Organic Pollutants (POP)	ng i-Teq										

7.2.5. BASE CASE 5: COMPLEX STB WITH HD AND HDD

Table 7-7 and Table 7-8 show the results of the environmental impact calculation for Base Case 5 (without any improvement option) and for Base Case 5 to which each individual options 1, 2, 3, 4, 5, 6, 7, 7+8, 11, 12, 13, 15 and 16are implemented separately.

Table 7-7: Improvements per Environmental Unit Indicator for Base Case 5 (one product, full life cycle) (Options 1, 2, 3, 4, 5 and 6)

	Base Case 5		Option						
	Other Resources & Waste		BC	1	2	3	4	5	6
8	Total Energy (GER)	MJ	8064	6330	6051	7305	7742	7661	7628
9	of which, electricity (in primary MJ)	MJ	7415	5681	5402	6657	7093	7013	6980
10	Water (process)	ltr	752	636	618	701	731	725	723
11	Water (cooling)	ltr	19529	14905	14161	17506	18671	18456	18367
12	Waste, non-haz./ landfill	g	27934	25923	25600	27054	27561	27467	27429
13	Waste, hazardous/ incinerated	g	1388	1348	1342	1371	1381	1379	1378
			0	0	0	0	0	0	0
	Emissions (Air)		0	0	0	0	0	0	0
14	Greenhouse Gases in GWP100	kg CO2 eq.	369	293	281	336	355	351	350
15	Ozone Depletion, emissions	mg R-11 eq.	0	0	0	0	0	0	0
16	Acidification, emissions	g SO2 eq.	2280	1833	1761	2084	2197	2176	2167
17	Volatile Organic Compounds (VOC)	g	7	6	6	7	7	7	7
18	Persistent Organic Pollutants (POP)	ng i-Teq	84	73	71	80	82	82	82
19	Heavy Metals	mg Ni eq.	386	357	352	373	381	380	379
	PAHs	mg Ni eq.	97	94	93	96	97	97	96
20	Particulate Matter (PM, dust)	g	259	250	248	255	258	257	257
			0	0	0	0	0	0	0
	Emissions (Water)		0	0	0	0	0	0	0
21	Heavy Metals	mg Hg/20	261	250	248	257	259	259	259
22	Eutrophication	g PO4	6	6	6	6	6	6	6
23	Persistent Organic Pollutants (POP)	ng i-Teq							

Table 7-8: Improvements per Environmental Unit Indicator for Base Case 5 (one product, full life cycle) (Option 7, 7+8, 11, 12, 13, 15 and 16)

Base Case 5

	Other Resources & Waste		7	7+8	11	12	13	15	16
8	Total Energy (GER)	MJ	7332	6716	8064	7106	7598	7615	7932
9	of which, electricity (in primary MJ)	MJ	6683	6068	7414	6514	6951	7362	7320
10	Water (process)	ltr	703	662	752	686	749	627	760
11	Water (cooling)	ltr	17577	15936	19526	17163	18241	19442	19274
12	Waste, non-haz./ landfill	g	27085	26372	27937	18426	19819	35302	27194
13	Waste, hazardous/ incinerated	g	1371	1357	1397	1350	1395	737	1386
			0	0	0	0	0	0	0
	Emissions (Air)		0	0	0	0	0	0	0
14	Greenhouse Gases in GWP100	kg CO2 eq.	337	310	369	326	349	340	363
15	Ozone Depletion, emissions	mg R-11 eq.	0	0	0	0	0	0	0
16	Acidification, emissions	g SO2 eq.	2091	1933	2279	2028	2170	2019	2250
17	Volatile Organic Compounds (VOC)	g	7	6	7	6	7	5	7
18	Persistent Organic Pollutants (POP)	ng i-Teq	80	76	84	72	81	61	78
19	Heavy Metals	mg Ni eq.	374	363	387	366	380	218	411
	PAHs	mg Ni eq.	96	95	97	76	95	34	76
20	Particulate Matter (PM, dust)	g	255	252	260	240	256	123	259
			0	0	0	0	0	0	0
	Emissions (Water)		0	0	0	0	0	0	0
21	Heavy Metals	mg Hg/20	257	253	261	244	277	122	269
22	Eutrophication	g PO4	6	6	6	6	6	4	7
23	Persistent Organic Pollutants (POP)	ng i-Teq							

7.2.6. BASE CASE 6: COMPLEX STB WITH HD, HDD, SECOND TUNER, RETURN PATH

Table 7-9 and Table 7-10 show the results of the environmental impact calculation for Base Case 6 (without any improvement option) and for Base Case 6 to which each individual options 1, 2, 3, 4, 5, 6, 7, 7+8, 9, 10, 11, 12, 13, 15 and 16 are implemented separately.

Table 7-9: Improvements per Environmental Unit Indicator for Base Case 6 (one product, full life cycle) (Options 1, 2, 3, 4, 5, 6 and 7)

Base Case 6 — Option

	Other Resources & Waste		BC	1	2	3	4	5	6	7
8	Total Energy (GER)	MJ	12735	9638	9140	11700	12252	12332	12019	12002
9	of which, electricity (in primary MJ)	MJ	12086	8989	8491	11051	11603	11684	11370	11354
10	Water (process)	ltr	1063	857	824	994	1031	1037	1016	1015
11	Water (cooling)	ltr	31985	23727	22398	29225	30697	30911	30075	30032
12	Waste, non-haz./ landfill	g	33349	29759	29181	32150	32790	32883	32519	32501
13	Waste, hazardous/ incinerated	g	1496	1424	1413	1472	1485	1487	1479	1479
	Emissions (Air)									
14	Greenhouse Gases in GWP100	kg CO2 eq.	573	438	416	528	552	555	542	541
15	Ozone Depletion, emissions	mg R-11 eq.								
16	Acidification, emissions	g SO2 eq.	3482	2685	2557	3216	3358	3379	3298	3294
17	Volatile Organic Compounds (VOC)	g	9	8	7	8	9	9	8	8
18	Persistent Organic Pollutants (POP)	ng i-Teq	115	95	92	108	112	112	110	110
19	Heavy Metals	mg Ni eq.	467	413	405	449	458	460	454	454
	PAHs	mg Ni eq.	107	100	99	104	106	106	105	105
20	Particulate Matter (PM, dust)	g	285	268	265	279	283	283	281	281
	Emissions (Water)									
21	Heavy Metals	mg Hg/20	292	272	268	285	288	289	287	287
22	Eutrophication	g PO4	6	6	6	6	6	6	6	6
23	Persistent Organic Pollutants (POP)	ng i-Teq								

Table 7-10: Improvements per Environmental Unit Indicator for Base Case 6 (one product, full life cycle) (Options 7+8, 9, 10, 11, 12, 13, 15 and 16)

Base Case 6

	Other Resources & Waste		7+8	9	10	11	12	13	15	16
8	Total Energy (GER)	MJ	11592	12551	12078	12734	11777	12269	12286	12603
9	of which, electricity (in primary MJ)	MJ	10944	11903	11430	12085	11185	11622	12033	11991
10	Water (process)	ltr	987	1051	1020	1063	998	1060	939	1071
11	Water (cooling)	ltr	28938	31496	30234	31981	29618	30696	31898	31729
12	Waste, non-haz./ landfill	g	32025	33137	32588	33353	23841	25234	40717	32609
13	Waste, hazardous/ incinerated	g	1470	1492	1481	1504	1457	1503	844	1494
	Emissions (Air)									
14	Greenhouse Gases in GWP100	kg CO2 eq.	523	565	544	573	530	553	544	567
15	Ozone Depletion, emissions	mg R-11 eq.								
16	Acidification, emissions	g SO2 eq.	3188	3435	3313	3482	3231	3372	3222	3452
17	Volatile Organic Compounds (VOC)	g	8	9	8	9	8	9	6	9
18	Persistent Organic Pollutants (POP)	ng i-Teq	108	114	111	115	102	112	91	109
19	Heavy Metals	mg Ni eq.	447	463	455	467	446	460	298	491
	PAHs	mg Ni eq.	104	106	105	107	85	105	44	85
20	Particulate Matter (PM, dust)	g	279	284	282	286	266	282	149	285
	Emissions (Water)									
21	Heavy Metals	mg Hg/20	284	290	287	292	274	307	152	299
22	Eutrophication	g PO4	6	6	6	6	6	6	4	7
23	Persistent Organic Pollutants (POP)	ng i-Teq								

7.2.7. PRODUCT CASE 7: TRIPLE PLAY BOX

Table 7-11 shows the results of the environmental impact calculation for Product Case (PC) 7 (without any improvement option) and for Product Case 7 to which each individual options 6, 7, 9, 10, 11, and 14 are implemented separately.

Table 7-11: Improvements per Environmental Unit Indicator for Product Case 7 (one product, full life cycle)

	Product Case 7		Option						
	Other Resources & Waste		PC	6	7	9	10	11	14
8	Total Energy (GER)	MJ	4034	3814	3302	3851	3377	4034	4013
9	of which, electricity (in primary MJ)	MJ	3754	3535	3022	3571	3098	3753	3753
10	Water (process)	ltr	366	352	318	354	323	366	365
11	Water (cooling)	ltr	9890	9304	7937	9402	8140	9887	9881
12	Waste, non-haz./ landfill	g	10749	10495	9901	10537	9988	10753	10745
13	Waste, hazardous/ incinerated	g	988	983	971	984	973	997	545
	Emissions (Air)								
14	Greenhouse Gases in GWP100	kg CO2 eq.	182	173	150	174	154	182	182
15	Ozone Depletion, emissions	mg R-11 eq.							
16	Acidification, emissions	g SO2 eq.	1098	1041	909	1051	929	1098	1096
17	Volatile Organic Compounds (VOC)	g	3	3	3	3	3	3	3
18	Persistent Organic Pollutants (POP)	ng i-Teq	29	28	24	28	25	29	29
19	Heavy Metals	mg Ni eq.	103	99	90	100	92	103	96
	PAHs	mg Ni eq.	25	25	24	25	24	25	25
20	Particulate Matter (PM, dust)	g	132	131	128	131	128	133	108
	Emissions (Water)								
21	Heavy Metals	mg Hg/20	71	69	66	69	66	71	68
22	Eutrophication	g PO4	3	3	3	3	3	3	2
23	Persistent Organic Pollutants (POP)	ng i-Teq							

7.2.8. OVERVIEW OF THE ENVIRONMENTAL IMPACT IMPROVEMENT

Table 7-12 summarises the calculated improvement potential of each individual option for the key environmental indicator "Total Energy" for each Base Case (and Product Case 7). Typically, all environmental indicators run parallel with Total Energy (as most options tackle power consumption). Only for those options, which are not directly power related, some environmental indicators show a different trend than "Total Energy" (e.g. the option "Slim Design" shows a higher improvement potential for the environmental indicator "acidification, emissions" compared to option "Low power standby mode").

The red, orange, and yellow cells represent the first, second and third "top options" respectively, in terms of reduction of the "Total Energy" indicator.

Table 7-12: Overview of the improvement potential for "Total Energy" per option and Base Case/Product Case

Base Cases / Product Case	Option															
	1	2	3	4	5	6	7	7+8	9	10	11	12	13	14	15	16
	Low power standby mode (1W): 30 min wake-up interval	Low power standby mode (1W): 2 h wake-up interval	APD	Power down components	3.5" State-of-the-art HDD	85% Power supply efficiency	Good design practice: General	Good design practice: General + HD	Modem ASICs	Modem standby	Hard-off switch	2.5" State-of-the-art HDD	Solid state disk	Design for Recyclability	Slim design	Disable functionalities
(1) "basic" complex STB with SD	18.1 %	21.8 %	11. 8%	4.7 %		5.2 %	25%				0.1 %			0.1 %		
(2) complex STB with SD, HDD	14.8 %	17.2 %	15. 1%	3.2 %	8.0 %	5.2 %	14.6 %				0.0 %	19.1 %	9.3 %		6.5 %	2.6 %
(3) complex STB with SD, HDD, second tuner, return path	21.8 %	25.3 %	10. 7%	3.3 %	4.2 %	52. 0%	7.6%		1.9 %	6.8 %	0.0 %	9.9%	4.8 %		3.3 %	1.4 %
(4) "basic" complex STB with HD	25.8 %	31.1 %	5.6 %	4.5 %		5.3 %	11.9 %	22.9 %			0.0 %				6.1 %	
(5) complex STB with HD, HDD	21.5 %	25.0 %	9.4 %	4.0 %	5.0 %	5.4 %	9.1%	16.7 %			0.0 %	11.9 %	5.8 %		5.6 %	1.6 %
(6) complex STB with HD, HDD, second tuner, return path	24.3 %	28.2 %	8.1 %	3.8 %	3.2 %	5.6 %	5.7%	9.0%	1.4 %	5.2 %	0.0 %	7.5%	3.7 %		3.5 %	1.0 %
(7) triple play box						5.4 %	18.2 %		4.5 %	16. 3%	0.0 %			0.5 %		

7.3. SUBTASK 7.3 – LIFE CYCLE COSTS

The economic impact of implementing various improvement options to average EU products (Base Cases) is calculated in terms of Life Cycle Cost (LCC) using the EcoReport tool. The resulting LCC per improvement option are listed below for each Base Case, and for Product Case 7.

As already calculated for the Base Cases in task 5, the LCC for a complex STB is equal to: "Product cost + Electricity cost during use phase" (no repair/installation costs are assumed). Therefore, implementing an option which affects the STB's initial cost and its performance in terms of electricity consumption will affect the LLC.

The analysis of the results is provided later in § 7.4.

7.3.1. BASE CASE 1: "BASIC" COMPLEX STB WITH SD

Table 7-13 presents the different LCCs calculated for Base Case 1 without any options and for Base Case 1 with option 1, 2, 3, 4, 5, 6, 7, 11, and 14 individually.

Table 7-13: Life Cycle Costs for Base Case 1 (one product)

Base Case 1		Option								
		BC	1	2	3	4	6	7	11	14
LCC new product	Euro	134.93	132.60	131.11	130.14	134.01	134.84	124.81	134.88	134.93

7.3.2. BASE CASE 2: COMPLEX STB WITH SD AND HDD

Table 7-14 and Table 7-15 present the different LCCs calculated for Base Case 2 without any options and for Base Case 2 with option 1, 2, 3, 4, 5, 6, 7, 11, 12, 13, 15 and 16 individually.

Table 7-14: Life Cycle Costs for Base Case 2 (one product) (options 1- 7)

Base Case 2		Option							
		BC	1	2	3	4	5	6	7
LCC new product	Euro	310.21	304.89	303.23	299.67	308.98	304.62	308.60	300.04

Table 7-15: Life Cycle Costs for Base Case 2 (one product) (options 11 - 13, 15 and 16)

Base Case 2		Option				
		11	12	13	15	16
LCC new product	Euro	312.19	312.92	403.51	460.21	309.87

7.3.3. BASE CASE 3: COMPLEX STB WITH SD, HDD, SECOND TUNER, RETURN PATH

Table 7-16 and Table 7-17 present the different LCCs calculated for Base Case 3 without any options and for Base Case 3 with option 1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12, 13, 15 and 16 individually.

Table 7-16: Life Cycle Costs for Base Case 3 (one product) (Options 1 – 6)

Base Case 3								
		Option						
		BC	1	2	3	4	5	6
LCC new product	Euro	375.09	350.84	346.14	360.72	371.62	369.50	307.17

Table 7-17: LCC for Base Case 3 (one product) (Options 7, 9, 10, 11, 12, 13, 15, and 16)

Base Case 3									
		Option							
		7	9	10	11	12	13	15	16
LCC new product	Euro	364.92	372.55	365.97	377.06	377.79	468.38	525.09	374.75

7.3.4. Base Case 4: "Basic" complex STB with HD

Table 7-18 present the different LCCs calculated for Base Case 4 without any options and for Base Case 4 with option 1, 2, 3, 4, 5, 6, 7, 7+8, 11 and 15 individually.

Table 7-18: Life Cycle Costs for Base Case 4 (one product)

Base Case 4											
		Option									
		BC	1	2	3	4	6	7	7+8	11	15
LCC new product	Euro	325.40	308.43	303.93	320.61	322.57	322.88	315.29	308.86	327.35	525.40

7.3.5. Base Case 5: complex STB with HD and HDD

Table 7-19 and Table 7-20 present the different LCCs calculated for Base Case 5 without any options and for Base Case 5 with option 1, 2, 3, 4, 5, 6, 7, 7+8, 11, 12, 13, 15, and 16 individually.

Table 7-19: Life Cycle Costs for Base Case 5 (one product) (Option 1-5)

Base Case 5							
		Option					
		BC	1	2	3	4	5
LCC new product	Euro	450.89	431.80	427.93	440.35	447.42	445.30

Table 7-20: LCC for Base Case 5 (one product) (Option 6, 7, 7+8, 11, 12, 13, 15 and 16)

Base Case 5									
		Option							
		6	7	7+8	11	12	13	15	16
LCC new product	Euro	446.84	440.72	435.18	452.87	453.59	544.18	550.89	450.55

7.3.6. Base Case 6: complex STB with HD, HDD, second tuner, return path

Table 7-21 and Table 7-22 present the different LCCs calculated for Base Case 6 without any options and for Base Case 6 with option 1, 2, 3, 4, 5, 6, 7, 7+8, 9, 10, 11, 12, 13, 15, and 16 individually.

Table 7-21: Life Cycle Costs for Base Case 6 (one product)(Options 1-6)

Base Case 6		Option						
		BC	1	2	3	4	5	6
LCC new product	Euro	515.77	477.76	470.84	501.40	510.06	510.18	507.82

Table 7-22: LCC for Base Case 6 (one product) (Options 7, 7+8, 9, 10, 11, 12, and 14)

Base Case 6		Option								
		7	7+8	9	10	11	12	13	15	16
LCC new product	Euro	505.60	502.90	513.23	506.65	517.74	518.47	609.06	615.77	515.43

7.3.7. Product Case 7: Triple Play Box

Table 7-23 presents the different LCCs calculated for Product Case 7 without any options and for Product Case 7 with option 6, 7, 9, 10, 11, and 14 individually.

Table 7-23: Life Cycle Costs for Product Case 7 (one product)

Product Case 7		Option						
		PC	6	7	9	10	11	14
LCC new product	Euro	100.87	99.82	90.70	98.33	91.76	102.85	100.87

7.3.8. Overview of the Impacts on the Life Cycle Cost

Table 7-24 summarises the different LCC reduction potentials resulting from the implementation of a single option for each Base Case (and the Product Case). Negative values were calculated ("-") which are due to an increase in the STB's initial cost implied by the implementation of the option.

The red, orange, and yellow cells represent the first, second, and third "top options" respectively, in terms of reduction of the LCC.

Table 7-24: Overview of the improvement potential for “LCC“ per option and Base Case/Product Case

Base Cases / Product Case	Option															
	1	2	3	4	5	6	7	7+8	9	10	11	12	13	14	15	16
	Low power standby mode (1W): 30 min wake-up interval	Low power standby mode (1W): 2 h wake-up interval	APD	Power down components	3.5” State-of-the-art HDD	85% Power supply efficiency	Good design practice: General	Good design practice: General + HD	Modem ASICs	Modem standby	Hard-off switch	2.5” State-of-the-art HDD	Solid state disk	Design for Recyclability	Slim design	Disable functionalities
(1) “basic” complex STB with SD	1.7%	2.8%	3.6%	0.7%		0.1%	7.5%				0.0%			0.0%		
(2) complex STB with SD, HDD	1.7%	2.3%	3.4%	0.4%	1.8%	0.5%	3.3%				-0.6%	-0.9%	-30.1%		-48.4%	0.1%
(3) complex STB with SD, HDD, second tuner, return path	6.5%	7.7%	3.8%	0.9%	1.5%	18.1%	2.7%		0.7%	2.4%	-0.5%	-0.7%	-24.9%		-40.0%	0.1%
(4) “basic” complex STB with HD	5.2%	6.6%	1.5%	0.9%		0.8%	3.1%	5.1%			-0.6%				-61.5%	
(5) complex STB with HD, HDD	4.2%	5.1%	2.3%	0.8%	1.2%	0.9%	2.3%	3.5%			-0.4%	-0.6%	-20.7%		-22.2%	0.1%
(6) complex STB with HD, HDD, second tuner, return path	7.4%	8.7%	2.8%	1.1%	1.1%	1.5%	2.0%	2.5%	0.5%	1.8%	-0.4%	-0.5%	-18.1%		-19.4%	0.1%
(7) triple play box						1.0%	10.1%		2.5%	9.0%	-2.0%			0.0%		

7.4. SUBTASK 7.4 - ANALYSIS LLCC AND BAT

The LLCC analysis and BAT analysis assesses the effects of implementing individual improvement options and combinations of options (combinations of options are analysed while taking into account complementary effects implied by summing some options e.g. a power supply efficiency of 85% has a lower absolute impact, if combined with other power saving measures).

The graphs for the key environmental indicator "Total Energy" and LCCs are depicted below for each Base Case. Typically, all environmental indicators can be correlated with Total Energy (as most options tackle power consumption). Only for those options, which are not directly power related, some environmental indicators show a different trend than "Total Energy".

In the following figures, on the left vertical axis the environmental indicator is scaled while Life Cycle Costs on the right vertical axis.

7.4.1. BASE CASE 1: "BASIC" COMPLEX STB WITH SD

Among the options and combination options calculated, the combinations of options 1, 3, 4, and 7 with or without option 14 are the point of LCCs.

In combined options, the option 6 ("85% power supply efficiency") adds significant life cycle costs for this Base Case (see difference between options 1-4 and 1-6 in Figure 7-1).

With adding option "Design for Recyclability" ("1-4,7,14") the LCCs remain unchanged[238], "Total Energy" is lowered by a marginal value of 3 MJ, and nearly all other indicators are also slightly lower, but "waste, hazardous/incinerated" showing a significant improvement (see Figure 7-1).

The point of LLCC for Base Case 1 consequently is a combination of (option "1-4, 7, and 14" in Figure 7-1)):

- Low power standby mode (1W) (option 1)
- Automatic Power Down (option 3)
- Power down components (option 4)
- Good design practice: Next Generation Silicon / General (option 7)
- Design for Recyclability (option 14)

Life cycle costs at LLCC are € 15.45 lower per STB than for the Base Case, "Total Energy" consumption is 1,550 MJ lower per STB, which is a saving of 53% compared to the Base Case.

Here a combination with the low power standby mode (1W) with an 2-hours wake-up interval is not calculated, which would result in even lower life cycle costs and environmental impacts (if not disabled by a larger percentage of users than hypothetically a low power standby mode with 30-min wake-up interval).

Best available technology, i.e. the combination with the lowest "Total Energy" consumption is a combination of the above listed LLCC combination plus "85% power supply efficiency" and "hard-off switch" (option "1-11"). However, the improvement compared to the point of LLCC is minor (another 70 MJ) at higher life cycle costs of € 3 (Figure 7-1).

238 As the assumed lower end-of-life costs are not rewarded under WEEE

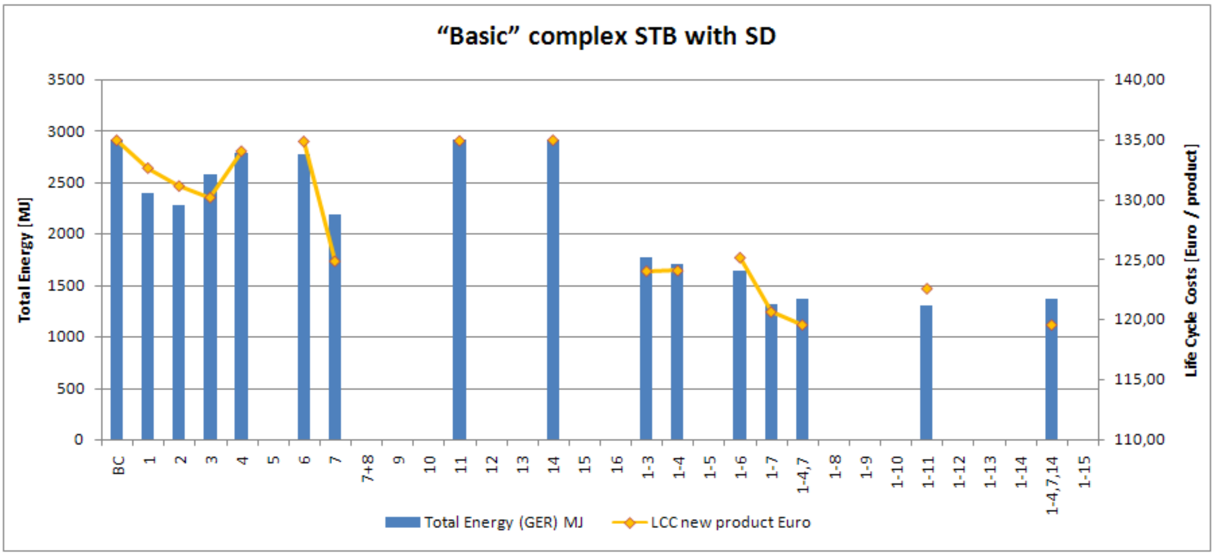

Figure 7-1: Base Case 1 – Total Energy and LCC per option (individual or combination)

Figure 7-2 shows the same analysis for the environmental unit indicator "Global Warming Potential", which clearly shows exactly same trends . Hence, for all following Base Case analysis "Total Energy" is taken as the reference indicator for assessing environmental impacts.

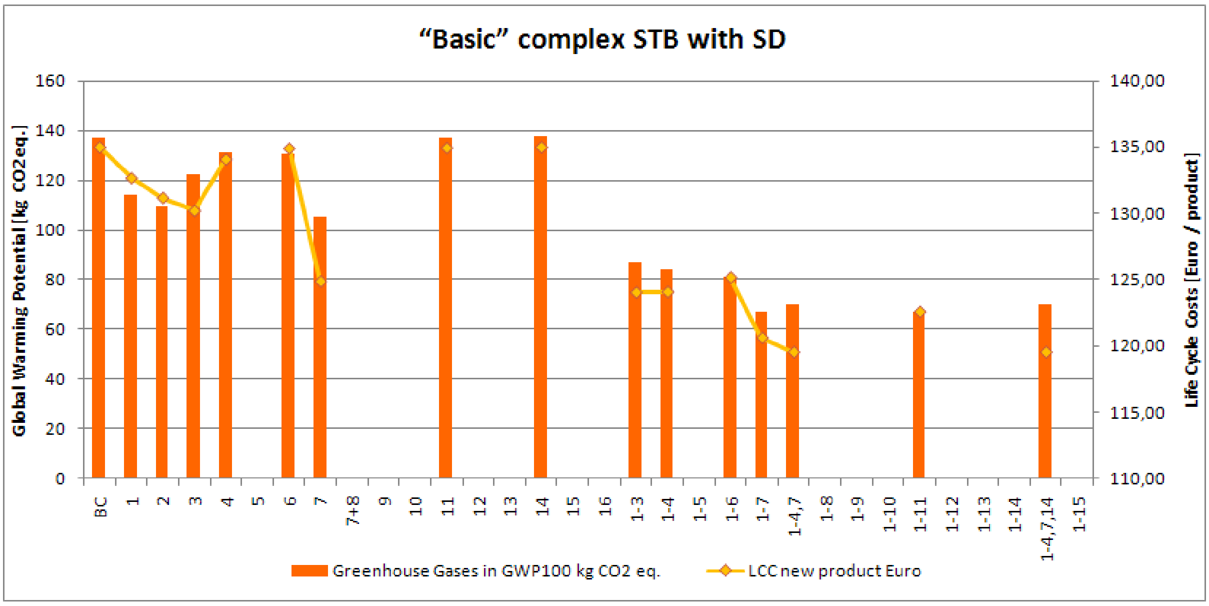

Figure 7-2: Base Case 1 – Global Warming Potential and LCC per option (individual or combination)

Figure 7-3 shows the same analysis, but now for the environmental unit indicator "waste, hazardous / incinerated": all options and combination options have nearly no impact on this category, except for one, the "Design for Recyclability" option (option 14 and combination thereof). This option reduces "waste, hazardous / incinerated" by 210 g per STB compared to the Base Case calculation.

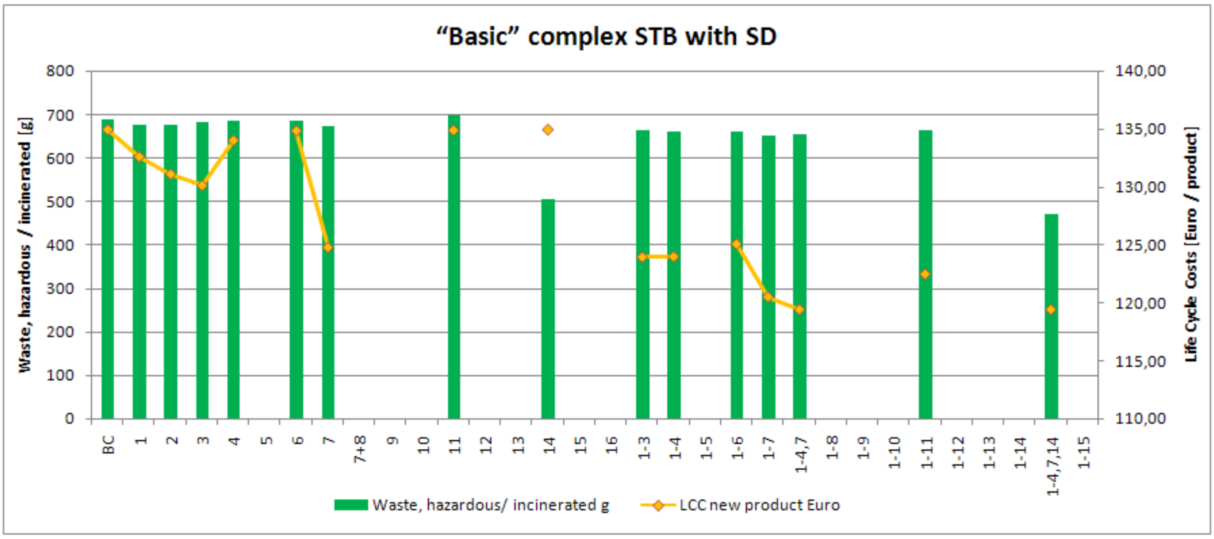

Figure 7-3: Base Case 1 – Waste (hazardous / incinerated) and LCC per option (individual or combination)

7.4.2. BASE CASE 2: COMPLEX STB WITH SD AND HDD

Contrary to Base Case 1, for the Base Case 2, the point of LLCC includes an "85% power supply efficiency", which is logical: total power consumption for Base Case 2 (and also the following ones) is higher than for Base Case 1. Consequently the absolute power savings of higher power conversion efficiency is larger – and pays off.

The point of LLCC for Base Case 2 is a combination of (see Figure 7-4 , option "1-7"):

- Low power standby mode (1W) (option 1)
- Automatic Power Down (option 3)
- Power down components (option 4)
- 3.5" State-of-the-art HDD (option 5)
- 85% power supply efficiency (option 6)
- Good design practice: Next Generation Silicon / General (option 7)

Life cycle costs at LLCC are € 19.50 lower than for the Base Case 2,"Total Energy" consumption is 2,700 MJ lower, which is a saving of calculated 54%.

Best available technology, i.e. the combination with the lowest "Total Energy" consumption is a combination of the above listed LLCC combination plus "hard-off switch", "2.5" state-of-the-art HDD", and "Slim Design" (option "1-15"). However this combination implies much higher life cycle costs (> € 400). Due to the assumed low acceptance of a hard-off switch for such type of products, the implementation of a hard-off switch does not result in significant further savings, but slightly higher life cycle costs. The option of an efficient 2.5" HDD reduces the environmental impacts further, but at higher life cycle costs. Further improvements regarding manufacturing impacts can be achieved with miniaturisation / slim design, which however, for the coming years will not be a low-cost option. Implementing both, an efficient 2.5" HDD and a miniaturised design has the potential for a further significant reduction of 500 MJ "Total Energy" (i.e. another 22% reduction from the point of LLCC).

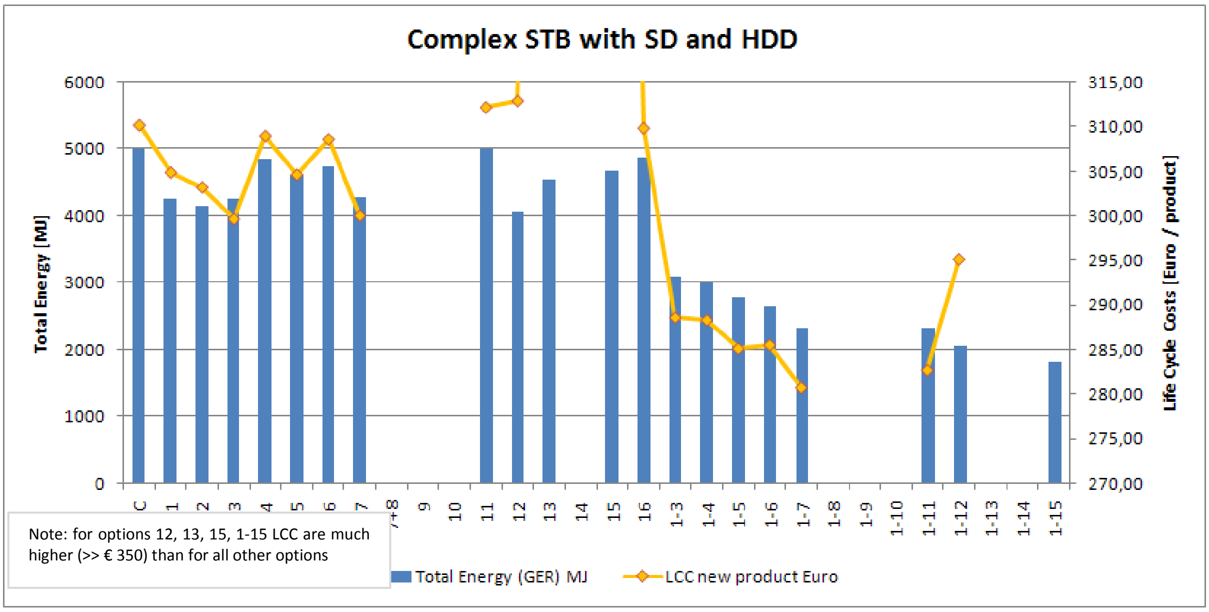

Figure 7-4: Base Case 2 – Total Energy and LCC per option (individual or combination)

For comparison, Figure 7-5 shows the same analysis for the environmental unit indicator "acidification, emissions to air": the trend is basically the same as for "Total Energy", only for "Slim Design" (option 15 and combinations thereof) the improvement potential measured by this indicator is significantly larger.

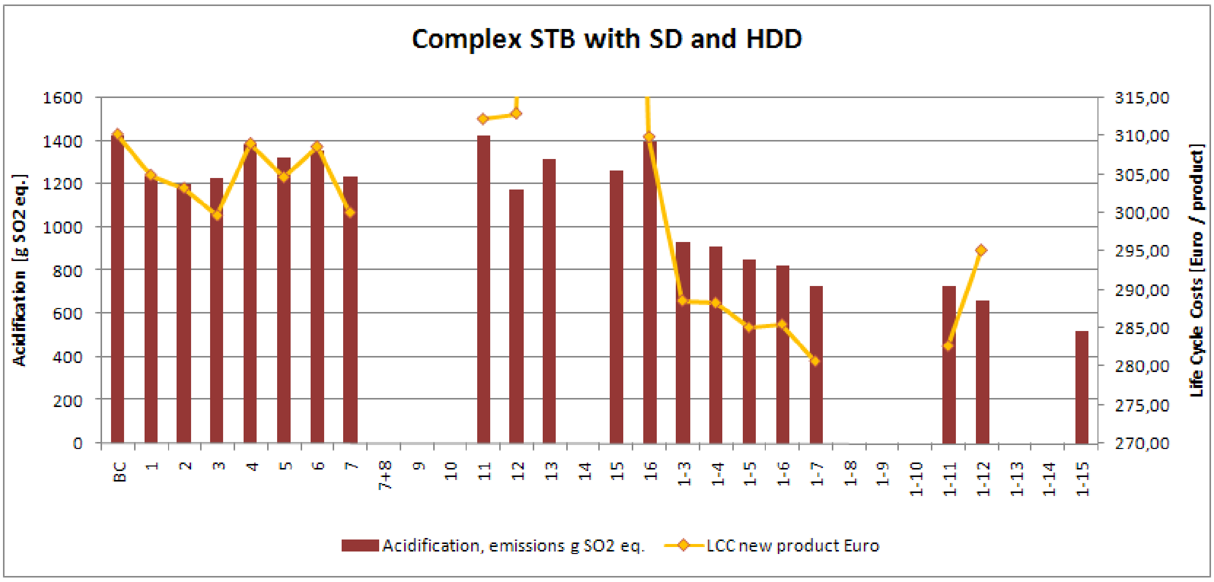

Figure 7-5: Base Case 2 – Acidification (emissions to air) and LCC per option (individual or combination)

7.4.3. BASE CASE 3: COMPLEX STB WITH SD, HDD, SECOND TUNER, RETURN PATH

The point of LLCC for Base Case 3 is a combination of (see Figure 7-6, option "1-10"):

- Low power standby mode (1W) (option 1)
- Automatic Power Down (option 3)
- Power down components (option 4)
- 3.5" State-of-the-art HDD (option 5)
- 85% power supply efficiency (option 6)
- Good design practice: Next Generation Silicon / General (option 7)
- Modem ASICs with lowered power consumption (option 9)
- (Potential239) Modem standby (option 10)

Life cycle costs at LLCC are € 70.50 lower than for the Base Case, "Total Energy" consumption is 5,650 MJ lower, which is a saving of calculated 58%.

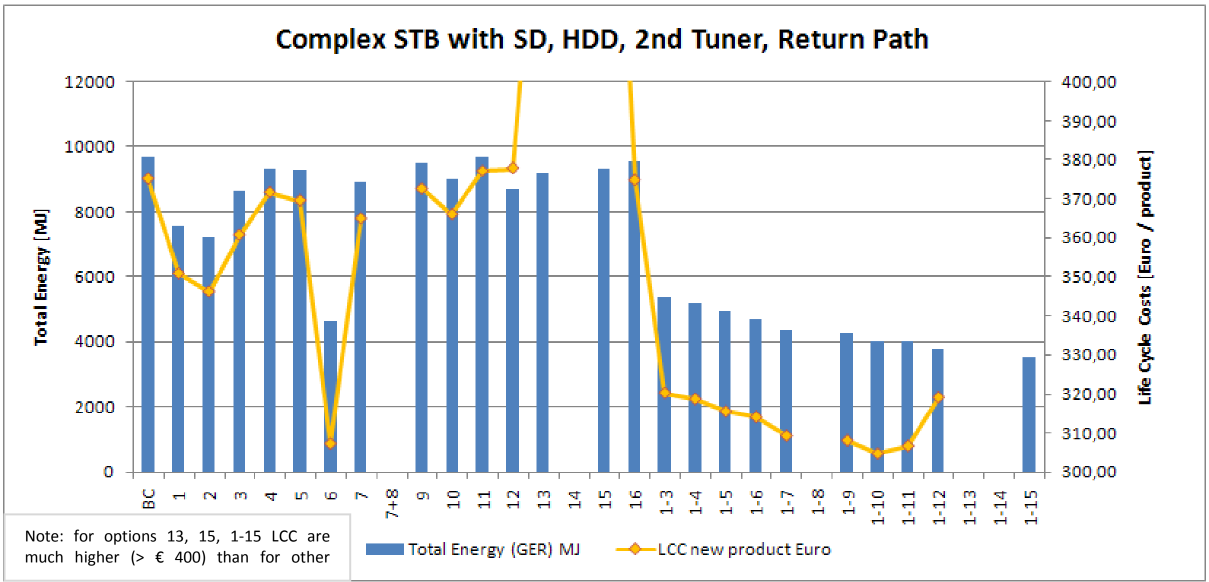

Figure 7-6: Base Case 3 – Total Energy and LCC per option (individual or combination)

Implementing both, an efficient state-of-the-art 2.5" HDD and a miniaturised design, as well as the option "Hard-off switch", "Modem Standby" and "Modem ASICs" (Option "1-15") has the long-term potential for a further significant reduction of 500 MJ "Total Energy" (i.e. another 13% reduction from the point of LLCC) and can be considered as "Best Available Technology combination".

7.4.4. Base Case 4: "Basic" complex STB with HD

The point of LLCC for Base Case 4 is a combination of (see Figure 7-7, option "1-8")):

- Low power standby mode (1W) (option 1)

239 Modem standby is a systems aspect and need adaptation of the communication standard used for network interaction, which is "not yet available" – see later section 7.5.

- Automatic Power Down (option 3)
- Power down components (option 4)
- 85% power supply efficiency (option 6)
- Good design practice: Next Generation Silicon / General and HD components (option 7+8)

Life cycle costs at LLCC are € 39.60 lower than for the Base Case (BC), ”Total Energy” consumption is 3,650 MJ lower, which is a saving of calculated 59%.

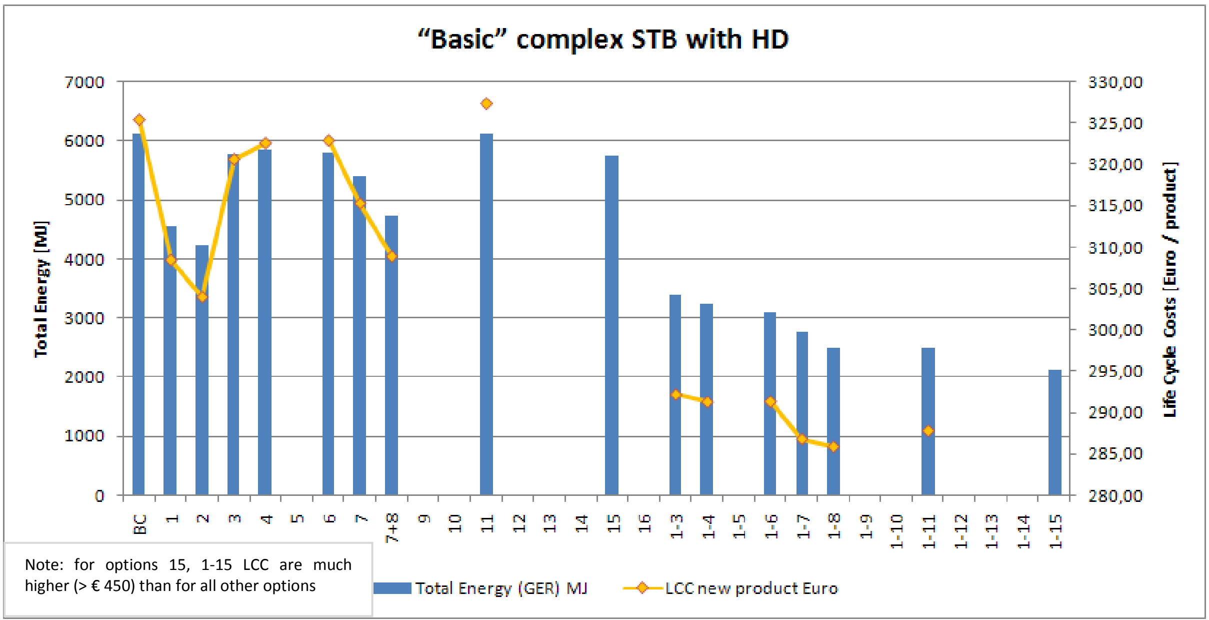

Figure 7-7: Base Case 4 – Total Energy and LCC per option (individual or combination)

Going for a miniaturised design (option “1-15”) has the potential for a further significant reduction of 400 MJ “Total Energy” (i.e. another 15% reduction from the point of LLCC) and can be considered as “Best Available Technology combination”.

7.4.5. Base Case 5: complex STB with HD and HDD

The point of LLCC for Base Case 5 is a combination of (see Figure 7-8, Option “1-8”):

- Low power standby mode (1W) (option 1)
- Automatic Power Down (option 3)
- Power down components (option 4)
- 3.5” State-of-the-art HDD (option 5)
- 85% power supply efficiency (option 6)
- Good design practice: Next Generation Silicon / General and HD components (option 7+8)

Life cycle costs at LLCC are € 53.60 lower than for the Base Case 5, "Total Energy" consumption is 4,650 MJ lower, which is a saving of calculated 58%.

Implementing both, an efficient state-of-the-art 2.5" HDD and a miniaturised design (Option "1-15") has the long-term potential for a further significant reduction of 635 MJ "Total Energy" (i.e. another 19% reduction from the point of LLCC).

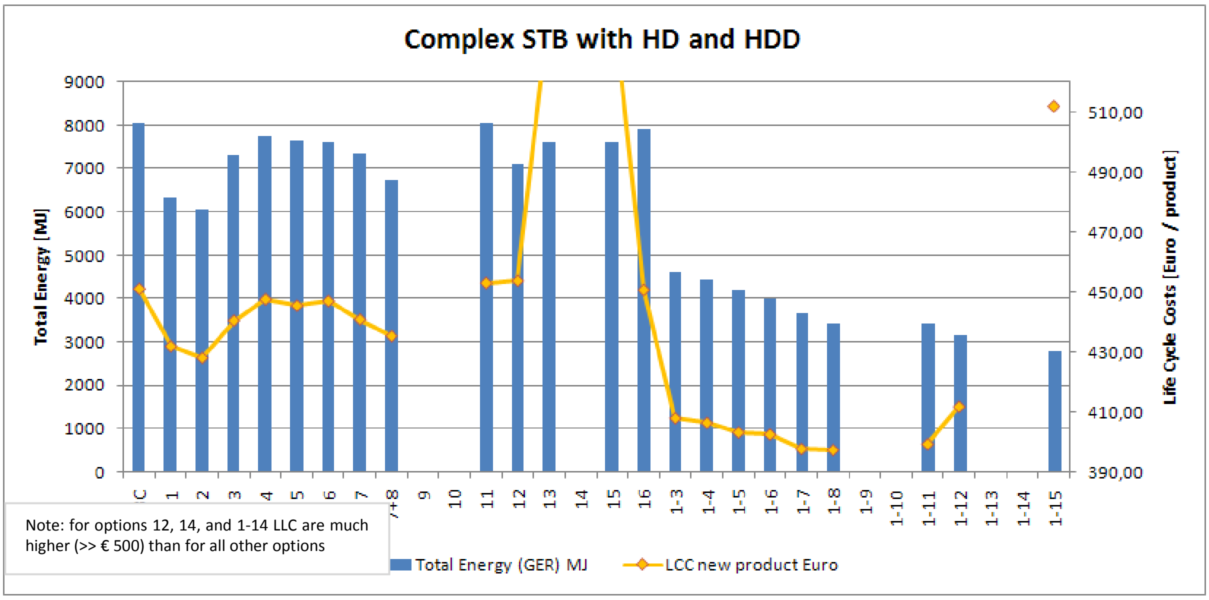

Figure 7-8: Base Case 5 – Total Energy and LCC per option (individual or combination)

7.4.6. BASE CASE 6: COMPLEX STB WITH HD, HDD, SECOND TUNER, RETURN PATH

The point of LLCC for Base Case 6 is a combination of (see Figure 7-9, option "1-10"):

- Low power standby mode (1W) (option 1)
- Automatic Power Down (option 3)
- Power down components (option 4)
- 3.5" State-of-the-art HDD (option 5)
- 85% power supply efficiency (option 6)
- Good design practice: Next Generation Silicon / General and HD components (option 8)
- Modem ASICs with lowered power consumption (option 9)
- (Potential) modem standby (option 10)

Life cycle costs at LLCC are € 94.60 lower than for the Base Case 6, "Total Energy" consumption is 7,600 MJ lower, which is a saving of calculated 60%.

Implementing both, an efficient state-of-the-art 2.5" HDD and a miniaturised design (Option "1-15") has the long-term potential for a further significant reduction of 630 MJ "Total Energy" (i.e. another 12% reduction from the point of LLCC).

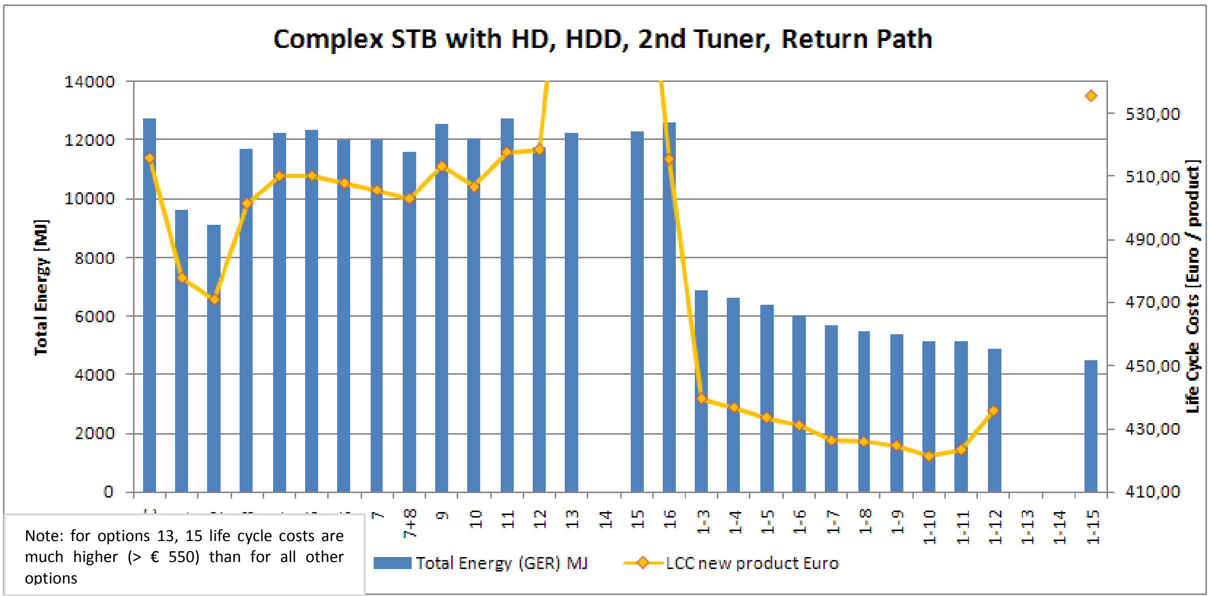

Figure 7-9: Base Case 6 – Total Energy and LCC per option (individual or combination)

As Base Case 6 is the most comprehensive one, Figure 7-10 and Figure 7-11 present another perspective, namely that of the environmental unit indicators “waste, hazardous / incinerated” and “acidification, emissions to air”: As with prior Base Cases, same trends can be confirmed: A “slim design” clearly reduces the amount of “waste, hazardous / incinerated” per STB (but has a contrary effect on “waste, non-hazardous / landfill”, see § 7.2.6). “Acidification, emissions to air” basically correlates to “Total Energy” with an even more positive trend for “slim design” again.

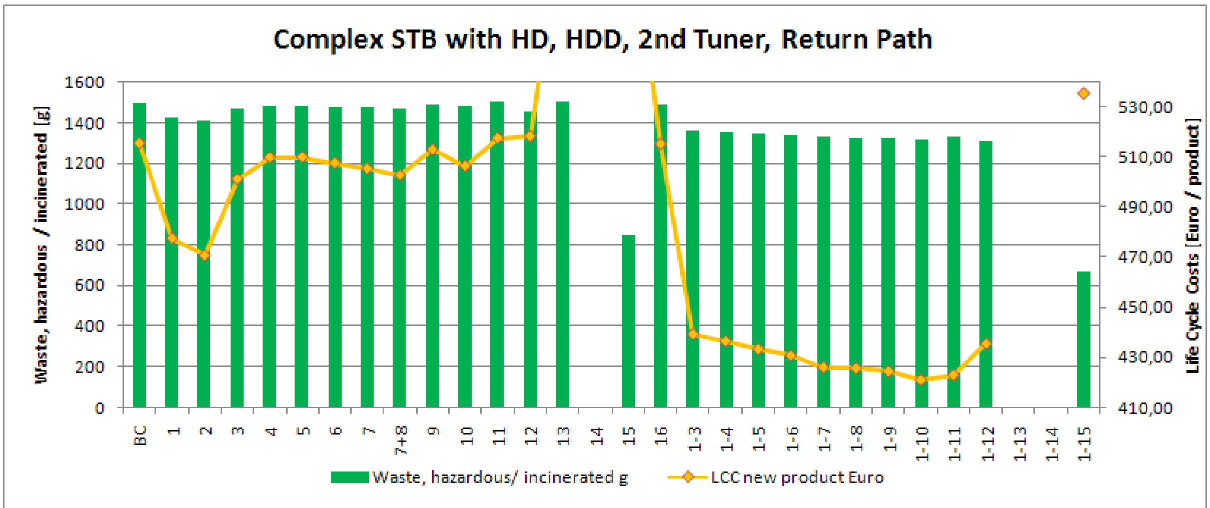

Figure 7-10: Base Case 6 – Waste (hazardous / incinerated) and LCC per option (individual or combination)

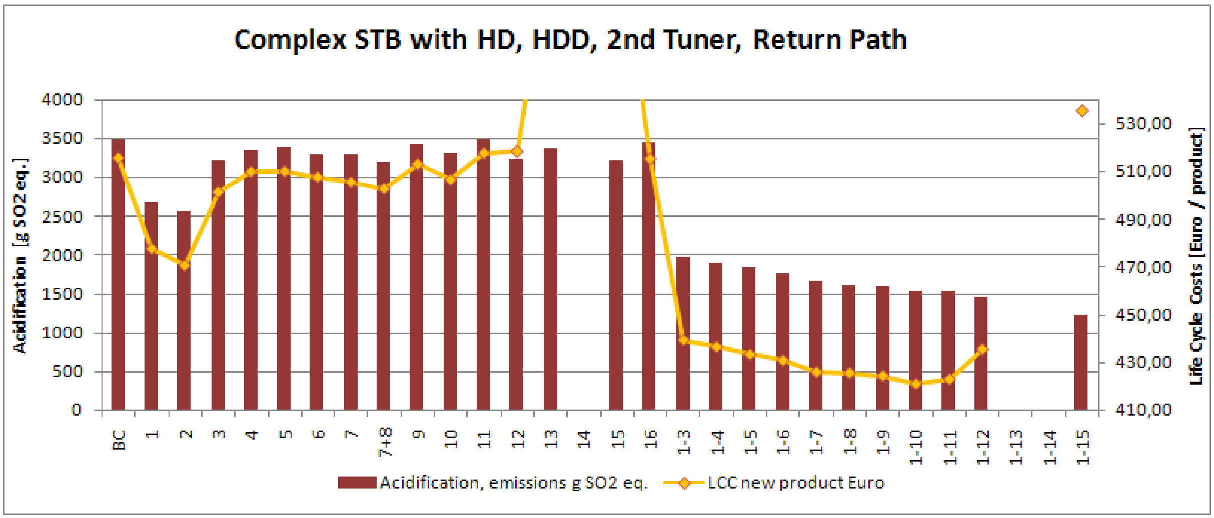

Figure 7-11: Base Case 6 – Acidification (emissions to air) and LCC per option (individual or combination)

7.4.7. PRODUCT CASE 7: TRIPLE PLAY BOX

For Product Case 7, a low power standby mode as for the other STB Base Cases is not a feasible option as this would have a severe impact on the "triple" play use, i.e. telephony / VoIP. Consequently, these options are not calculated here (although such a low power standby mode might be an option for a complex STB, which is combined with a triple play box). Combination options include added options starting with option 6, "85% power supply efficiency".

As the hard-off switch is a cost adder, an additional combination option is calculated ("6-10 and 14"): the life cycle costs of this combination remains unchanged[240] compared to option 6-10; "Total Energy" is lowered slightly by 20 MJ per box, and nearly all other indicators are also slightly lower, but "waste, hazardous/incinerated" showing a significant improvement (see Figure 7-13).

The point of LLCC for Product Case 7 is a combination of (Figure 7-12, option "6-10 and14"):

- 85% power supply efficiency (option 6)
- Good design practice: Next Generation Silicon / General (option 7)
- Modem ASICs with lowered power consumption (option 9)
- (Potential) modem standby (option 10)
- Design for Recyclability (option 14)

Life cycle costs at LLCC are € 22.30 lower than for the Product Case calculation (PC), "Total Energy" consumption is 1,770 MJ lower, which is a saving of calculated 59%.

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[240] As the assumed lower end-of-life costs are not rewarded under WEEE

A hard-off switch for a triple play box severely hampers the intended use and therefore is not considered as a BAT option. However, to switch-off e.g. WLAN functionality manually or automatically at certain times definitely would be an option, but is not taken into consideration in this analysis.

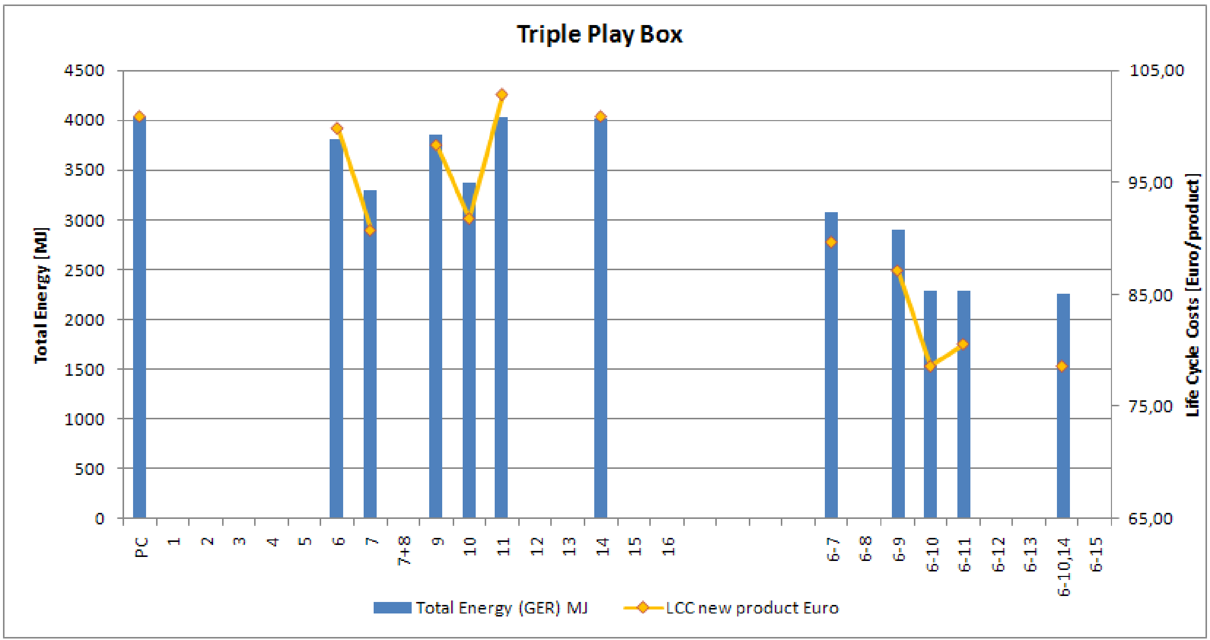

Figure 7-12: Product Case 7 – Total Energy and LCC per option (individual or combination)

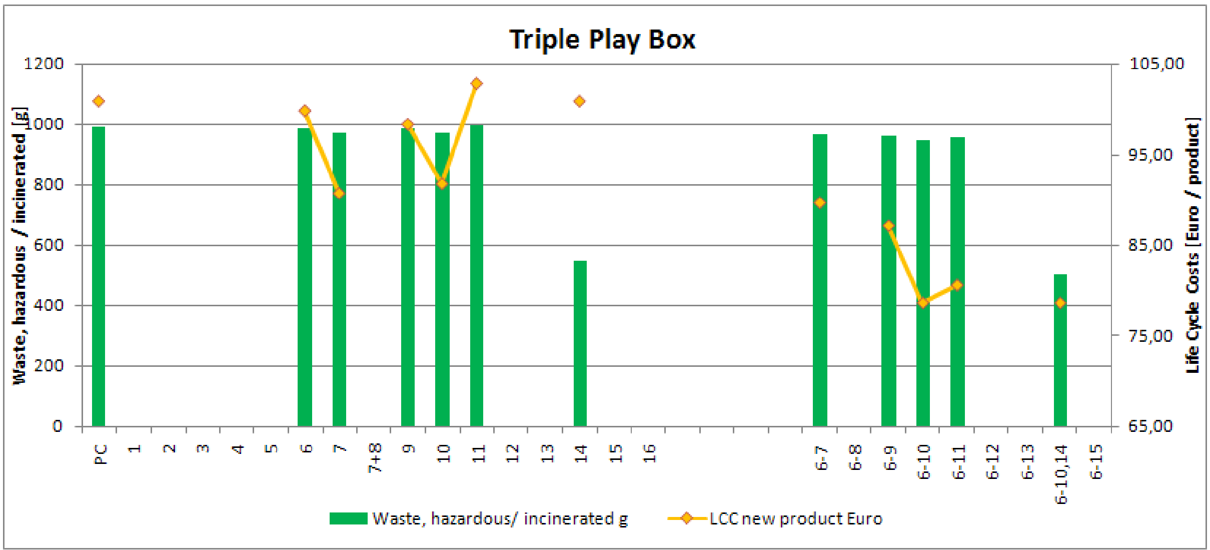

Figure 7-13: Product Case 7 – Waste (hazardous / incinerated) and LCC per option (individual or combination)

7.4.8. OVERVIEW OF THE BAT AND LLCC OPTIONS FOR EACH BASE CASE/ PRODUCT CASE

Table 7-25 and Table 7-26 summarise the LCC and 'Total Energy" reduction potentials (in comparison with the values obtained for the Base Case/Product Case in Task 5) for the combinations of options leading to the LLCC point and the BAT point.

Table 7-25: Overview of the LLCC options for each Base Case / Product Case

Base Cases / Product Case	LLCC point is a combination of:																	
	1	2	3	4	5	6	7	7+8	9	10	11	12	13	14	15	16		
	Low power standby mode (1W): 30 min wake-up interval	Low power standby mode (1W): 2 h wake-up interval	APD	Power down components	3.5" State-of-the-art HDD	85% Power supply efficiency	Good design practice: General	Good design practice: General + HD	Modem ASICs	Modem standby	Hard-off switch	2.5" State-of-the-art HDD	Solid state disk	Design for Recyclability	Slim design	Disable functionalities	LCC reduction potential	"Total Energy Reduction potential"
(1) "basic" complex STB with SD – LLCC Option	●		●	●			●							●			11.4%	53.0%
(2) complex STB with SD, HDD – LLCC Option	●		●	●	●	●	●										9.5%	53.9%
(3) complex STB with SD, HDD, second tuner, return path	●		●	●	●	●	●		●	●							18.8%	58.4%
(4) "basic" complex STB with HD	●		●	●		●		●									11.9%	54.8%
(5) complex STB with HD, HDD	●		●	●	●	●		●									11.9%	57.7%
(6) complex STB with HD, HDD, second tuner, return path	●		●	●	●	●		●	●	●							18.3%	59.7%
(7) triple play box						●	●		●	●				●			22.1%	43.9%

Table 7-26: Overview of the BAT options for each Base Case / Product Case

Base Cases / Product Case	BAT point is a combination of:																	
	1	2	3	4	5	6	7	7+8	9	10	11	12	13	14	15	16		
	Low power standby mode (1W): 30 min wake-up interval	Low power standby mode (1W): 2 h wake-up interval	APD	Power down components	3.5" State-of-the-art HDD	85% Power supply efficiency	Good design practice: General	Good design practice: General + HD	Modem ASICs	Modem standby	Hard-off switch	2.5" State-of-the-art HDD	Solid state disk	Design for Recyclability	Slim design	Disable functionalities	LCC reduction potential	"Total Energy Reduction potential"
(1) "basic" complex STB with SD – LLCC Option	●		●	●		●	●				●						9.2%	55.2%
(2) complex STB with SD, HDD – LLCC Option	●		●	●	●	●	●				●	●	●		●		- 43.5%	64.0%
(3) complex STB with SD, HDD, second tuner, return path	●		●	●	●	●	●		●	●	●	●	●		●		- 25.0%	63.6%
(4) "basic" complex STB with HD	●		●	●		●		●			●				●		- 49.9%	65.6%
(5) complex STB with HD, HDD	●		●	●	●	●		●			●	●	●		●		- 13.5%	65.6%
(6) complex STB with HD, HDD, second tuner, return path	●		●	●	●	●		●	●	●	●	●	●		●		-3.8%	64.7%
(7) triple play box						●	●		●	●				●			22.1%	43.9%

7.5. SUBTASK 7.5 - LONG-TERM TARGETS (BNAT) AND SYSTEMS ANALYSIS

Some BNAT options and systems aspects have been taken into account already for the LLCC analysis above, but should be pointed out here once more, to clarify, that these options do not constitute short-term options:

- Solid state disks still lack maturity and reliability and have to be considered "not yet available" as required for STBs
- Modem standby is a systems aspect and need adaptation of the e.g. EuroDOCSIS specification, which is also "not yet available". Furthermore, on

the long run, there might be new, not yet predictable communication standards and specifications – which should provide support for any kind of end-device standby mode right from the beginning.

In the mid- to long-term the functionality of “complex STBs” is likely to merge with either the personal computer or/and the TV set, meaning, we are leaving the product archetype which is subject of this study. However, the functionalities basically will remain the same (encryption, recording, playing, triple play etc.) and could be addressed by overarching measures. In principle, this merging is likely to result in power savings (and therefore should not be hindered as such) as the number of devices is reduced, which should have a positive effect on power consumption per function provided.

With the trend towards multiple TVs per household, a client-STB structure is also likely to gain ground in the near future, where a master STB could provide e.g. the recording function for all client STBs (see 4.4.2): such networked structures could mean lower environmental impacts compared to the same number of stand-alone devices.

Wireless communication also gains ground in the home environment, and is already relevant for IPTV. WLAN power consumption is not addressed specifically by this study, but could become a major source of power consumption in the mid-term future. WLAN power management (reduce transmitter power when no content is transmitted) is highly relevant under such conditions.

Recently, there are some examples which show that service providers / pay TV operators are taking a pro-active role for an improved “system design” by adapting their update policy to allow for a better power management of set-top boxes, i.e. the implementation of a low power standby mode. These activities prepare the ground for an optimised pay-TV-system. However, joint cooperation of components manufacturers, service provider / operator / broadcasters, middleware providers and STB manufacturers is required to implement such options, which means the need for longer transition phases than a product redesign cycle only, as here it is rather a system redesign.

7.6. CONCLUSIONS FOR TASK 7

As discussed in this task, the improvement potential of each of complex STBs is significant. The EcoReport analysis show that most of the environmental indicators decrease thanks to the implementation of one or several improvement options, mainly due to their electricity savings potential.

The assessment of the improvement potential of each Base Case and of the Product Case will be further investigated in Task 8 when defining several scenarios until the year 2020. These scenarios, based on relevant assumptions, will evaluate the energy savings potential for the whole EU market of complex STBs, which are in the scope of this study.

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8. Task 8 - Scenario-, Policy-, Impact-, and Sensitivity Analysis

The objective of Task 8 is to analyse the results of the lot 18 preparatory study in the overall policy context of the Ecodesign Directive.

Impact scenarios for the reference years 2007, 2010, 2015 and 2020 are developed to quantify the improvements that can be achieved through the implementation of different options versus a Business-As-Usual scenario.

This is followed by a brief policy analysis including an overview of the existing voluntary and mandatory programs existing in Europe and overseas that have been developed to promote the energy efficiency of complex STBs.

Finally, the main results of the study are submitted to a sensitivity analysis to provide a critical review of the findings and test the robustness of the outcomes.

It has to be kept in mind that the conclusions drawn here are preliminary and represent solely a point of view of the consortium and they do not reflect the opinion of the European Commission in any way. Unlike task 1-7 reports, which will serve as the baseline data for the future work (impact assessment, further discussions in the consultation forum, and development of implementing measures, if any) conducted by the European Commission, Task 8 simply serves as a summary of policy implications as seen by the consortium. Further, some elements of this task may be analysed again in a greater depth during the impact assessment.

8.1. SCENARIO ANALYSIS

Different scenarios are drawn up to illustrate quantitatively the improvements that can be achieved through the implementation of different sets of improvement options at EU level by 2020 versus a Business-As-Usual scenario (reference scenario).

For each of the 6 Base Cases and the triple play IPTV Product Case, following three scenarios are analysed:

- Business-as-Usual (BAU),
- Least Life Cycle Cost – version 1 (LLCC1) which assumes the future stock of complex STBs is continuously improved through the reduction of the power requirement of the STBs in basic configuration and for basic functionalities in different operating modes.
- Least Life Cycle Cost – version 2 (LLCC2) which assumes the future stock of complex STBs is further improved through the penetration of the Auto Power Down and Low power standby mode options.

A scenario based on the Best Available technology option (BAT) identified in Task 7 is not analysed here as the Task 7 showed that the improvements achieved through BAT option were not significantly higher than what can be achieved through the LLCC options but led to significantly higher LCCs. Moreover, the BAT options will become viable options only in the long-term when the volume of complex STBs is assumed to become less important in EU 27 (see Task 2, § 2.2.2.2.).

The BAU scenario assumes that continuity is maintained with the current situation and trends.

The LLCC1 and LLCC2 scenarios depict situations where products are improved through the integration of the technical options corresponding to the LLCC points as identified in Task 7. A distinction is made here between the LLCC point obtained through options which have an effect on the power requirement levels (analysed in LLCC1 scenario) and the options which also influence the duty cycle of the complex STB (analysed in the LLCC2 scenario).

The following common assumptions apply to all the scenarios:

- A product life of 4 years
- In order to build realistic scenarios, an appropriate timeframe for manufacturers to redesign products needs to be considered (i.e. redesign cycle). A complete redesign cycle of a maximum of 4 years is considered in all scenarios and distributed as following: 2 years for the redesign of the silicon components (hardware), 1 year for the complex STB manufacturer to redesign the STB and for the software/middleware development, and a maximum 1 year for the production and commercialisation of the redesigned product. A shorter redesign cycle can be considered when e.g. silicon redesign is not necessary. When shorter re-design cycles were considered, this has been explicitly mentioned in the scenario.

In these scenario analyses, and for all Base/Product Cases, the expected trends (2007-2020) on environmental impacts are presented in terms of three indicators:

- Total Energy Requirement (TER) during the whole life cycle of the installed base of complex set-top boxes (STBs) (expressed in PJ/year)
- Annual electricity consumption of the installed base of complex STBs during the use phase (expressed in TWh/year)
- Greenhouse gases emissions of the installed base over product life (in GWP100 – Global Warming Potential expressed in million ton CO_2 equivalent)

To recapitulate, the characteristics and market data (2007) for the Base/Product Cases are summarised in Table 5-3 below:

Table 8-1: An overview of Base Cases

Base / Product Case	Market data (2007)	
	Sales (Million units)	Stock (Million units)
(1) "basic" complex STB with SD[241]	18.2	54.2
(2) complex STB with SD, HDD[242]	2.8 assumed split (BC2) – 20%, (BC3) – 80%	8.2 assumed split (bC2) – 20%, (BC3) –80%
(3) complex STB with SD, HDD, Second tuner, return path		
(4) "basic" complex STB with HD[243]	0.6	1.6
(5) complex STB with HD, HDD	0.6 assumed split (5) – 20%, (BC6) – 80%	1.6 assumed split (BC5) – 20%, (6) – 80%
(6) complex STB with HD, HDD, Second tuner, return path		
(7) triple play box	2.0 (IPTV)	6.0 (IPTV)

8.1.1. SALES AND STOCK DATA

In order to develop the scenarios, the sales/stock data for the reference years (i.e. 2007 – 2010 – 2015 – 2020) are calculated.

8.1.1.1 Stock data

Based on the market trend analysis in Task 2 (see Task 2, § 2.3.5), the total market for different types of complex STBs for the years 2007, 2010, 2015 and 2020 was estimated. However, for the years 2015 and 2020, these figures are highly speculative, but remain the best available assumption for the long-term 2015/2020. Following key features were considered for market segmentation purpose (see Table 8-2):

- SD (Standard Definition Digital Set-top box)
- HD (High Definition / processing of advanced codecs Digital Set-top box)
- SD-STB with internal mass media (Standard Definition Digital Set-top box with an internal mass storage media)
- HD-STB with internal mass media (High Definition Digital Set-top box with an internal mass storage media)

241 Standard Definition
242 Hard Disk Drive
243 High Definition

Table 8-2: Estimated stock of complex STBs by feature (EU 27)

Complex STB (EU 27) Stock (million units)	2007	%	2010	%	2015	%	2020	%
SD	54.2	82.5%	55.0	67.1%	4.1	5%	0	0%
HD	1.6	2.5%	3.4	4.2%	4.1	5%	0	0%
SD-STB with internal mass storage media DVR	8.2	12.5%	13.3	16.3%	8.1	10%	0	0%
HD-STB with internal mass storage media DVR	1.6	2.5%	10.2	12.5%	65.6	80%	41	100%
Total	**65.7**		**81.9**		**81.9**		**41**	

A narrower feature wise market distribution was estimated in Task 5 on the basis of following assumptions:

- For STBs with HDD a split of 20% without return path and 80% with return path was assumed, as no robust market data are available for the number of STBs with return paths (see Task 2),
- In the case of complex STBs used for the Internet transmission platform (IPTV or IP), an assumption is made that this market segment will represent 18% and 20% of the stock of complex STBs in 2015 and 2020, respectively244 (highly speculative assumption). A share of 9.1% and 15.4% (of the total complex STB stock) was calculated for the years 2007 and 2010 respectively (see Task 2, § 2.2.2.2 and Table 8-3). The terrestrial platform is expected to lose significance in the future while the Cable and Satellite will remain important in the long term (Table 8-3).

Table 8-3: Estimated stock of complex STBs by platform (EU-27)

Complex STB stock (million units)	2007	%	2010	%	2015	%	2020	%
Cable	24.4	37.2%	28.7	35.0%	31.5	38.5%	15.8	38.5%
Satellite	29.9	45.5%	30.5	37.2%	31.5	38.5%	15.8	38.5%
IP	6.0	9.1%	12.6	15.4%	14.7	18.0%	8.2	20.0%
Terrestrial	5.4	8.2%	10.1	12.3%	4.1	5.0%	1.2	3.0%
Total	**65.7**		**81.9**		**81.9**		**41**	

8.1.1.2 Sales data

The sales of complex STB for the years 2015 and 2020 were estimated on the basis of stock data using the following approximate formula:

Sales data for the year (n) = Stock data for the year (n) / Product Lifetime,

where Product Lifetime = 4 years.

244 Driven by the latent broadband growth and the general move towards digital TV services, and by the demand for more "personalised" TV services for the consumer, see Task 2, section 2.3.1

For sales distribution per feature and per transmission platform, it was assumed that they follow the same trend as the stock (Table 8-4 and Table 8-5). Again, these long term projections are highly speculative, but remain the best available estimates.

Table 8-4: Estimated sales of complex STBs by feature (EU-27)

Complex STB (EU 27) Sales (million units)	2007	%	2010	%	2015	%	2020	%
SD	18.2	82.5%	39.5	67.1%	1.0	5%	0.0	0%
HD	0.6	2.5%	2.5	4.2%	1.0	5%	0.0	0%
SD-STB with internal mass storage media DVR	2.8	12.5%	9.6	16.3%	2.1	10%	0.0	0%
HD-STB with internal mass storage media DVR	0.6	2.5%	7.4	12.5%	16.4	80%	10.3	100%
Total	**22.0**		**58.8**		**20.5**		**10.3**	

Table 8-5: Estimated sales of complex STBs by transmission platform (EU-27)

Complex STB Sales (million units)	2007	%	2010	%	2015	%	2020	%
Cable	8.2	37.2%	20.6	35.0%	7.9	38.5%	4.0	38.5%
Satellite	10	45.5%	21.9	37.2%	7.9	38.5%	4.0	38.5%
IP	2	9.1%	9	15.4%	3.7	18.0%	2.1	20.0%
Terrestrial	1.8	8.2%	7.2	12.3%	1.0	5.0%	0.3	3.0%
Total	**22**		**58.8**		**20.5**		**10.3**	

8.1.1.3 Summary of sales and stock data

The market data presented above allows the calculation of the stock and sales data for each of the 6 Base Cases and the Product Case as presented in Table 8-6. This data will be used in all scenarios calculations and a linear interpolation will be made for the years in between the reference years (see Figure 8-2).

Table 8-6: Estimated stock and sales data (EU-27)

Complex STBs (million units)	2007		2010		2015		2020	
	STOCK	SALES	STOCK	SALES	STOCK	SALES	STOCK	SALES
Base Case 1	54.2	18.2	55.0	39.5	4.1	1.0	0.0	0.0
Base Case 2	1.6	0.6	2.7	1.9	1.6	0.4	0.0	0.0
Base Case 3	6.6	2.2	10.7	7.7	6.5	1.6	0.0	0.0
Base Case 4	1.6	0.6	3.4	2.5	4.1	1.0	0.0	0.0
Base Case 5	0.3	0.1	2.0	1.5	13.1	3.3	8.2	2.1
Base Case 6	1.3	0.5	8.2	5.9	52.5	13.1	32.8	8.2
Product Case 7	6.0	2.0	12.6	9.0	14.7	3.7	8.2	2.1

Figure 8-3 shows the relative market significance of the different Base Cases. The Product case 7 is not represented in this figures as it represents the impacts of the "modem" only for complex STBs operating with the internet transmission platform (it adds up to the total in terms of environmental impacts but not in terms of market data see Figure 8-1).

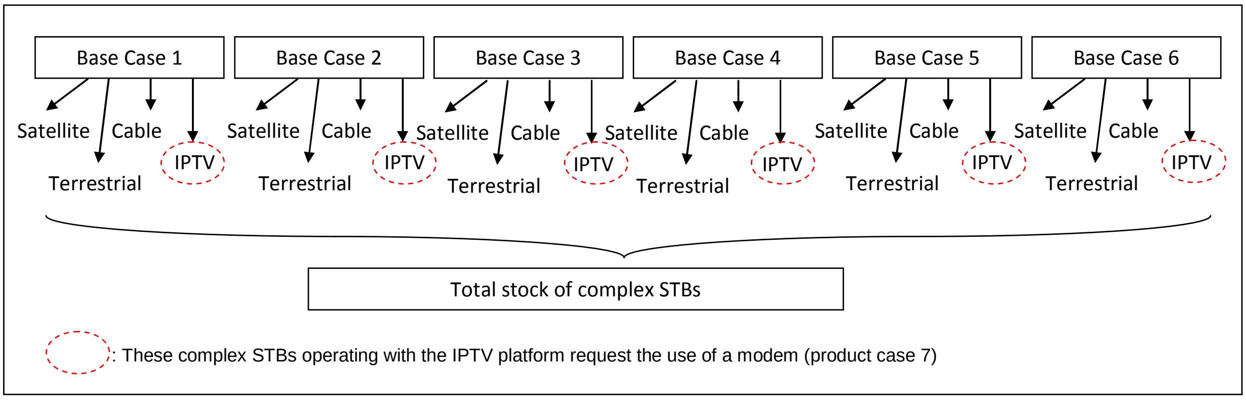


Figure 8-1: Stock distribution among the Base Cases / Product Case

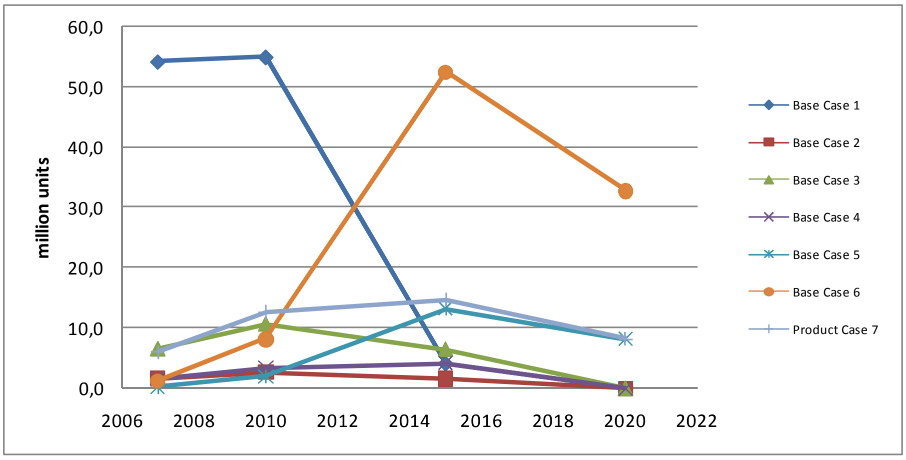


Figure 8-2: Stock evolution of complex STBs per Base Case/ Product Case (EU-27)

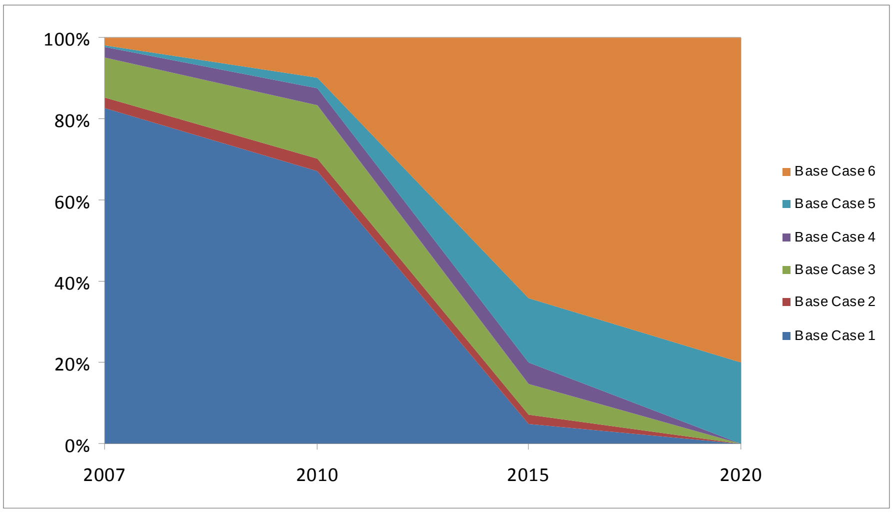


Figure 8-3: Significance of each of the Base Cases in term of stock (in %) (EU-27)

8.1.2. Business-as-Usual Scenario

The Business-as-usual scenario (BAU) assumes that continuity is maintained from the current situation and the market will continue to follow the current trends in terms of market development, technology development, and regulations.

In order to develop the BAU scenario, it was assumed that the future technical improvements of the complex STBs will lead to reduction in terms of power requirements in different operating modes but that these improvements will be compensated by an increasing number of functionalities provided by the STBs.

As such, the BAU scenario represents a situation where the technical parameters of the products remain identical to the products installed in 2007 and where the sales and stock are the only parameters that will change over time. This scenario need to be interpreted with care as complex STBs will not stop evolving in terms of technologies and performance (see description of the market trends in Task 2, § 2.3.). However, it is reasonable to assume that these technical improvements will not lead to an overall reduction of the power requirements as explained above. Moreover, in the absence of robust data to predict the future electricity consumption profiles of complex STBs, such approach allows limiting the number of "guesses" and provides a reasonable reference point for future comparison with alternative scenarios.

Due to the growing market share and growing number of more sophisticated complex STBs (see Figure 8-2), the BAU scenario clearly shows an increase in the environmental impacts of complex STBs until 2015 (see Figure 8-4). After 2015, the decrease in the sales and in the stock of complex STBs (as the functionality of complex STBs is more likely to merge into other products such as media centres, etc.) will lead to an overall reduction of the impacts of complex STBs in 2020 in comparison to the 2015 situation (however, still above the 2007 situation).

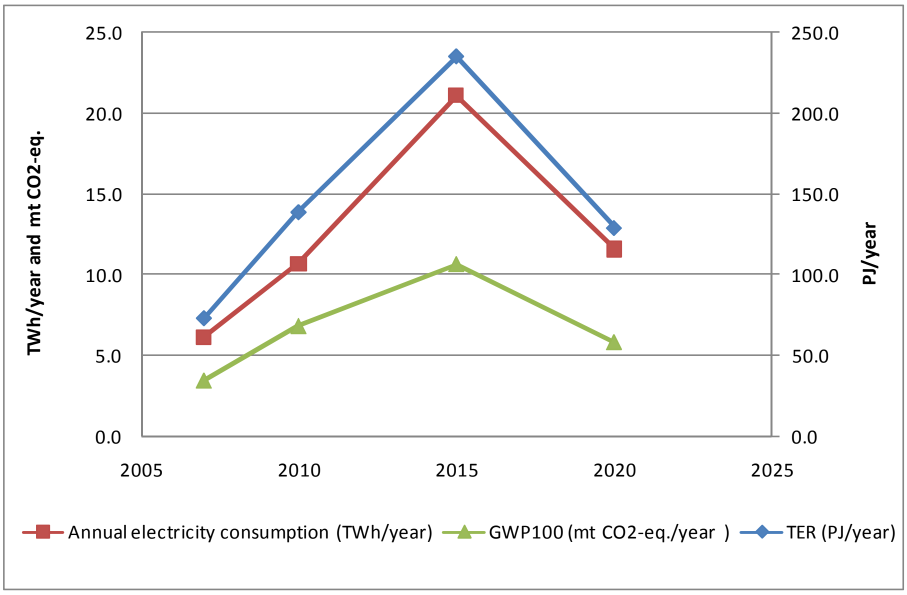


Figure 8-4: Environmental impacts – BAU scenario

The BAU scenario shows that for EU 27:

- Total Energy Requirement (TER) during the whole life cycle of the installed base of complex set-top boxes (STBs) will reach 129.3 PJ/year in 2020, with a peak of 235.4 PJ/year in 2015 (see Figure 8-4).
- Annual electricity consumption of the installed base of complex STBs during the use phase will reach 11.6 TWh/year in 2020, with a peak of 15.4 TWh/year in 2015 (see Figure 8-4 and Figure 8-5).
- Greenhouse gases emissions of the installed base over product life will reach 5.8 million ton CO2-eq, with a peak of 10.6 million ton CO2-eq in 2015 (see Figure 8-4).

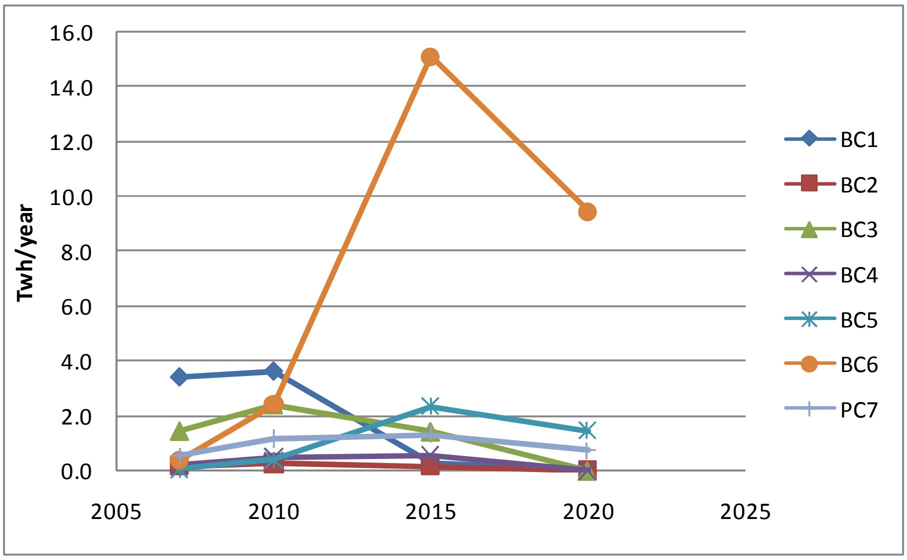


Figure 8-5: Annual electricity consumption per Base Case/ Product Case – BAU scenario

8.1.3. LLCC1 SCENARIO

8.1.3.1 Scenario development

The LLCC1 scenario represents a situation where the complex STBs achieve reductions in power requirements which are similar to the ones identified by the LLCC points in Task 7, but taking into account only the improvements which can be achieved through the implementation of design options which have a direct impact on the maximum on-mode and active-standby modes power consumption (i.e. at point of "LLCC1(a)").

Task 7 shows that the implementation of LLCC design options with direct impact on maximum on-mode and active standby mode power consumption are:

- Good design practice: General (option 7) and high definition (option 8)
- 85% power supply efficiency (option 6)
- 3.5" State-of-the-art HDD (option 5)
- Modem ASICs (option 9)

These measures and related energy saving are summarised in Table 4-15.

Table 8-7: Typical on mode and active standby power requirement levels of complex STBs at LLCC1(a), i.e. taking into account only the options 5, 6, 7, 8, and 9

STB (DVB-C, -S, -T, IPTV)	Typical power consumption → point of LLCC1(a) (without taking Option 1 and 3 into account) (W)	
	On-mode	Active standby
Basic "complex" STB, including all typical interfaces, digit display, CI and/or CAM, etc.	10 → **7.5**	5 → **2.8**
Additional power consumption for • Hard disk drive • Second tuner / multiple tuners • High definition capability • Return path	 + 8 → **+ 5.2** + 5 → **+ 4.7** + 8 → + **7.5** + 10 → **+ 8.9**	 + 2 → **+ 1.9** + 1 → **+ 0.9** + 8 → **+ 2.8** +10 → **+ 8.9**; plus modem standby: → **+ 5.2**

The LLCC1 scenario assumes the same use pattern as defined in Task 3 (Table 3-1) but that an increased share of the complex STBs installed on the market will achieve these LLCC1(a) typical power requirement levels (see Table 8-8)(LLCC1 (a) levels). The remaining complex STBs sold in the EU are assumed to stay at the level of the 2007 Base Cases. A typical redesign cycle between 1.5 - 2 years is considered here, i.e. the 100% LLCC1(a) performance for the STBs sold is achieved in 2011 (Task 6 and 7 show that these LLCC1(a) targets can be achieved through existing technical options and these may not require a 4 years redesign cycle).

Further to these achievements, the powering down of components is assumed to be implemented in 100% of the products sold in 2012 (i.e. after 2.5 years) (LLCC1 (b) levels) and the "modem standby" option and "design for recyclability" (where relevant i.e. for complex STBs with an external power supply) are assumed to penetrate the market in 2013 (LLCC1 (c) levels). Indeed, the LLCC points identified in Task 7 show that implementing these options will allow further reductions in of the environmental impacts related to complex STBs.

To summarise, three performance levels are used in this LLCC1 scenario:

- LLCC1(a) which corresponds to the LLCC1(a) power requirement levels
- LLCC1(b) which corresponds to the LLCC1 power requirement levels + additional "power down component" options + modem standby for IPTV STBs
- LLCC1(c) which corresponds to the LLCC1 power requirement levels + additional "power down component" options + modem standby (for BC 3,6 and PC7) + design for recyclability

The market penetration of complex STBs with these different performance levels was calculated based on the estimates on the share of sales of each of these types of products (Table 8-8).

Table 8-8: Estimated share of “improved LLCC1 complex STBs” in annual sales

sales	% Base Case level	% LLCC1(a)	% LLCC1(b)	% LLCC1level(c)
2007	100.0%	0.0%	0.0%	0.0%
2008	100.0%	0.0%	0.0%	0.0%
2009	95.0%	5.0%	0.0%	0.0%
2010	65.0%	35.0%	0.0%	0.0%
2011	50.0%	50.0%	0.0%	0.0%
2012	0.0%	50.0%	50.0%	0.0%
2013	0.0%	0.0%	0.0%	100.0%
2015	0.0%	0.0%	0.0%	100.0%
2016	0.0%	0.0%	0.0%	100.0%
2017	0.0%	0.0%	0.0%	100.0%
2018	0.0%	0.0%	0.0%	100.0%
2019	0.0%	0.0%	0.0%	100.0%
2020	0.0%	0.0%	0.0%	100.0%

Assuming the total stock and sales of complex STBs remain as presented in § 8.1.1. , the evolution of the stock can be calculated using the following stock-model for a given year *n*:

stock (n) = stock (n-1) + sales (n) – sales (n-X)

This formula only is an approximation and when the stock calculated using this formula exceeded the total stock of complex STBs, it was replaced by the total stock of complex STBs value.

Results are provided in Table 8-9 and depicted in Figure 8-6 (stock data only).

Table 8-9: Stock data calculated for the LLCC1 scenario in EU 27 (million units)

STOCK (million units)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
BC1	54.2	56.0	52.8	39.7	13.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC1 LLCC1(a)	0.0	0.0	1.5	15.3	31.2	22.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC1 LLCC1(b)	0.0	0.0	0.0	0.0	0.0	12.0	8.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC1 LLCC1(c)	0.0	0.0	0.0	0.0	0.0	0.0	16.4	14.3	4.1	3.3	2.5	1.6	0.8	0.0
BC2	1.6	2.1	2.2	1.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC2 LLCC1(a)	0.0	0.0	0.1	0.7	1.5	1.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC2 LLCC1(b)	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0
BC2 LLCC1(c)	0.0	0.0	0.0	0.0	0.0	0.0	1.0	1.7	1.6	1.3	1.0	0.6	0.3	0.0
BC3	6.6	8.2	8.9	7.7	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC3 LLCC1(a)	0.0	0.0	0.3	2.9	6.2	6.4	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC3 LLCC1(b)	0.0	0.0	0.0	0.0	0.0	2.6	2.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0
BC3 LLCC1(c)	0.0	0.0	0.0	0.0	0.0	0.0	4.1	6.9	6.5	5.2	3.9	2.6	1.3	0.0
BC4	1.6	2.5	4.2	2.5	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BC4 LLCC1(a)	0.0	0.0	0.1	1.0	2.1	2.8	1.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0
BC4 LLCC1(b)	0.0	0.0	0.0	0.0	0.0	0.9	0.9	0.9	0.2	0.0	0.0	0.0	0.0	0.0
BC4 LLCC1(c)	0.0	0.0	0.0	0.0	0.0	0.0	1.6	2.9	3.9	3.3	2.5	1.6	0.8	0.0
BC5	0.3	0.5	1.3	1.5	2.8	2.8	2.5	1.8	0.7	0.0	0.0	0.0	0.0	0.0
BC5 LLCC1(a)	0.0	0.0	0.0	0.6	1.5	2.6	2.6	2.6	2.6	0.0	0.0	0.0	0.0	0.0
BC5 LLCC1(b)	0.0	0.0	0.0	0.0	0.0	1.1	1.1	1.1	1.1	0.3	0.0	0.0	0.0	0.0
BC5 LLCC1(c)	0.0	0.0	0.0	0.0	0.0	0.0	2.6	5.5	8.8	11.8	11.2	10.2	9.2	8.2
BC6	1.3	2.0	5.1	6.0	11.2	11.3	9.9	7.1	2.8	0.0	0.0	0.0	0.0	0.0
BC6 LLCC1(a)	0.0	0.0	0.1	2.2	5.9	10.3	10.3	10.3	10.3	0.0	0.0	0.0	0.0	0.0
BC6 LLCC1(b)	0.0	0.0	0.0	0.0	0.0	4.4	4.4	4.4	4.4	1.4	0.0	0.0	0.0	0.0
BC6 LLCC1(c)	0.0	0.0	0.0	0.0	0.0	0.0	10.2	21.9	35.0	47.2	44.6	40.7	36.7	32.8
PC7	6.0	8.5	10.4	9.2	5.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PC7 LLCC1(a)	0.0	0.0	0.3	3.4	7.4	10.0	4.6	7.2	0.0	0.0	0.0	0.0	0.0	0.0
PC7 LLCC1(b)	0.0	0.0	0.0	0.0	0.0	3.4	3.4	3.4	0.4	0.0	0.0	0.0	0.0	0.0
PC7 LLCC1(c)	0.0	0.0	0.0	0.0	0.0	0.0	5.8	10.6	14.3	13.4	12.1	10.8	9.5	8.2

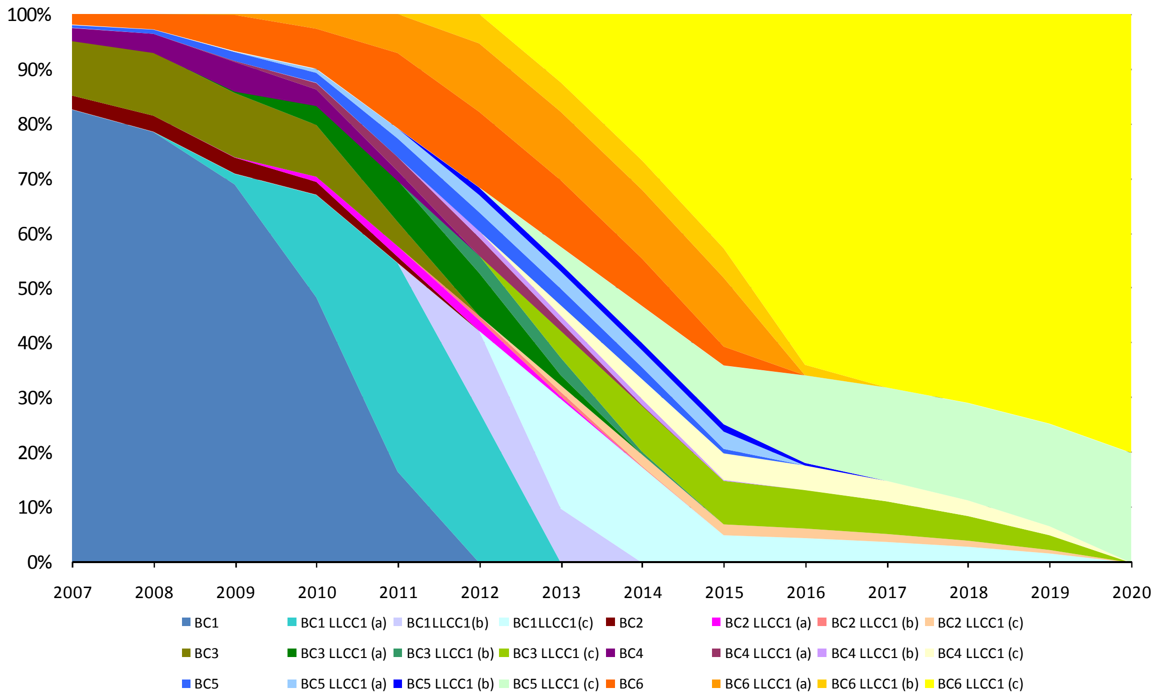


Figure 8-6: Significance of each of the Base Cases and improved LLCC1 scenario in term of stock (in %) (EU-27)

The analysis of the environmental impacts of complex STBs through EcoReport with the LLCC1 stock and sales configuration, shows that the penetration of improved complex STBs could reduce the environmental impacts of complex STBs compared to the 2020 BAU situation (see Figure 8-7).

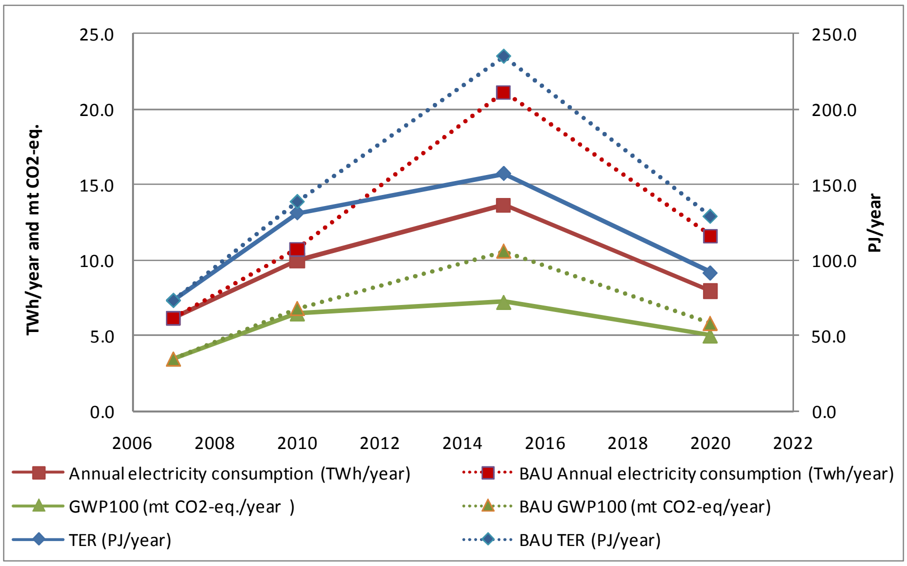


Figure 8-7: Environmental impacts – LLCC1 scenario

The LLCC1 scenario shows that for the total stock of complex STB in EU 27:

- TER during the whole life cycle of the installed base of complex STBs will reach 86.8 PJ/year in 2020, with a peak of 153.9 PJ/year in 2015 (see Figure

8-7), representing a 35% and 33% reduction compared to the same year BAU situation in 2015 and 2020, respectively.

- Annual electricity consumption of the installed base of complex STBs during the use phase will reach 7.6 TWh/year in 2020, with a peak of 13.4 TWh/year in 2015 (see Figure 8-7 and Figure 8-8), representing a 37% and 35% reduction compared to the same year BAU situation in 2015 and 2020, respectively.
- Greenhouse gases emissions of the installed base over product life will reach 4.4 million ton CO2-eq, with a peak of 7.1 million ton CO2-eq in 2015 (see Figure 8-4), i.e. this represents a 33% and 25% reduction compared to the same year BAU situation in 2015 and 2020, respectively.

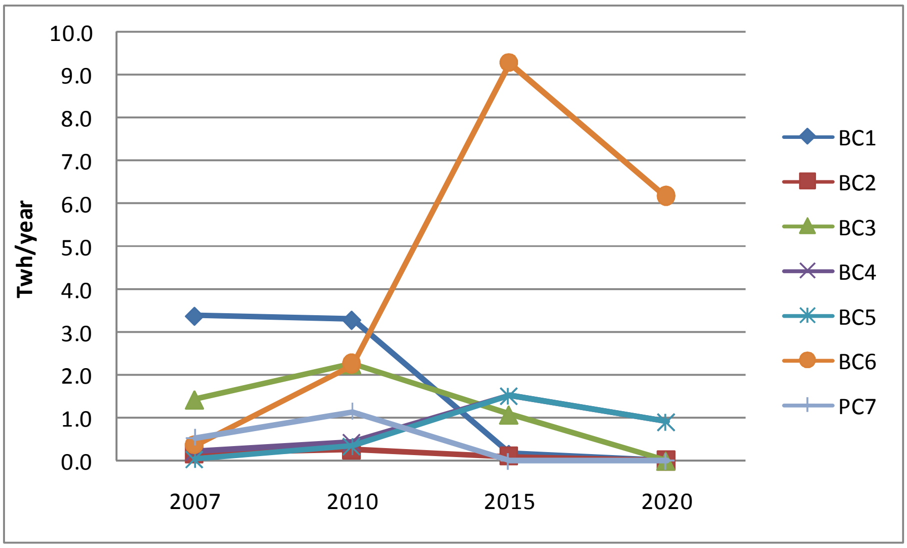


Figure 8-8: Annual electricity consumption per Base Case/ Product Case– LLCC1 scenario

Details on the improvement potential of LLCC1 compared to the BAU scenario for different environmental indicators are summarised in Table 8-10.

Table 8-10: Environmental Impact reduction potential of LLCC1 compared to BAU

Environmental impact reduction potential (% and absolute)	2010		2015		2020	
Total TER (PJ /year)	5%[245]	7.6	35%	81.4	33%	42.5
Total Annual electricity consumption (TWh/year)	5%	0.6	37%	7.7	35%	4.0
Total CO2-eq (Mt CO_2-eq/year)	5%	0.3	33%	3.6	25%	1.5

8.1.3.2 Mode Approach vs. TEC approach

These LLCC power requirement levels (Table 4-15) can also be expressed in terms of TEC ("Total Electricity Consumption") per year given a fixed use pattern scenario.

245 Please read: "LLCC1 scenario situation has 5% (or 7.6 PJ/yr) less impacts in 2010 compared to BAU-2010 situation in terms of TER"

Taking into account the reference use patterns as defined in Table 8-11, the maximum power requirements levels defined in Table 4-15 can be translated into TEC values. The reference use patterns differ from the typical use pattern defined in Task 3 as these represent actual usages of the box (not an average use pattern).

Table 8-11: Different use patterns (hours/day) depending on the complex STB configuration

STB (DVB-C, -S, -T, IPTV)	Use pattern(based on definitions in Task 3 and 6)
	w/o APD
On-mode	9 (HDD 1.5) (IPTV modem 10.5)
Active standby	15 (HDD 22.5) (IPTV modem 13.5)
Disconnected mode	0
Off mode	0
Low power standby	0

Table 8-12: Total Electricity Consumption (TEC) per year at the point of LLCC1(a)

STB (DVB-C, -S, -T, IPTV)	TEC at point of LLCC1(a) (kWh/year)
	w/o APD
Basic "complex" STB, including all typical interfaces, digit display, CI and/or CAM, etc.	40.0
Additional power consumption for • Hard disk drive / internal mass storage media • Second tuner / multiple tuners • High definition capability • Return path	 18.5 20.4 40.0 78.0
According to LLCC1 scenario, assumed to be reached by 100% of products sold after	1.5 years

8.1.4. LLCC2 SCENARIO

8.1.4.1 Scenario development

The LLCC2 scenario investigates the effects of further improvement (the starting point is therefore the products as described in LLCC1 scenario) through the implementation of[246]:

- Automatic Power Down (option 3), and
- Low power standby (option 1) (subject to the possibility, that the user actively disables this mode).

246 Implementation of options 1 and 3 on top of the improvements realised in the LLCC1 scenario

As analysed in Tasks 6 and 7, APD enables to reduce the on-mode time from 9 to 4.5 hours for complex STBs without internal mass storage media and from 10.5 to 6 hours and with internal mass storage media.

In order to better capture the effects of the speed of penetration of complex STBs with APD and a low power standby mode on the market, two alternatives of the LLCC2 scenario are proposed (see Figure 8-9):

- One "regular LLCC2" scenario (LLCC2-1) considering that the LLCC1 (a) levels are achieved after 1.5 year for 100% sales, and the 2 W low power standby mode is adopted on the market after 4 years (i.e. APD and 2W low power standby mode on 100% of product sold), and that the APD and the 1W low power mode reach the market after 5 years. This scenario therefore defines 3 different performance levels, based on the LLCC point identified in Task 7:
  - LLCC2-1 (a) = LLCC1 (a) level as defined in the LLCC1 scenario reached for 100% product sold in mid 2011 (+1.5 years)
  - LLCC2-1 (b) = LLCC1 (c) level as defined in the LLCC1 scenario + improvement through APD + 2W low power standby mode reached for 100% product sold in end 2013 (+ 4 years)
  - LLCC2-1 (c) = LLCC1 (c) level as defined in the LLCC1 scenario + improvement through APD + 1W low power standby mode reached for 100% product sold in end 2014 (+ 5 years)
- One "fast LLCC2" scenario (LLCC2-2) considering that the LLCC1 (a) levels are achieved after 1.5 year for 100% sales, and the APD and the 2 W low power standby mode is adopted on the market after 2.5 years, followed by the adoption of APD and the 1 W low power standby mode after 4 years.
  - LLCC2-2 (a) = LLCC1 (a) level as defined in the LLCC1 scenario reached for 100% product sold in mid 2011 (+1.5 years)
  - LLCC2-2 (b) = LLCC1 (b) level as defined in the LLCC1 scenario + improvement through APD + 2W low power standby mode reached for 100% product sold in mid 2012 (+2.5 years)
  - LLCC2-2 (c) = LLCC1 (c) level as defined in the LLCC1 scenario + improvement through APD + 1W low power standby mode reached for 100% product sold in end 2013 (+ 4 years)

In both cases ('regular" and fast" LLCC2 scenarios), for the years preceding the penetration of APD we keep the same assumptions as for the LLCC1 (a) performance level defined in the LLCC1 scenario (in term of market shares and power requirements levels).

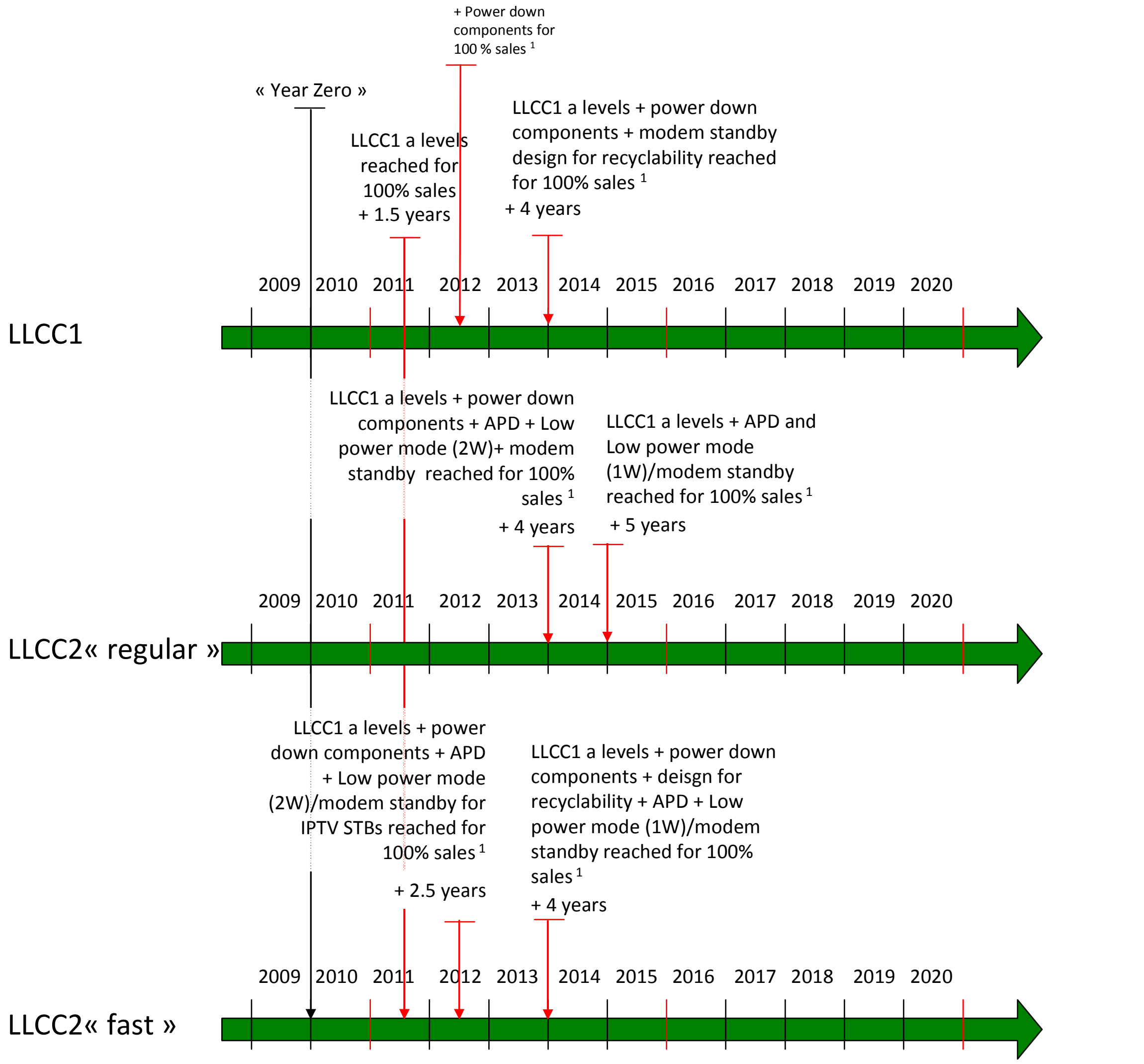
The sales and stock distribution for the LLCC2-1 scenario were recalculated based on the assumptions related to share of improved products put on the market (see Table 8-13).

Table 8-13: Estimated share of improved LLCC2-1 complex STBs in annual sales

Sales	% Base Case level	% LLCC2-1 level (a)	% LLCC2-1 level (b)	% LLCC2-1 level (c)
2007	100.0%	0.0%	0.0%	0.0%
2008	100.0%	0.0%	0.0%	0.0%
2009	95.0%	5.0%	0.0%	0.0%
2010	65.0%	35.0%	0.0%	0.0%
2011	50.0%	50.0%	0.0%	0.0%
2012	0.0%	50.0%	50.0%	0.0%
2013	0.0%	0.0%	100.0%	0.0%
2014	0.0%	0.0%	0.0%	100.0%
2015	0.0%	0.0%	0.0%	100.0%
2016	0.0%	0.0%	0.0%	100.0%
2017	0.0%	0.0%	0.0%	100.0%
2018	0.0%	0.0%	0.0%	100.0%
2019	0.0%	0.0%	0.0%	100.0%
2020	0.0%	0.0%	0.0%	100.0%

For the LLCC2-2 scenario, the same distribution of the sales and of the stock as for the LLCC1 scenario was assumed (i.e. % LLCC1 (x) sold for year n= % LLCC2-2 (x) sold for year n where x=a, b and c, and 2007 ≤ n ≤ 2020).

Also, to underline the differences between the LLCC2 “regular” and LLCC2 “fast” scenario, the environmental impacts of complex STBs for the years 2012, 2013, and 2014 are also calculated.



[1] the different improvement options are only applied where relevant (e.g. no « power down components » for the product case 7)

Figure 8-9: Timeline and assumptions used in the LLCC1 and LLCC2 scenarios

The LLCC2 “regular” scenario calculated with the EcoReport shows that the penetration of APD and Low power standby modes can achieve even greater reductions of the environmental impacts of complex STBs then the LLCC1 scenario, compared to the BAU scenario (see Figure 8-10).

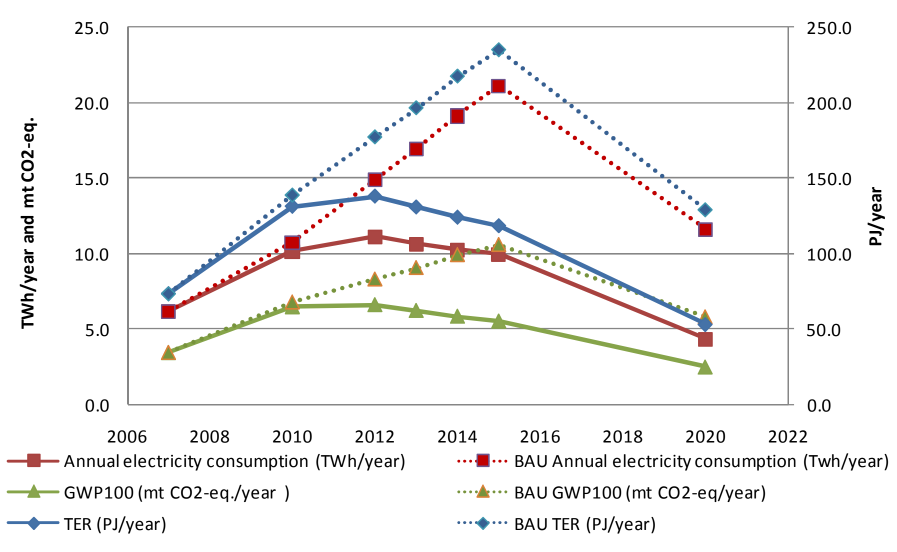


Figure 8-10: Environmental impacts – LLCC2 "regular" scenario

The LLCC2 "regular" scenario indicates that for the total stock of complex STB in EU 27:

- Total Energy Requirement (TER) during the whole life cycle of the installed base of complex set-top boxes (STBs) will reach 53.1 PJ/year in 2020, with a peak of 138.1 PJ/year in 2012 (see Figure 8-7), i.e. this represents a 22% and 59% reduction compared to the same year BAU situations in 2012 and 2020, respectively. The evolution of the total energy requirement continues to grow from 2007 to 2012 as the improvement of the complex STBs through the reduction of the power requirements in different operating modes is compensated by the growing market of complex STBs. In 2013, the introduction of APD and low power standby mode (2W) will drive the total energy requirement down to 130.9 PJ/year. In 2014, further improvement of the complex STBs will be reached through the penetration of 1 W low standby mode on the market and the total TER decreases down to 118.5 PJ/Year in 2015. After 2015, the market of complex STBs will decrease as these products merge with other equipment (e.g. media centres, see Task 2). As a consequence, the total energy requirement will be further reduced (see Figure 8-10).

- Annual electricity consumption of the installed base of complex STBs during the use-phase follows the same evolution as the TER and will reach 4.4 TWh/year in 2020, with a peak of 11.1 TWh/year in 2012 (see Figure 8-10 and Figure 8-11), i.e. this represents a 25% and 62% reduction compared to the same year BAU situations in 2012 and 2020, respectively.

- Greenhouse gases emissions of the installed base over product life will reach 2.5 million ton CO2-eq, with a peak of 6.6 million ton CO2-eq in 2012 (see Figure 8-10), representing a 21% and 57% reduction compared to the same year BAU situation in 2012 and 2020, respectively.

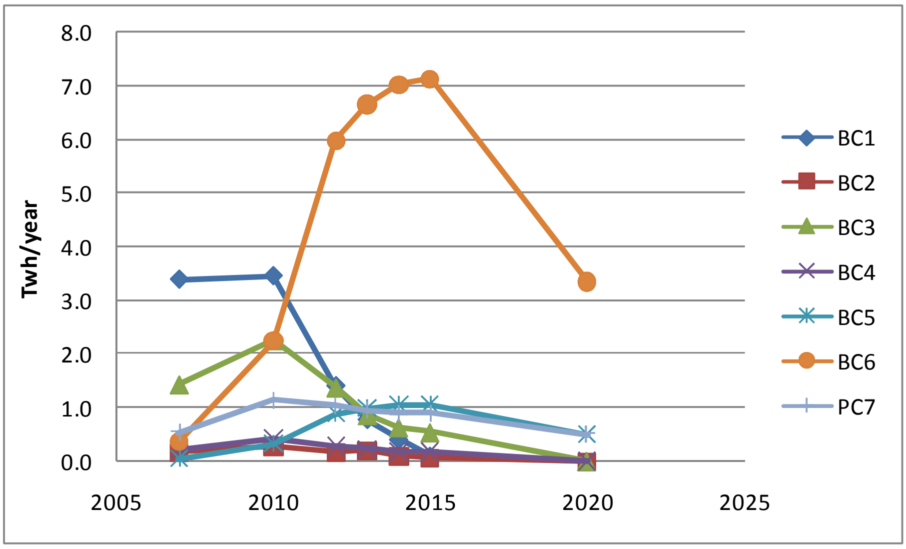


Figure 8-11: Annual electricity consumption per Base Case/ Product Case– LLCC2 "regular" scenario

Details on the improvement potential of LLCC2 "regular" compared to the BAU scenario for different environmental indicators are summarised in Table 8-14.

Table 8-14: Environmental impact reduction potential of LLCC2-1 compared to BAU

Environmental indicator reduction potential (% and absolute)	2010		2012		2013		2014		2015		2020	
Total TER (PJ /year)	5%	7.6	22%	39.5	34%	65.9	43%	93.7	50%	116.8	59%	76.2
Total Annual electricity consumption (TWh/year)	5%	0.6	25%	3.8	37%	6.3	46%	8.8	53%	11.1	62%	7.3
Total CO2-eq (Mt CO_2-eq/year)	5%	0.3	21%	1.7	31%	2.9	41%	4.1	48%	5.1	57%	3.3

In comparison, an accelerated version of this scenario (LLCC2 "fast" scenario) shows that an earlier introduction of highly improved products on the market (see Figure 8-9) would further increase the environmental benefits in year 2013.

The detailed improvement potential for the LLCC2 "fast" compared to the BAU scenario per environmental indicator are summarised in Table 8-15. Due to the assumptions on the evolution of the stock, only the year 2013 differ from the LLCC2 "regular" scenario.

Table 8-15: Environmental impact reduction potential of LLCC2-2 compared to BAU

Environmental impact reduction potential (% and absolute) for the year 2013 – LLCC2 "regular scenario" and LLCC2 "fast scenario" vs. BAU scenario	2013 "regular"		2013 "fast"	
Total TER (PJ /year)	34%	65.9	35%	68.1
Total Annual electricity consumption (TWh/year)	37%	6.3	38%	6.5
Total CO2-eq (Mt CO_2-eq/year)	31%	2.9	33%	3.0

8.1.4.2 Mode approach vs. TEC approach

The performance levels assumed to be achieved by future STBs in the LLCC2 scenario could also be translated into TEC values (kWh/year) based on reference usage patterns as presented in Table 8-16.

Table 8-16: Different use patterns depending on the complex STB configuration

STB (DVB-C, -S, -T, IPTV)	Use pattern(based on definitions in Task 3 and 6)				
	w/o APD	with APD	with APD and modem standby for home residential gateways only (triple play IPTV boxes)	With APD and 2W low-power standby	With APD, modem standby, 1W low-power standby
On-mode (h/d)	9 (HDD 1.5h) (modem 6h)	4.5 (HDD 1.5h) (modem 6h)	4.5 (HDD 1.5h) (modem 6h)	4.5 (HDD 1.5h)	4.5 (HDD 1.5h)
Active standby (h/d)	15 (HDD 22.5h) (modem 18)	19.5 (HDD 22.5h) (modem 18)	19.5 (HDD 22.5h) (modem 18)	3.5 (HDD 6.5 =4.5-1.5+3.5)	3.5 (HDD 6.5 =4.5-1.5+3.5)
Disconnected mode (h/d)	0	0	0	0	0
Off mode (h/d)	0	0	0	0	0
Low power standby (h/d)	0	0	0	16	16

Table 8-17: Total Electricity Consumption (TEC) per year at point of LLCC

STB (DVB-C, -S, -T, IPTV)	TEC at point of LLCC (kWh/year)				
	w/o APD	with APD	with APD and modem standby for home residential gateways only (triple play IPTV boxes)	With APD and 2W low-power standby	With APD, modem standby, 1W low-power standby
Basic "complex" STB, including all typical interfaces, digit display, CI and/or CAM, etc.	40.0	32.2	32.2	27.6	21.7
Additional power consumption for					
• Hard disk drive / internal mass storage media	18.5	18.5	18.5	7.4	7.4
• Second tuner / multiple tuners	20.4	14.1	14.1	8.9	8.9
• High definition capability	40.0	32.2	32.2	15.9	15.9
• Return path	78.0	78.0	51.6	26.0	21.3
According to LLCC2 scenario, assumed to be achieved by 100% of the STBs sold after	1.5 years		2.5 years	2.5 years	4 years

For home residential gateways ("triple play box"/IPTV) note that the same levels of performance could be reached unless where it is inappropriate for the intended use – which explicitly means VoIP.

For STBs which do not need the exceptional 1 hour per day wake-up period from low power standby more often than once every 14 days (measures to be documented) might calculate TEC with an adapted use profile of 3 h/d active standby and 16.5 h/d low power standby. Same conditions apply for STBs, which wake-up maximum every 2 hours from low power standby (for 5 minutes maximum each time, once for up to 1 hour). STBs which fulfil both, maximum wake-up every 2 hours and less than every 14 days need of the exceptional 1 hour wake-up time, the TEC calculation might be based on 2 h/d active standby and 17.5 h/d low power standby.

8.2. POLICY ANALYSIS

The calculations made in the Task 7 show that the potential TEC savings range between 43.9% (for the Product Case 7) and 59.7% (for the Base Case 6) when cumulating several options. Hence, by integrating some of these improvement potentials in the design, significant energy savings could be made by using more energy efficient complex STBs. Mandatory and/or voluntary measures could help in achieving these improvement targets.

This section presents both regulatory initiatives and non-regulatory actions such as voluntary labelling programs that have been put in place in Europe and in countries outside Europe to eliminate low efficiency appliances on the market or/and accelerate the number of high efficiency appliances.

It also provides a comparison of the different performance levels defined by the LLCC1 and LLCC2 scenarios with the performance levels provided by existing voluntary measures and analyses the overlaps with the requirements in the recent (draft) EuP Implementing Measure on standby and off mode losses.

8.2.1. Minimum Energy Performance Standards (MEPS) and other mandatory requirements

Switzerland, Australia and New Zealand are preparing mandatory legislation i.e. Minimum Energy Performance Standards (MEPS) for complex STBs (see Task 1, section § 1.3.3.). Mandatory MEPS are designed to accelerate the elimination of less efficient appliances on the market rather than to promote the most efficient (as in the case of the Japanese Top Runner program). As these regulations are still under development no comparison with the different performance levels defined by the LLCC1 and LLCC2 scenarios is provided here. Nevertheless, it is worth mentioning that the draft requirements presented in the possible Swiss regulation 2010 – 2012 and the forthcoming MEPS requirements from 1 December 2008 for digital STBs in Australia both set limits in terms of maximum power requirement levels (W) per operating mode (i.e. a mode approach) whereas the Energy Star program (see later sections 8.2.3.) rather adopts a TEC approach. The TEC approach basically can achieve the same power savings as a distinction by mode but leaves a higher level of flexibility to manufacturers which mode to improve by how much.

Nevertheless, if a TEC approach is preferred the actual / measured power consumption in:

- On-mode,
- Active standby and
- (where applicable) Low power standby (i.e. passive standby)

could be stated in the product's ecological profile / product documentation (i.e. combined TEC and mode approach).

The Swiss regulation Tier 1 proposes a 2 W allowance for the additional functionality corresponding to an internal hard disk drive, independently of the HDD storage size (no specific allowance for HDD in the forthcoming Australia/ New Zealand regulation).

However, in case MEPS are set, it might be advisable to allow for a higher MEPS accounting for the capacity of the internal storage medium, otherwise high capacity storage media might be seen as a disadvantage compared to low capacity products. Such an additional allowance would foster the use of the STB PVR as master STBs (one storage medium only instead of distributed stand-alone STBs with individual storage medias) and as replacement for players with removable media (DVD, Blu-ray disk; which would limit the number of devices and hence a more efficient use of the "recording / playback feature").

This additional allowance could be 1 W in on-mode for HDDs ≥ 320 GB, 1.5 W ≥ 500 GB in the short term and 2 W ≥ 1 TB in the long term (see Table 8-18 and Table 8-19)

Table 8-18: Power requirement HDD feature of complex STBs – distinction of storage capacity of HDDs

STB (DVB-C, -S, -T, IPTV)	TEC at point of LLCC (kWh/a)
	w/o APD[247]
Additional power consumption for Hard disk drive / internal mass storage media feature	
• < 320 GB	18.5
• 320≤…<500 GB	19.0
• 500 GB ≤ … < 1 TB	19.3
• ≥ 1 TB	19.5
Assumed to be achieved by 100% of STBs sold after	1.5 years

Table 8-19: TEC of the HHDD feature – distinction of storage capacity of HDDs

STB (DVB-C, -S, -T, IPTV)	TEC at point of LLCC (kWh/a) (1.5 h/d in on-mode, 22.5 h/d in active standby mode)				
	w/o APD	with APD	with APD and modem standby	With APD and 2W low-power standby	With APD, modem standby, 1W low-power standby
Additional power consumption for Hard disk drive / internal mass storage media feature					(same as < 320 GB for all)
• < 320 GB	18.5				
• 320≤…<500 GB	19.0	19.0	19.0	7.9	7.9
• 500 GB ≤ … < 1 TB	19.3	19.3	19.3	8.2	7.9
• ≥ 1 TB	19.5	19.5	19.5	8.4	7.9

MEPS do not (and cannot) address the following LLCC design options:

- Power down (non-used) components in on-mode
- Design for Recyclability
- Disabling functionalities

However, Task 7 showed that these aspects could be addressed with through:

- Reducing the on mode power consumption: it could be possible to reduce the power consumption in on-mode (documentation of modes and actual power consumption required), when:

247 Reference use pattern: On-mode=1.5 h/day; Active Standby mode=22.5 h/day; Off mode: 0/day; Disconnected mode: 0/day

  - only a Standard Definition resolution, but no High Definition signal (advanced codec) is processed (requirement for HD STBs only)
  - the hard disk drive is not meant to record / play any content (requirement for complex STBs with internal mass storage media only)
  - STB is used for free-to-air broadcasts only (i.e. Conditional Access Module / decryption system inactive)
  - Second / multiple tuner is in-active (no parallel broadcast watched or recorded)

  For example, documentation for the end user could be provided in order for him to know whether or whether not these options are implemented (and power consumption values, in case these are already implemented). Further, a possibility would be to make reduction of the on-mode power consumption mandatory (+ 2.5 years).

- Design for Recyclability
  - all STBs and triple play boxes (home residential gateways) with an external power supply (i.e. typically running on 12 VDC) and all remote controls
    - could have plastic housing parts (fully plastics, or only front- and/or backside plastics parts) only be fixed with snap-in connectors or similar, but no fixations by screws or glue or similar (exemption: fixation of connectors, which otherwise might be subject to mechanical reliability concerns)
    - could have printed circuit boards affixed to the housing only by snap-in connectors or similar, but no fixations by screws or glue or similar (exemption: fixation of connectors, which otherwise might be subject to mechanical reliability concerns)
  - all plastics housing parts could be of a uniform type of plastics (unless easily separable) and without any surface coating (except for small brand name prints, button markings and similar) which hinders recycling of these plastics for a similar purpose

  STBs, which are provided by a service provider on a refund or lease base and for which the provider can demonstrate a high rate of take back and refurbishment and reuse of STBs and parts, this requirement might be waived.

- Disabling certain features:
  - Product documentation could provide:
    - Instructions, how to disable them (menu could provide this information on the first level)
    - Example calculation for the consumer, how much electricity costs can be saved by disabling this feature (based on EU average electricity rate, a clearly presented use pattern and 4 years lifetime))

- the cost incentive for the consumer in a prominent place in the product documentation with a comparison with "conventional STBs" for STBs which do not provide certain features per se (i.e. there are retail STBs with HDD, which do not offer rewind at all)

As discussed at the stakeholder meeting, the possibility to disable features has an impact on functionality and therefore might not qualify for a mandatory requirement. Under the EU Eco-Label nevertheless this possibility might be encouraged by incentives.

Following the Art. 11 of the Ecodesign framework Directive ("Requirements for components and sub-assemblies") power consumption and efficiency values are highly relevant for

- Hard disk drives: Power consumption in the various modes of the HDD (read/write, depending on e.g. I/O operations per second, idle mode, motor start-up power consumption and power saving features) to allow STB developers an educated choice and optimal implementation. This would require a standardisation of HDD power measurements and duty cycles.
- External power supplies: Average active efficiency (as required by the draft Commission Regulation implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Ecodesign requirements for no-load condition electric power consumption and average active efficiency of external power supplies) and efficiency at low load (< 1 W, which is specifically important for the implementation of a low power standby mode).

Further parameters of relevancy for complex STBs which might be candidates for criteria of an ecological profile, are:

- Size of hard disk drive (if any) in inches diameter (distinction of 3.5", 2.5" and with a longer perspective maybe even smaller as indicator for production related impacts)
- Efficiency of internal power supply circuitry
- Typical boot times from low power standby to full operational mode (conditional access configured)
- Content of PVC based plastic parts (weight, in case policy target is to create incentives to phase out PVC)
- Precious metal content (gold finishes), printed circuit board sizes and types, electronic components (weight and type) – all these parameter have a demonstrated influence on production related environmental impacts, although a thorough, straight forward methodology to address these aspects is not at hand yet.

Moreover, MEPS do not adress

- Automatic Power Down (APD)(option 3) and

- Low power standby[248] (option 1)(subject to the possibility, that the user actively disables this mode)

which introduction of could be considered in parallel with the introduction of maximum power requirements.

In case less stringent minimum requirements are set, an Energy Labelling could provide strong incentives for a voluntary shift in the market. Comparative energy labelling promotes the introduction of energy efficient equipment on the market. Firstly, it helps buyers identify energy efficient cabinets without detailed technical knowledge. Secondly, it stimulates innovation and creates a challenge for manufacturers who seek to differentiate themselves from competitors on the basis of energy efficiency. An A to G class would need to be defined on the basis of the TEC value of the box.

The necessity of developing an Energy Label for complex STBs can be discussed as most of them are not directly sold to the end-user (no buying decision). Indeed, complex STBs are most of the time provided by service providers (i.e. not retail boxes). However, it is most likely that service providers will want to vehicle a good image of their company to their customers therefore choosing higher efficiency class products rather than low efficiency class products.

8.2.1.1 Specification of a test standard

The implementation of MEPS for complex STBs would require specifying the test standard used for measuring the power requirement levels in different modes (and calculating the TEC if a TEC approach is chosen) in order to have an accurate and repeatable measurement process.

The IEC 62087 (new version forecast publication date January 2009, section related to STBs currently being revised) could be the basis for defining the test standard but would require some adaptations in order to precisely define in which conditions the STB should be tested, e.g. the test standard should tackle issues such as (non exhaustive):

- In what software configuration should the complex STB be tested? A suggestion could be to test the STB with the software configuration as shipped to the end users.
- Should the conditional access be configured during the measurement? In case of retail boxes, which CA?

The Energy Star test procedure[249] for complex STBs could also provide a basis to define a test standard. However, it does not provide guidance on how to measure the "Low power standby mode".

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248 Mode to be entered by default, wake-up cycle maximum every 30 minutes, spending maximum 5 minutes in active standby or on-mode thereafter and entering low power standby thereafter automatically. One automatic wake-up period of up to 1 hour allowed per day.

249 www.energystar.gov/ia/partners/prod_development/revisions/downloads/settop_boxes/Procedure.pdf

8.2.2. EUROPEAN CODE OF CONDUCT FOR DIGITAL TV SERVICES

The comparison of the EU Code of Conduct for digital TV services Version 7 (from 1-1-2009 to 31-12-2009) with the LLCC1 (a) power requirement levels defined based on the LLCC points shows that the targets set by the CoC are more ambitious than the current status quo (Base Cases). However, they are less stringent than the LLCC1(a) levels set by the LLCC points identified in Task 7 (Tier 1 limits) (see Figure 8-12), more specifically in terms of base functionality power requirement (Figure 8-13).

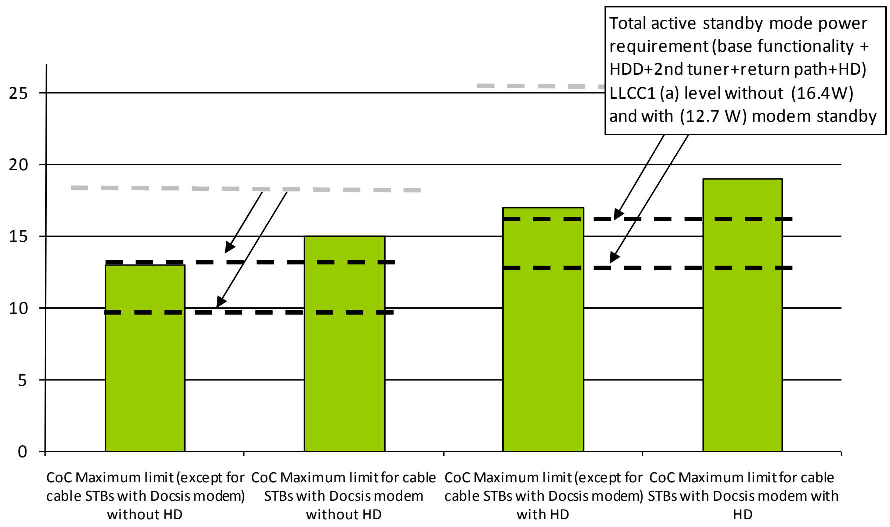

Figure 8-12: Comparison of CoC total maximum active standby mode power requirement targets with the total power requirement levels as defined by LLCC1(a)

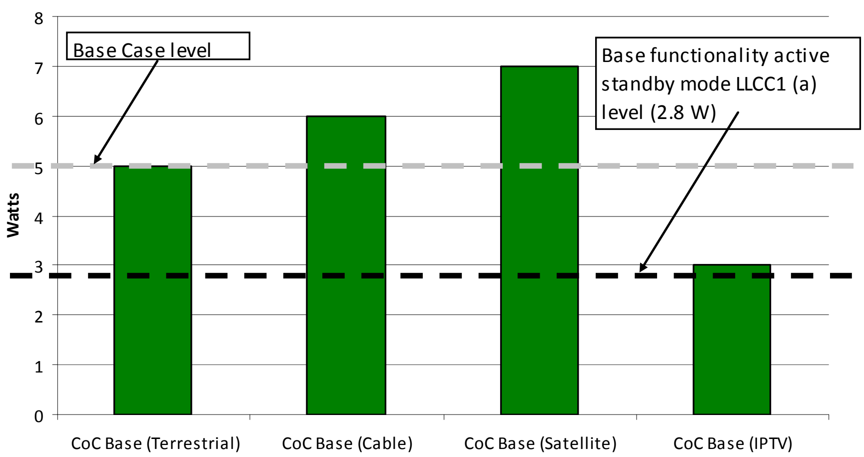

Figure 8-13: Comparison of CoC base functionality power requirement in active standby mode with the LLCC1(a) levels

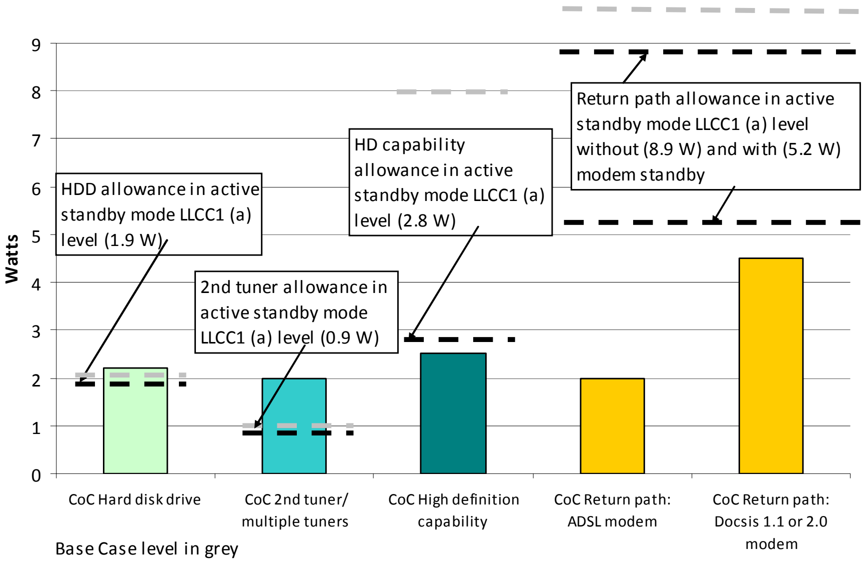

Figure 8-14: Comparison of the CoC power requirements with LLCC1(a) levels for additional functionalities in active standby mode

However, the CoC is undergoing a revision process, and new targets will probably be defined. A group of experts from the industry is developing a proposal for the next version of the CoC for digital TV services. A first draft of the proposal[250] indicates efficiency criteria in terms of TEC (kWh/year) and not in terms of power levels in different operating modes (W) (see Table 8-21). Standard use patterns are also provided by the industry's draft proposal. The only difference between these use pattern with the reference use patterns used to defined the LLCC1 (a) levels in kWh/year is the number of hours in on-mode for the DVR/HDD (2 hours here vs. 1.5 hours).

Table 8-20: Use patterns provided by the industry's draft proposal for the next CoC

STB with **NO** APD	**On**	**Standby**	
Daily time duration in this mode	T_{On}= 9h	$T_{Standby}$=15h	
STB **with** APD	**On**	**Standby**	**Standby from APD**
Daily time duration in this mode	T_{On}= 4.5h	$T_{Standby}$=15h	T_{APD} =4.5h

Mode	DVR (Hours/ Day)	Removable Media Playback (Hours/Day)	Removable Media Playback w/ Record capability (Hours/Day)
Hours On-Playback/ Record ($H_{Playrec}$)	2	1	1

250 A first version of this proposal was presented during the meeting of the CoC of September 9th 2008 sunbird.jrc.it/energyefficiency/pdf/meeting%20digital%20TV%209%20September%202008/indicative%20COC%20proposal%20-%2027-8-08.pdf

Table 8-21: Base and additional functionalities allowances in industry's draft proposal

Base Functionality	Tier1 (1Jan2010-31Dec2012) Annual Energy Allowance *(kWh/year)*	Tier2[1] (1jan2013->) Annual Energy Allowance *(kWh/year)*
Cable (KWh/year)	70	56
Satellite (KWh/year)	70	56
IP (KWh/year)	55	42
Terrestrial (KWh/year)	55	42
Thin-Client/Remote (KWh/year)	45	36

Additional Functionalities	Tier 1 Annual Energy Allowance *(kWh/year)*	Tier 2 Annual Energy Allowance *(kWh/year)*
Additional Tuners2	14	11
Adv. Video Processing3	18	12
DVR	60	32
Removable Media Player	12	8
Removable Media Player/Recorder	23	10
DOCSIS/EuroDOCSIS4	53	40
Home Network Interface	20	10
High Definition	18	12
Multi-Room	44	25

Based on the use pattern provided by the industry's draft proposal, the TEC defined by the Base Case levels and LLCC1 levels can be calculated and compared the limit values proposed by the industry. Table 8-22 shows the result of this comparison: in blue values which are less ambitious then the draft CoC limits, and in red the values which are more ambitious.

In general, the proposed draft CoC Tier 1 is significantly more ambitious than the current status quo (i.e. Base Cases), except for DVR: there is a clear mismatch of the proposed annual allowance with the typical power consumption values. As most of the complex STBs in the future are likely to be equipped with DVRs this could significantly weaken the CoC limits. Moreover, the CoC does not require the implementation of Auto Power Down, or of a low power standby mode.

The draft CoC Tier 2 limits are more ambitious then the Base Case levels, but in general they remain less stringent then the levels that could be reached at the point of LLCC identified in Task 7 (LLCC1(a) level).

Table 8-22: Comparison of Base Case and LLCC1(a) levels with industry's draft proposal

	Industry's proposal		Base case Levels (compared with the industry's proposal's Tier 1)	TEC at point of LLCC [LLCC1(a) levels] (compared with the industry's proposal Tier 2)				
	Tier 1 Annual Energy Allowance (1Jan2010-31Dec2012)	Tier 2 Annual Energy Allowance (1jan2013->)		w/o APD	with APD	with APD and modem standby	With APD and 2W low-power standby	With APD, modem standby, 1W low-power standby
Base Functionalities *(kWh/year)*								
Cable	70	56	60.2	40.0	32.2	32.2	27.6	21.7
Satellite	70	56						
IP	55	42						
Terrestrial	55	42						
Thin Client	45	36						
Additional Functionalities *(kWh/year)*								
Additional tuner	14	11	21.9	20.4	14.1	14.1	8.9	8.9
Adv. Video Processing	18	12	No separate additional allowance, included in high definition capability (see below)					
DVR	60	32	19.7	19.1	19.1	19.1	8.0	8.0
Removable Media Player	12	8	No separate additional allowance (seems to be a very minor market share currently)					
Removable Media Player/Recorder	23	10	Out of scope					
DOCSIS/EuroDOCSIS4	53	40	87.6[251]	78.0	78.0	51.6	26.0	21.3
Home Network Interface	20	10	No separate functional allowance					
High Definition	18	12	70.1	40.0	32.2	32.2	15.9	15.9
Multi-Room	44	25	No separate additional allowance					

8.2.3. US EPA ENERGY STAR PROGRAM FOR COMPLEX STBs

The Version 2.0 of the Energy Star program for complex STBs[252] provides efficiency limits expressed as TEC (kWh/year) for the base functionality and for additional functionalities of complex STBs. Using the same use pattern as presented in the Energy Star program (see Table 8-23 and Table 8-24) the TEC values equivalent to the points of LLCC identified in Task 7, and to the Base Case levels were calculated and compared with the efficiency limits defined in the Energy Star program.

Table 8-23: Use pattern as defined in the Energy Star program

Use pattern (h/d)	no APD	APD
On-mode	14	7
Active standby mode	10	10

251 (return path, i.e. including e.g. ADSL modem)

252 www.energystar.gov/ia/partners/prod_development/revisions/downloads/settop_boxes/Set-top_Boxes_Spec.pdf

Table 8-24: Duty Cycle for the DVR as defined in the Energy Star program

Mode	DVR (Hours/Day)	Removable Media Playback (Hours/Day)	Removable Media Playback w/ Record capability (Hours/Day)
Hours On-Playback ($H_{Playback}$)	2	2	2
Hours On-Record (H_{Record})	3	0	1

Table 8-25 shows that the Energy Star Tier 1 targets are more ambitious than the current status quo (i.e. Base Cases), except once again for DVR for which the proposed annual allowance is much higher than what was defined as the Base Case level. Neither the Energy star program for complex STBs version 2.0, nor the industry's draft proposal for the next CoC do not document the power requirements levels in the different operating modes which were the basis to calculate the overall TEC values presented.

Table 8-25: Comparison of Energy Star targets with the Base Case and LLCC performance levels

	Energy Star Version 2.0		Base case Levels (compared with the Energy Star Tier 1)	TEC at point of LLCC [LLCC1(a) levels] (compared with the Energy Star Tier 2)				
	Tier 1 Annual Energy Allowance (January 1, 2009)	Tier 2 Annual Energy Allowance (January 1, 2011)		w/o APD	with APD	with APD and modem standby	With APD and 2W low-power standby	With APD, modem standby, 1W low-power standby
Base Functionalities *(kWh/year)*								
Cable	70	50	60.2	48.5	36.5	36.5	32.4	27.1
Satellite	88	56						
IP	45	36						
Terrestrial	27	22						
Thin Client	27	22						
Additional Functionalities *(kWh/year)*								
Additional tuner	53	16	29.2	27.3	17.6	17.6	12.9	12.9
Additional tuner (Terrestrial and IP)	14	8						
Adv. Video Processing	18	12	No separate additional allowance, included in high definition capability (see below)					
DVR	60	32	19.7	19.9	19.9	19.9	12.7	12.7
Removable Media Player	12	8	No separate additional allowance (seems to be a very minor market share currently)					
Removable Media Player/Recorder	23	10	Out of scope					
DOCSIS/EuroDOCSIS4	20	TBD	87.6[253]	78.0	78.0	55.0	31.5	27.9
Home Network Interface	20	10	No separate additional allowance					
High Definition	35	12	70.1	48.5	36.5	36.5	21.9	21.9
Multi-Room	44	25	No separate additional allowance					

253 (return path, i.e. including e.g. ADSL modem)

8.2.4. EuP Implementing Measures (IM) for standby and off mode losses

The recent implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Ecodesign requirements for standby and off mode electric power consumption of electrical and electronic household and office equipment sets stage 1 and stage 2 requirements for the power consumption in these modes (see Task 1, § 1.1.2. for a detailed definition of these modes)

Complex STBs are not explicitly covered by the draft IM for standby and off mode losses[254]. However, this section provides a comparison between the recommended improvement targets and the IM requirements for standby and off mode losses.

Specific comments for complex STBs are provided in Table 8-26.

Table 8-26: Comparison of the LLCC improvement targets with the IM for standby and off mode losses

		Ecodesign Requirement	Comment
Stage 1 (+1 year)	a)	Power consumption in "Off mode": Power consumption of equipment in any off mode condition shall not exceed 1 W.	The off mode is however not relevant for complex STBs. A hard off switch is rather seen as inappropriate for complex STBs given the need for the STB to maintain regular contact with the service provider's network. Also, complex STBs have a long boot-time which may discourage some consumers from using the function even when implemented.
	b)	Power consumption in "Standby modes" The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 1.00 W. The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display, shall not exceed 2.00 W.	Corresponds to the implementation of low power mode (including reactivation on internal signal / timer). For complex STBs, considering the redesign cycle and the need for strong collaboration between service providers, STBs manufacturers, software/middleware providers, and silicon vendors such low power mode is not foreseen in the short term. However, with a TEC approach, the power consumption in a given mode is not subject to a minimum requirement as such.
	c)	Availability of Off mode and/or Standby mode Equipment shall, except where this is inappropriate for the intended use, provide Off mode and/or Standby mode, and/or another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source.	See above Stage 1 a) and b)
Stage 2 (+ 4 years)	a)	Power consumption in "Off mode": Power consumption of equipment in any off mode condition shall not exceed 0.50 W.	See above Stage 1. a)

[254] Complex STBs are not listed under the Annex I of the draft regulation published by the European Commission on 23/06/2008 see ec.europa.eu/energy/demand/legislation/doc/regulatory_committee/2008_06_23_standby_post_vote_en.pdf

		Ecodesign Requirement	Comment
	b)	Power consumption in "Standby modes" The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 0.50 W. The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display, shall not exceed 1.00 W.	A low power standby mode is taken into account in TEC calculations with 2 W for tier 2 and 1 W for tier 3.
	c)	Availability of Off mode and/or Standby mode Equipment shall, except where this is inappropriate for the intended use, provide Off mode and/or Standby mode, and/or another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source.	In line with the recommendation to have low power standby mode mandatory for complex STBs in the long term
	d)	Power management When equipment is not providing the main function, or when other energy using product(s) are not dependent on its functions, equipment shall, unless inappropriate for the intended use, offer a power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into – Standby mode, or – Off mode, or – Another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source. The power management function shall be activated before delivery.	In line with the recommendation to have APD mandatory for complex STBs in the long term

8.2.4.1 Conclusions

MEPS could be set either in terms of power requirements (“mode approach”) limits or in terms of total electricity consumption limits (“TEC approach”). If the TEC approach is chosen, it should be a must to declare the power levels for which the TEC is reached, and not only the TEC value. Indeed, end users are more familiar with the “Mode approach” (i.e. understands Power in WATTS better than a value of electricity consumption in kWh) more specifically for standby and it is recommended that the consumer is provided clearly understandable information on the actual power requirements of the device in different modes. However, the TEC provides flexibility for the STB manufacturer and is more representative of the actual electricity consumption of the STB (i.e. provides more information to the end user than e.g. the power requirement in standby mode as the On-mode will be significant in the electricity consumption of the STB)

8.3. IMPACT ANALYSIS, INDUSTRY AND CONSUMERS

8.3.1. IMPACT ON THE CONSUMER

Lifecycle cost calculations in Task 7 confirmed the existing improvement potentials as economically feasible for the manufacturer with a cost advantage for the consumer from the LLCC point of view. Savings for the consumer, in case ambitious requirements are set, are in the range of a few tens of Euros.

With the outlined measures no impact on convenience for the user is correlated.

The option to disable actively some (power consuming) functionalities and to deal with the standby settings means higher level of complexity regarding the user interface / menu. This might pose a problem for less technology-experienced consumers and cannot be avoided fully. However, it is up to the manufacturer / software developers to ease the use of these features.

8.3.2. IMPACT ON THE INDUSTRY

The goal of this section is to identify the potential impacts to setting eco-design requirements on manufacturers. Some identified impacts include:

- The capital investment needed by the manufacturer to upgrade or redesign his products and his production platforms, happening before the end-of-life of the production platform (typical life time is estimated to 4 years), can imply conversion costs that otherwise would not be required (earlier capital investments). However, redesign through component level modification does not always require upgrading the production platform.
- Redesign could affect the product quality and reliability for a short period of time. This could increase warranty costs to manufacturers.

The analysis shows that short term (+1.5) improvement can be technically achieved while being economically feasible for the manufacturer. It also shows that further improvement could be reached through the implementation of APD and low power mode standby.

Ambitious levels regarding power savings actually is in line with the promoted targets of a couple of leading semiconductor manufacturers and actually provides incentives for those, which are actively pushing power saving features. This holds true not only for the components manufacturers, but also for STB manufacturers as such: There are a couple of companies (partly EU based) which follow a stringent roadmap to save energy. Some even implement more costly power saving solutions, as they see a market demand for this, but not being able to transfer these added manufacturing and component costs to the consumer. Ambitious MEPS create a level playing field and force less active players to follow to remain on the market.

It should be noted that the implementation of a low power mode with a wake up/ sleep cycle will require a strong collaboration between all stakeholders (i.e. STB manufacturers, middleware and software providers, silicon vendors and service providers). A high level of collaboration between stakeholders will indeed be needed in order to ensure that the whole population of STBs will not “wake-up” at the same time as this could generate excess traffic on the service provider's network and would overload systems.

One example of a how to reach this objective could is provided by the UK Market Transformation Program[255]. Each service provider could be allocated one wake identifier (or many, depending on quantity of boxes being covered). This identifier would be associated with a unique time trigger for the service provider, which they could use as a flag within their boxes to control their wake scheduling. A standardisation organisation could be involved to act as an impartial party in allocating these time slots / trigger points.

8.3.3. PRODUCT DESIGN CYCLES AND TECHNOLOGY INNOVATION

Given the rapid innovation in complex STBs and the maximum redesign cycle of 4 years, it is important to provide clear long term (+4years) targets for all stakeholders, particularly manufacturers/silicon vendors/ middleware and software manufacturers, and to predetermining a date for a new specification levels.

8.4. SENSITIVITY ANALYSIS OF THE MAIN PARAMETERS

The robustness of the outcomes of the study depends on the underlying assumptions. These assumptions were already mentioned throughout of the study. The most critical aspects and assumptions are tested under this section, related to:

- The economic data, such as the electricity tariff which has an influence on the LCC,
- The assumptions on the typical use pattern as defined in Task 3.

8.4.1. ASSUMPTIONS ON THE USE PATTERN

The electricity consumption of complex STBs was calculated based on the assumptions on the typical use pattern as presented in Task 3. In this section we performed the EcoReport Base Case/Product Case analysis using a different use pattern as presented in Table 8-27.

Table 8-27: Assumptions for alternative use pattern

h/d	On-mode	Active Standby mode	Off mode	Disconnected
Task 3 without internal mass storage media	9	14.76	0.12	0.12
Task 3 without internal mass storage media	10.5	13.38	0.06	0.06
Alternative with internal mass storage media	4.5	17.1	1.2	1.2
Alternative with internal mass storage media	6	16.8	0.6	0.6

[255] Example provided by the UK Market Transformation Programme on November 17th 2008

The results show that the choice of the use pattern is a critical parameter when estimating the environmental impacts related to complex STBs. The longer the device is on-mode or in active standby, the higher the impacts (Table 8-28).

Table 8-28: Variation of the EU 27 environmental impacts of complex STBs (alternative use pattern)

main life cycle indicators	unit	Totals
Total Energy (GER)	PJ	14.4%
of which, electricity	TWh	16.3%
Water (process)*	mln.m3	9.1%
Waste, non-haz./ landfill*	kton	4.4%
Waste, hazardous/ incinerated*	kton	1.3%
Emissions (Air)		
Greenhouse Gases in GWP100	mt CO2eq.	13.4%
Acidifying agents (AP)	kt SO2eq.	12.9%
Volatile Org. Compounds (VOC)	kt	4.6%
Persistent Org. Pollutants (POP)	g i-Teq.	8.1%
Heavy Metals (HM)	ton Ni eq.	3.5%
PAHs	ton Ni eq.	2.6%
Particulate Matter (PM, dust)	kt	1.8%
Emissions (Water)		
Heavy Metals (HM)	ton Hg/20	2.2%
Eutrophication (EP)	kt PO4	0.3%

***=caution: low accuracy for production phase**

Moreover, the significance of the options which are meant to reduce the on-mode time and the time spend in active standby mode are of less significance while using a use pattern with e.g. lower on mode times and higher off mode times. For example the Auto Power Down option’s improvement potential is significantly decreased when lower on-mode times are assumed (about 5 fold reduction of the improvement potential with the alternative use pattern). On the contrary, the importance of the option “85% efficiency power supply” and of “hard off switch” is increased when the on-mode time and off-mode times are higher.

8.4.2. ASSUMPTIONS ON THE ELECTRICITY TARIFF

This section investigates to which extent the national differences in electricity tariffs as well as the general increase or decrease of these tariffs will influence the point of LLCC.

Table 8-29: Variation in total annual consumer expenditure (EU 27) depending on electricity tariff

Electricity Tariff (€ / 100 kWh)		Life Cycle Costs: total annual consumer expenditure in EU 27 (new products) million Euros							
		BC 1	BC 2	BC 3	BC 4	BC 5	BC 6	PC 7	Total
Bulgaria (BG)	6.6	2034	151	653	164	46	192	135	3374
Denmark (DK)	25.79	2657	184	923	203	56	262	235	4520
EU 27 Average	15.28	2316	166	775	182	50	224	180	3892

Table 8-29 shows that taking the lowest electricity tariff in EU 27 (Bulgaria) and the highest electricity tariff applied in EU 27 (in Denmark) implies approximately a ± 15% variation of the LCC.

The assessment leads to the conclusion that all measures and proposed improvement options will not be influenced in their applicability by whatever kind of assumed change of electricity tariffs.

Moreover, the high likeliness that the electricity tariffs will increase in the years to come[256] will actually increase the cost savings for the consumer in all parts of the EU.

8.4.3. CONCLUSIONS FOR THE SENSITIVITY ANALYSIS

The sensitivity analysis allows identifying the factors that could influence the various assumptions made on the improvement potential of the Base Cases. Some factors have a foreseeable effect such as the impact of the electricity tariff on the LCC. However, the assumptions on the electricity consumption are more sensitive. This is due to uncertainties on the assumed used pattern.

8.5. CONCLUSIONS FOR TASK 8

The various scenarios allow quantifying the effects of an increase in the energy efficiency of complex STBs in Europe. The BAU scenario shows that the total stock of complex STBs could represent an annual electricity consumption of 11.6 TWh in 2020 compared to 4.4 TWh in the case of a more optimistic scenario, based on the improvement potential identified in Task 7.

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256 See trend analysis provided by DG TREN, *Energy and Transport, Trends to 2030, update 2007*, 2008. bookshop.europa.eu/eubookshop/FileCache/PUBPDF/KOAC07001ENC/KOAC07001ENC_002.pdf

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ANNEXES

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ANNEX A: LIST OF EUROPEAN STANDARDS BASED ON DVB'S SPECIFICATIONS

Category	Number	Date of publication	Title
Transmission	EN 300 421 V1.1.2	08/97	Framing structure, channel coding and modulation for 11/12 GHz satellite services
	EN 302 307 V1.1.2	06/06	Second generation framing structure, channel coding and modulation systems for Broadcasting, Interactive Services, News Gathering and other broadband satellite applications
	EN 300 429 V1.2.1	04/98	Framing structure, channel coding and modulation for cable systems
	EN 300 473 V1.1.2	08/97	DVB Satellite Master Antenna Television (SMATV) distribution systems
	EN 300 744 V1.5.1	11/04	Framing structure, channel coding and modulation for digital terrestrial television
	EN 302 304 V1.1.1	11/04	Transmission system for handheld terminals
	EN 300 748 V1.1.2	08/97	Multipoint Video Distribution Systems (MVDS) at 10 GHz and above
	EN 300 749 V1.1.2	08/97	Framing structure, channel coding and modulation for MMDS systems below 10 GHz
	EN 301 701 V1.1.1	08/00	OFDM modulation for microwave digital terrestrial television
	EN 301 210 V1.1.1	02/99	Framing structure, channel coding and modulation for Digital Satellite News Gathering (DSNG) and other contribution applications by satellite
	EN 301 222 V1.1.1	07/99	Co-ordination channels associated with Digital Satellite News Gathering (DSNG)
Multiplexing	EN 300 468 V1.7.1	05/06	Specification for Service Information (SI) in DVB systems
	EN 300 472 V1.3.1	05/03	Specification for conveying ITU-R System B Teletext in DVB bitstreams
	EN 301 775 V1.2.1	05/03	Standard for conveying VBI data in DVB bitstreams
	EN 301 192 V1.4.1	11/04	Specification for data broadcasting
Subtitling	EN 300 743 V1.3.1	11/06	Subtitling systems
Interactivity	EN 301 193 V1.1.1	07/98	Interaction channel through the Digital Enhanced Cordless Telecommunications (DECT)
	EN 301 199 V1.2.1	06/99	Interaction channel for Local Multipoint Distribution System (LMDS) distribution systems
	EN 301 195 V1.1.1	02/99	Interaction channel through the Global System for Mobile Communications (GSM)
	EN 301 790 V1.4.1	09/05	Interaction channel for Satellite Distribution Systems

Category	Number	Date of publication	Title
	EN 301 958 V1.1.1	03/02	Digital Video Broadcasting (DVB); Specification of interaction channel for digital terrestrial TV including multiple access OFDM
Interfacing	EN 50221 V1	02/97	Common Interface Specification for Conditional Access and other Digital Video Broadcasting Decoder Applications
	EN 50083-9	2002	Interfaces for CATV/SMATV Headends and similar Professional Equipment

ANNEX B: STAKEHOLDER CONSULATION ON TYPICAL POWER CONSUMPTION

Feedback on typical power consumption was requested through a stakeholder questionnaire published on June 28, 2008. Following table was included in the questionnaire to present the estimates derived from available data on existing products.

Table 8-30: Suggested typical on mode and active standby power consumption based on available product data (as presented originally in the stakeholder consultation questionnaire)

STB (DVB-C, -S, -T, IPTV)	Typical power consumption (W)	
	On mode	Active standby
Basic "complex" STB, including all typical interfaces, digit display, CI and/or CAM, etc.	10	4
Additional power consumption for		
• Hard disk drive	+ 5	+ 2
• Second tuner / multiple tuners	+ 5	+ 1
• High definition capability	+ 8	+ 8
• Return path	+ 10	+ 6

A summary of the comments received from nine stakeholders (manufacturers or service providers) is following:

- For the question: "Given the broad span of products in the market, do you agree in principle that the power consumption stated above is "typical" for such STB configurations?" three respondents answered YES.
- Four replied NO supporting it with following, more detailed comments:
  - No. 1: on mode power consumption much higher (without stating values)
  - No. 2: no disagreement with on mode, but on (active) standby:
    - for DOCSIS cable modems standby today does not exist (no power management in the current DOCSIS specification)
    - In general the notion is challenged that there is such a thing as active standby, there are rather multiple power consumption modes in future STBs and to talk about on and active standby is too simplistic
  - No. 3:
    - Basic on mode is ok
    - Basic active standby is too low, should be 6.5 W in place of 4 W
    - Additional power related to high definition / advance coding might be +6W in both modes in place of +8W
    - Additional power for return path seems very high, rather +5W in both modes

- o No. 4:.HDD on mode 6-9 W depending on capacity [comment by the consultants: dependency is acknowledged, but major market share is assumed to be rather with the "lower" capacity HDDs, i.e. 80 GB currently]

At the final stakeholder meeting another industry expert raised concerns regarding HDD power consumption and provided a written statement after the meeting, that the least power consuming 3.5" HDDs are typically in the range of 8-10 W in on mode and they are aware of only one 3.5" HDD achieving less than 5 W currently (actually 4.7 W).

These conflicting comments don't allow for a consensus on typical power consumption levels and following modifications were made to the initial assumptions:

- Basic active standby adapted to 5 W
- Typical power consumption of HDD in on mode accounted for with +8 W
- Return path should indeed have same values for DOCSIS cable modems in on mode and active standby, for ADSL modems (IPTV mainly) this is not necessarily the case as there are power saving features in standby (L2 and L3 modes – basically meant for the headend equipment, but also the remote terminal end in principle can power down in these modes). Nevertheless, as cable modems are likely to have the higher market share and as enabled L2 and L3 modes are questionable, both values should be the same. The value is set on a higher level (i.e. +10W) as it is not only the modem as such, which is taken into account here, but also STBs with return path which are a premium segment with additional features (not only the 5 W of the modem itself is relevant, the modem / return path rather represents an "indicator" a certain type of complex STBs).

In light of these modifications, the updated typical power consumption levels are presented in the table below. With these adaptations, the assumptions for "typical" power consumption can be considered rather conservative.

Table 8-31: Updated typical on mode and active standby power consumption of complex STBs per functionality, based on available product data and stakeholder consultation

STB (DVB-C, -S, -T, IPTV)	typical power consumption (W)	
	On mode	Active standby
Basic "complex" STB, including all typical interfaces, digit display, CI and/or CAM, etc.	10	4 → 5
Additional power consumption for		
• Hard disk drive	+ 5 → +8	+ 2
• Second tuner / multiple tuners	+ 5	+ 1
• High definition capability	+ 8	+ 8
• Return path	+ 10	+ 6 → +10

ANNEX C: REGISTERED STAKEHOLDERS

Below is a list of Lot 18 preparatory study registered stakeholders (total of 245 individual organisations). Please note that all of them did not participate actively in the study, but they were regularly informed about the study and encouraged to contribute, and provide feedback.

Industry (Product manufacturers)

Beko Elektronik A.S.
Cisco Systems
Dream Multimedia
Echostar Europe
Handan
Hitachi
Kathrein
Motorola Home and Networks Mobility Solutions
Motorola Inc., Sweden
NEC
PACE
Philips Electronics
Sagem Communications
Samsung
Samsung Electronics
Scientific Atlanta
Siemens Scheiwz AG
Sony Electronics Inc
Suomen Schneider Ab
Technisat
Thomson
Triax A/S
VESTEL

Industry (Component manufacturers)

AMD
ARM
Broadcom Corporation
Microsoft
NXP Semiconductors
ON Semiconductor
ST Microelectronics
Texas Instruments
Zilog

Industry (Soft- / Middleware manufacturer)

NDS
Ocean Blue
Ip.access ltd
Interdirect
Digital STROM
Intel Corporation
Echostar

Industry (Manuf. with other linked activities)

3 M
Adhoco AG
Bayer MaterialScience
ciq
Dassault Systems
EBV Elektronik BmbH & Co. KG
Flextronics
Fujitsu General Ltd.
Genpact
Hitachi, Ltd.
HP
Industrial Structure General Research Institute, Ltd.
Infineon Technologies AG
Integrated Service Technology Co.
Jabil circuit Belgium N.V.
JVC
lab
LG Electronics
Mitsubishi Electric Corp.
oneclick
Panasonic Europe Ltd.
Philips GmbH Zentraler Umweltschutz
Pioneer Corporation
Pioneer Europe NV
Sanyo
SetOne GmbH
Sharp Corporation
Sony Computer Entertainment Ltd
Sony Deutschland GmbH
TOSHIBA Cooperation
Winkler Communications
ZVEI e.V.

Industry (Broadcasters & Networks)

BSkyB
BT
Canal +
Freebox
Liberty Global
Orange
Premiere AG
S&L Communications
Sky Italia
Swisscom
T Com
Telenet
UPC Broadband Holding Services BV (subsidiary of Liberty Global)
Virgin Media
Digital Switchover Help Scheme

Austar
BigPond
T-online

Industry (Associations etc.)

ADAT
AeA Europe (American Electronics Association)
AMDEA
Consumer Electronics Association (CEA)
EICTA
ElektronikBranschen
EuroCommerce
IABM
Intellect
JBCE
KEA
Korea Environmental Council in Europe
Korean Electronics Association
SIMAVELEC
SWICO
Consumer Electronics Association
FAMBSI

Environmental NGOs

International Network for Sustainable Energy (INFORSE)
Schweizerische Agentur für Energieeffizienz
Energitjenesten SYD
Environment and Development Foundation
EEB - European Environmental Bureau
BSI
Stichting Natuur & Milieu
Energy Saving Trust
Taylor Hobson Precision
European Environmental Bureau
Danish Society for Nature Conservation
European Environmental Citizens' Organisation for Standardisation (asbl)
WWF
Stichting Natuur&Milieu
NRDC

Consumer NGOs

VDE Test and Certification Institute
Future Energy Solutions
Glengarnock Technology Centre
BEUC (Bureau Européen des Unions de Consommateurs)
DGCCRF
(Direction Générale de la Concurrence, de la Consommation et de la Répression des Fraudes)
CEMAGREF
(Agricultural and Environmental Engineering Research)
Consumer Council of DIN
International Sauna Society / Suomen Saunaseura

ANEC
BEUC/ ANEC
S.A.F.E. Swiss Agency for Efficient Energy Use
Sanyo BPL Private Limited
Consumentenbond
Conseil du Commerce de France
PERIFEM
(French technical association of Trade and Distribution
OIVO
European Community of Consumer Co-operatives
Confédération des Organisations familiales de la Communauté Européenne (COFACE)
Ricability

Institutes, Consultants

ITRI
Perchards
Öko-Institut e.V.
Viegand & Maagøe
PlesTech Ltd
eco-product research institute in korea
Austrian Energy Agency
Eco Stewardship Strategies
R. Brüniger AG Engineering&Consulting/
Swiss Federal office of Energy
AEA
TWI Ltd
AEA
BABT
Keene Public Affairs
Enviro-Solutions
Foresite Systems
Kreab
Viegand & MaagÃ¸e
Robert Harrison & Associates Ltd
German Advisory Council on the Environment
SGS TW Ltd.
Protiviti Japan Ltd
ProLog - Dr. Christoph Jehle
Danish Technological Institute
IVF Industrial Research and Development Corporation
Design Chain Associates, LCC
Taiwan Foundation of Industry Services
Nemko China
Ajou University
AIST
The Levinson Law Firm
Krug und Petersen Affairs and Consulting GmbH
Eamonn Bates Europe
Troyes University of Technology
Ecos

ZetaCast
Lawrence Berkeley National Laboratory
Finnish Environment Institute (=Research institute)
Interel
Pollet Environmental Consulting
eutema Technology Management GmbH
CERA
INPG
Meko Ltd
EuP Network Germany c/o Ökopol GmbH
Ökopol
Foundation of Taiwan industry service
KERP
The University of Tokyo
AEA Technology
ENVIRON
VITO
Viegand & Maagoe /
Danish Energy Authority
Université Libre de Bruxelles
IVF
Öko-Institut
Eco Product Research Institute
KEMA
Helsinki University of Technology
AEAT
Terra Novum
Australian Digital Testing
FTL
Fleishman Europe
Digital Technology Advisory
TWI
ADRENIO
Informa plc
EnergyConsult

Member State Authorities, Agencies

Federal Public Service, Belgium
dena
Business Enterprise and Regulatory Reform
Federal Environment Agency (UBA)
Danish Energy Authority
UK Government Market Transformation Programme
Natural Resources Canada
Ministry for the Environment (NL)
Slovak Innovation and Energy agency
Defra
Federal Public Service Environment
Ministry of Economy of the Slovak Republic
Danish Energy Agency/Danish Energy Authority

Federal Environment Agency
SenterNovem
Danish Environmental Protection Agency
UK Market Transformation Programme
BERR
UBA

International Agencies

International Energy Agency
US Department of Commerce, Office of the European Union

Miscellaneous

Arclite
Stiftung-Warentest
Power Integrations
Ofcom
PTC
SGS
Ajou university
TüV SüD Hong Kong
LG-Nortel
PIME
ENDS Europe
COX
Deutscher Kabelverband
JTS2 Communications Ltd

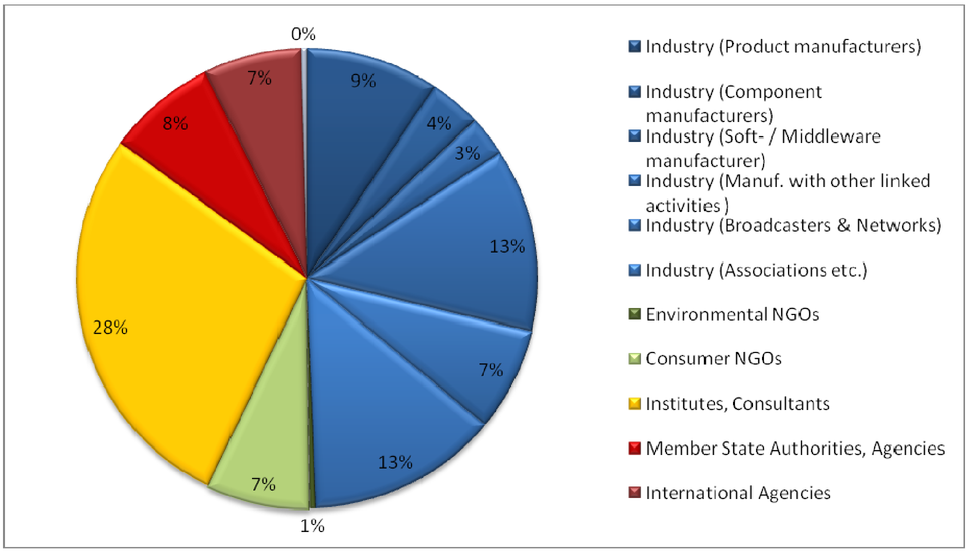

Figure A-1: Lot 18 Preparatory study stakeholder profile

ANNEX D: STAKEHOLDERS'COMMENTS TO INDIVIDUAL TASK REPORTS

Date	Task	Sub-section	Commented version's publication date	Page	Comment	Answer / Action
05/02/2008	**1**	-	18/12/2007	-	Overall, we need better definitions on the power modes, test methods. There are many open or "to be completed" sections.	Ok - completed where robust data available in the report
19/02/2008	**1**	-	18/12/2007	-	Current DVB standards based implementations of conditional access do require a more active mode of reception during standby in order to receive and respond to subscriber entitlement changes (Entitlement Management Messages – EMM's) and (for those systems that employ them) new service de-cryption keys. Standardisation has allowed interoperability and choice in the market place without restricting innovation or security. The role of middleware (such as NDS's Mediahighway solution) in complex STB's is not currently highlighted in the document. NDS feels that this is a serious omission as the control of the 'state' of the STB is typically under master control of the middleware, with hardware drivers (as typically supplied by the STB manufacturer) being slaved to the control of the middleware. Having a power saving 'aware' middleware architecture with appropriate interfaces to conditional access, EPG and STB hardware will be a key part of enabling deployments of complex STB's that meet the future power saving requirements as proposed by the Code of Conduct.	Ok, middleware aspects are addressed in later Tasks 4, 5 , and 6 and are now explicitly included in the scope of the study
15/01/2008	**1**	1.1	18/12/2007	4	"television broadcasting - …" In this part it is explained that Interactivity can be achieved and enhanced thanks to the use of a return channel. Then we fail to understand the reference that follows into brackets "(internet or mobile)"? In practice most of return channels when implemented use PSTN networks (PSTN modem or ADSL technology), or proprietary cable networks (using DOCSIS or EUDOCSIS). → You may in consequence want to remove this reference to "internet or mobile".	Deleted

Date	Task	Sub-section	Commented version's publication date	Page	Comment	Answer / Action
08/01/2008	**1**	1.1	18/12/2007	5, 8	On page 5 channels of media content delivery are discussed. On page 8 also the term 'transmission platform' is used. I doubt whether IPTV is a channel; IP as the name indicates is a protocol, that can be used on various channels. I suggest for the discussion to separate: - the transmission platform - the channel (air, various cables: twisted pair, fiber, coax); in practice to bring the signal from the source to the end-user various channels are used (e.g. air (satellite; to the cable head-end) and coax from the cable head-end to the user). What is relevant for the study is the channel to which the STB is connected. - the protocol (e.g. IP)	Modified in page 5 and 6
15/01/2008	**1**	1.1	18/12/2007	6	Par. 2 "internet Protocol (IP) STB", second bullet: Within the IP set top box category, it is mentioned that IP broadband connection can be provided through DSL, cable and optical. → This is correct but when the broadband access is provided by the cable network combined with (EU)-DOCSIS technology, the corresponding products are generally called "Cable STB", not "IP STB".	Modified
15/01/2008	**1**	1.1	18/12/2007	6	Par 3, "Trickle Video on demand IP Set top box" This paragraph mentions that Trickle video on demand more commonly called "push VoD" is related to IP set top boxes. Note that push VoD (where the content is pushed on a hard disc drive located in the set top box) is not an IP set top box exclusivity. This technology is used with satellite and cable also. → We would therefore suggest amending the proposed categorisation by explaining that the services provided by set top boxes can be divided into several main categories: 1. Access to Free To Air broadcast programs (same free program for all users) 2. Access to Pay TV broadcast programs 3. Access to full Video On Demand programs with several levels of interactivity (real video on demand, near video on demand, push video on demand) 4. Access to others services like DVR, Voice (telephone) and Data Then the so-called "simple STB" are the product compliant to provide ONLY the service 1 (FTA). All other services are handled by more complex products called "complex STB".	Categorisation per service introduced, reference to DVR not included (not seen as a "service"), and category (4) only falls indirectly under "complex STBs" (explanation given in the report)
20/02/2008	**1**	1.1	18/12/2007	6	Comment that STB cost is being pushed to consumer is not representative of the business model of many pay or subscriptions STBs.	Deleted

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08/01/2008	**1**	1.1	18/12/2007	6	What is the use of the categorisation on page 6 regarding regular broadcast, internet protocol and trickle VOD? Since conditional access is a crucial element in the definition of a complex STB, I would expect in this section (1.1) a discussion on service providers. Especially what type of service providers would require conditional access would be interesting to describe.	Categorisation of stbs was modified
19/02/2008	**1**	1.1	18/12/2007	6	Paragraph 3: Trickle video on demand is more commonly known as progressive download	Deleted, see comments above
19/02/2008	**1**	1.1	18/12/2007	6	FTA Receivers: Non-encoded is incorrect – should read non-encrypted	Ok
19/02/2008	**1**	1.1	18/12/2007	7	2.: Should be Conditional Access Module (CAM) slot	Ok
19/02/2008	**1**	1.1	18/12/2007	7	3.: Use of the term 'hard disk' – better replaced with 'internal mass storage media', this will make the terminology more future proof.	Ok, modified HDD and replaced by "internal mass storage media"
19/02/2008	**1**	1.1	18/12/2007	7	Convergence of products: 'telecom modems' should be 'data modems'	Ok
18/01/2008	**1**	1.1	18/12/2007	7	sub-categorisation of STBs - Receivers with a smartcard or common interface slot: We have STBs with and without smartcards. Some STBs provide CA without smartcards using a secure micro chip that is soldered to the circuit board, rather than having a removable card containing the chip. - Recorders: Again, most of the IP STB's with HDD manufactured by Scientific Atlanta do not include smartcard readers. We're also planning Cable STB's with HDD without smartcard readers	Clarifications added
19/02/2008	**1**	1.1	18/12/2007	8	Table 1-1: Satellite Adressability and Terrestrial Addressability are incorrect and possibly reflecting a specific EU market. Both of these services are available in the UK for example	Ok, see comments above
19/02/2008	**1**	1.1	18/12/2007	8	Data Encryption: STB's allow for decryption not encryption! Also the purpose of remaining in some current consumption mode is due to reception of subscription entitlements, firmware upgrades, guide data, progressive download of VOD material and other operator defined functions	Ok
05/02/2008	**1**	1.1	18/12/2007	8	Table 1-1: What is the true definition of DSL here? Proposed change: I think the DSL name should be changed here to IPTV STB.	Ok - changed DSL to IPTV
20/02/2008	**1**	1.1	18/12/2007	8	Table 1-1: Table is difficult to interpret. It appears to be attempting to map potential services onto broadcast platforms. In any event this represents today's functionality, but we are looking towards a regulation in 201x. Table 1-1 is also inaccurate particularly on the points of cable being the highest	Table title refers to "status", making clear this is the situation of today, no outlook; inaccuracy corrected in line with other stakeholder comments

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					capacity, terrestrial not having pay options and satellite not being addressable or having interactivity.	
15/01/2008	**1**	1.1.	18/12/2007	8	Table 1.1 In our opinion, this table contains some information that does not reflect the real European situation → For example: - "Sat dominated by FTA": This situation might be true for Germany, but pay TV and pay per view services are also common on Satellite in Europe. - "Pay TV not offered on terrestrial": This information is not correct: please refer to Canal+ in France, Top Up TV in UK, Sky-Italia…	Modified accordingly
05/02/2008	**1**	1.1	18/12/2007	9	[Existing product definitions] This document refers to coc Rev.5 Proposed change: I think this document should show the latest coc version, Rev 6.	Version 7 referenced now
15/01/2008	**1**	1.1.	18/12/2007	9	EU coc: this paragraph refers to coc version5. → Please find attached the current version7 of coc which is now properly referring to "Complex Set Top Box".	Modified accordingly
20/02/2008	**1**	1.1	18/12/2007	9, …(?), 16	We presume the use of "(free)" (whereby CA is equated with pay TV) is an editorial error. In section 1.1.1.1 the definition is given for a simple STB: here the use of the word "free" means without CA. It is not always the case that without CA means free. The more significant error is at the top of page 16, where the definition of a simple STB has been pasted in to the definition of a complex box.	Ok
05/02/2008	**1**	1.1	18/12/2007	10	Table: STB,digital TV with IRD. The last column is calling DSL, what is the definition of this? Proposed change: Again, I think this should be IPTV, plus IPTV STB can have off-air tuners of demodulator.	Ok

Date	Task	Sub-section	Commented version's publication date	Page	Comment	Answer / Action
15/01/2008	**1**	1.1.	18/12/2007	10	About the sentence below the "STB, Digital TV with IRD" table: Stand alone STB, Digital TVs with integrated receivers…. We would like to stress the fact that the table entitled "STB, Digital TV with IRD" in CoC V5 was not meant to list functions specific to complex STBs in order to differentiate them from simple ones. Please note that this table extracted from the EU CoC presents a list of functions that might be embedded in a STB in its basic configuration. In other words, it means that the listed functionalities do not provide any additional allowance for extra-power, their corresponding power consumption is supposed to be included in the max values defined for basic configurations. This exercise has no relationship with the objective of defining complex-standalone or simple STBs. → Please refer to our proposed categorisation above.	Table has been deleted for the sake of clarity
18/01/2008	**1**	1.1	18/12/2007	11	Existing Mode Definitions: - In our opinion, Energy Star's two modes of operation (On and Sleep) are more in line with the overall network operation of a cable or IP STB plant that the CoC's three operational modes (On, active standby and passive standby). On the surface passive standby sounds great, however what is not addressed in any of the recommended definitions for passive standby is the expected performance (from the standpoint of the time required to reach 100% of full operational capacity) once coming out of passive standby. For example, if DRAM is completely shutdown during passive standby, the client will have to be reloaded via FLASH, HDD, or network. This is a process which at the moment can take several minutes to 10s of minutes, especially if a new client needs to be loaded into FLASH. Now, there are ways around this by placing DRAM into a self refresh mode, however the turn on time still may not appear to be instant. Thus, the main point is that passive standby needs to be qualified with expected turn on performance. - On top of that, I'm sure you have seen the comments made by AeA and EICTA concerning the definitions on standby for LOT6. What is defined as "standby"? This mode defines the status in which the energy-using product is connected to a mains power source and offers only one or more of the following user oriented or protective functions: • To facilitate the activation of other modes (including active mode) by remote switch (including remote control), internal sensor, timer • Continuous function: information or status displays including clocks	No changes in task 1: Performance aspects will be taken into account, when it comes to "improvement options" and "policy options" in later tasks. In general, consistency with standby definitions given in the lot 6 study is aimed at. The lot 18 study has to takle standby for complex stbs regardless what the EC might plan as an horizontal IM on standby.

Date	Task	Sub-section	Commented version's publication date	Page	Comment	Answer / Action
					• Continuous function: sensor-based functions What is "networked standby"? This mode defines the mode in which the energy-using product is connected to a mains power source and at least one network function is available (such as reactivation via network command or network integrity communication). The energy-using product is also considered to be in "network standby", if the network function is active but not connected (e.g. cable unplugged). A network function in this context includes both one way (e.g. PC – monitor) and two way (e.g. PC – printer) communication between two or more devices. Another example of a network reactivation function is FAX, which is maintained in a standby condition to receive incoming transmission. A wide variety of network standby functions are present in energy-using products. Due to the complexity of this, networked standby is not addressed under the EuP Implementing Measure on Standby. Where necessary networked standby limits should be incorporated in Implementing Measures for specific ("vertical") product classes (e.g. imaging equipment, PCs) in which studies these modes have been suitably investigated. I believe DGTREN already confirmed that networked standby is too complex to be treated in LOT6, thus this will need to happen in LOT18. Does "standby" in LOT6 equal "Standby passive" or "Passive standby" defined at page 17? Would it then already be covered in LOT6?	
20/02/2008	**1**	1.1	18/12/2007	11-13, 17	In the definitions sections on page 11- 13 and in the table on page 17 there should be a definition for disconnected and it should be in the Off description. It is in the testing scenarios in IEC 62087.	ok
19/02/2008	**1**	1.1	18/12/2007	12	At the Paris IEA meeting in April 07,Energy Star made reference to an additional mode – 'Download Acquisition Mode – DAM' - this is not refereced here.	ok
20/02/2008	**1**	1.1	18/12/2007	12	"Sleep" mode. Energy Star recognises that a sleep mode may have similar power consumption (and capability) to "on" mode. The point here is that decoding the video and generating the analogue output signals does not consume a significant amount - despite it begin the most apparent function of the STB.	no changes required
19/02/2008	**1**	1.1	18/12/2007	14	Scope: Consider including reference to the use of 3rd party software (i.e. Middleware). Increasingly the ability to manage power consumption in various modes of operation is controlled by software.	ok

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17/11/2008	**1**	1.1	18/12/2007	14-15	1.1.2 Scope (page 14) MTP supports the definition of the complex set top box (STB) as being one that allows conditional access. (page 15) The additional functional elements that can go into a sophisticated complex STB compared to a basic complex STB could make the setting of a single target across the product sector more difficult. A single threshold approach could result in rather un-ambitious targets for those more basic models, due to the need to make allowances for high levels of functionality on more advanced products within a single threshold. Therefore, it is advised that approaches be considered whereby the various product features can be accounted for flexibly in the implementing measure requirements, via a TEC or similar approach. Accounting for the increasing complexity in the complex STB as product convergence continues, the definition needs to be clear regarding how products will be classified when the complex STB technology is merged with other products such as media centres, home hubs etc.	No action necessary
08/01/2008	**1**	1.1	18/12/2007	16	Regarding the definition on page 16 I suggest that you also define conditional access, because conditional access is the other constituting element of the definition. A suggestion is to take the definition made up for the new version of the Code of Conduct: "Conditional Access" means an active system that enables the STB to process and apply targeted data from a Service Provider.	Definition for CA added accordingly
15/01/2008	**1**	1.1.	18/12/2007	16	Definition of complex Set Top Boxes for the purpose of this study → We would recommend deleting the word "free" in the definition indicated for Complex STB, in the group of words "for the reception of (free) SD or HD digital broadcasting services". Such reference is in contradiction with the definition of complex STB related to pay TV services requiring Conditional Access.	"(Free)" has been deleted
08/01/2008	**1**	1.1	18/12/2007	16	Please check whether there is no gap between the definition of the complex STB in this report and the definition of simple STB in the simple STB study report.	Definitions are complementary, but e.g. Stbs with removable mass storage media are excluded from both studies (by purpose)
08/01/2008	**1**	1.1	18/12/2007	16	The definition refers to the "conversion to analogue RF and/or line signals". Does this mean that a STB that provides digital output (e.g. HDMI) only would not be covered by this definition? This would be a strong incentive for manufacturers to move towards digital output STB only to avoid an implementing measure.	Modified: as the aspect of digital-output-only might be relevant in the long term (not for the market as it is today), the definition has been adapted accordingly

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18/01/2008	**1**	1.1	18/12/2007	16	Definition of Complex STB's for this study This study for the EUP directive seems to exclude - STB's with CD or DVD player - Devices that require a separate signal processing device. Since STBs are evolving into more than just a simple device for decoding and displaying video, the complex STB definition must take products with additional circuitry for supporting advanced features for gaming, home networking, transcoding, portable player adapters, cell phone extenders into consideration. Or does this mean that these STB's won't need to comply with any EUP requirement at all?	Modified: stbs with players are included (see above); but stbs, which can work only with a separate signal processing device (for add-on features, not for the basic function of providing a broadcast signal to the TV set) are to be excluded for complexity reasons. The EC has to decide, whether such devices fall under any of the ims.
08/01/2008	**1**	1.1	18/12/2007	16	The definition indicates that receivers with recording function based on removable media in a standard library format are excluded. However in the bullet list on page 16 also STB with CD/CD-ROM/ DVD player are excluded. I am afraid that especially the last exclusion offers a too easy opportunity to avoid an implementing measure based on the definition you provide. In my opinion at least STB with integrated (CD/CD-ROM/ DVD) player should be included. In the test protocol this function could not be used.	Modified: complex STB with players are included now to be coherent with the simple STB study
19/02/2008	**1**	1.1	18/12/2007	16	Definition box: Suggest changing from hard disk to 'internal mass storage media'	Ok
19/02/2008	**1**	1.1	18/12/2007	17	Standby Active, guidance: Suggest adding 'entitlements' to the list.	Ok
18/01/2008	**1**	1.1	18/12/2007	16	In the definition part of the task 1 report it is mentioned that set-top boxes with recording function based on removable media (DVD, VHS tape etc.) are excluded from the scope of the study. The DEA does not think it is a good idea to exclude such products. We recommend that the study includes set-top boxes with CD/CD-RM and DVD-player/recorder or other removable recording/playing media. Furthermore set-top boxes with removable hard disks or other portable data storage cards or sticks for instance USB-keys should be included.	For coherency, stbs with removable media (DVD etc.) Are excluded - just as it is for simple stbs. For clarification, connectivity to external / removable hdds, memory (USB stick etc.) Is in the scope (definition extended accordingly)

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15/01/2008	**1**	1.1.	18/12/2007	17	Table 1.2 definition of modes: "OFF" MODE Please note that the CoC definition for off-mode is "flawed". As a matter of fact, literally, this definition would mean that it is impossible for the user to leave this "off mode"… → We would propose for clarification to use a definition close to the following: "The equipment is connected to power source, fulfills no function except the capability to leave the "off" mode my means of a user action on an "ON" button located on the product cabinet. Typically the product cannot be switched into another mode with the remote control unit, an external signal nor an internal signal other than the one generated by an action of the user on the "ON" button located on the product.	Added: "...other than by the user pressing the "on" button located on the product"
19/02/2008	**1**	1.1	18/12/2007	18	Basic functionalitities: Suggest changing 'Digital Tuner' to 'Network Interface'	Added: "or basic ethernet or networking capability for reception of IP video packets (IPTV stbs)"
19/02/2008	**1**	1.1	18/12/2007	18	Sophisticated functionalities: 'internal mass storage media' in place of hard disk	Ok
08/01/2008	**1**	1.1	18/12/2007	18	On page 18 you pose the general statement "In general all of these functionalities, if implemented, are correlated with additional power consumption". Although not at stake in this task, this goes right to the heart of the matter if you want to regulate complex STBs. A few comments. First, I would add "and used" after implemented. One of the important tools of reducing power consumption in STB is power management: switching off those parts that are not used/needed. The statement in general would open up for an unlimited power consumption by adding ever more features. Second, the study need to think what features need to be taken into account when measuring power consumption. The open bullets in the list of functionalities indicate that the list can be in principle endless. My conclusion is that the approach followed by the Code of Conduct (see tables 1-6 and 1-7) and Energy Star (tables 1-10 and 1-11) is doomed to fail with such (in principle) endless list. The solution should be found in a) a restricted test set-up and b) power management. (But this is something to discuss in later tasks).	Added "and used"

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18/01/2008	**1**	1.1	18/12/2007	18	Sophisticated functionalities a list of additional features: • Multi-stream decoding, such as simultaneous decoding of n=2 HD MPEG H.264 video streams. • DVB-S2 or DVB-S tuners (it is import to recognize the difference between a satellite tuner and terrestrial tuner in that satellite tuners must provide power to the antennas LNB. • DVD ROM drives • Multiple System-on-Chip designs that provide service to multiple televisions. For example, SA manufactures a STB which includes n=3 SoC's with all the necessary peripheral circuitry (FLASH, DRAM, Ethernet circuitry, etc.) for decoding and distributing n=3 independent video signals to 3 independent televisions. Although, looking at the STB one would not know this since two of the video outputs are modulated and placed onto a single RF output connector. • Video conferencing capability • Advanced 3D graphics • Multi function STB which could include additional processing power to support video gamming • STB's functioning as a gateway (router), such that the STB may have to be always on in order to bridge and route IP packets throughout the in home network. • Additional networking technology such as Homeplug A/V (wire line), and HPNA (Ethernet over COAX). • Number of hard drives supported (newer STB's are providing provisions for supporting both an internal SATA drive as well as an external SATA drive). Important since the STB's power supply may have to provide power to the external HDD. Thus, this must be considered when sizing the supply which will have an impact on total power consumption and standby power consumption. • Advanced display devices such as VFD and LED displays	List partly integrated
18/01/2008	**1**	1.1	18/12/2007	18	"t-commerce": The list of t-commerce encryption systems is not comprehensive, and therefore should be removed or expanded to include other encryption systems such as PowerKEY. Also t-commerce does not require CI slots - PowerKEY is an embedded solution.	As the introduction to the list states, this is not a comprehensive listing (which is not possible anyxhow due to unforeseeable future features). Hence, only powerkey has been added in the list
05/02/2008	**1**	1.1	18/12/2007	18	[Technical Parameters] Sophisticated vs. Complex STB Proposed change: I think they should be called by the same name. Complex STB can have all functionalities of the sophisticated STB.	Not changed: Complex stbs might have the functionalities of a "sophisticated STB", but functionalities under "sophisticated" are explicitly NOT part of the definition of "complex stbs".

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						Same wording would cause confusion.
18/01/2008	**1**	1.1	18/12/2007	18	Basic functionalities: In a true IP STB, a digital tuner is not a basic functionality. As a matter of fact, any tuner (DVB-T, DVB-C, DVB-S..) is considered optional. Regardless, here is a list of IP STB basic functions: • Basic Ethernet or networking capability for reception of IP video packets • Decoding of MPEG transport streams • Basic operational feedback indicators (power LEDs, link LED, etc.) • SD video output capability through a composite video interface • SD audio capability through baseband right and left audio outputs	Text modified and list partly integrated
19/02/2008	**1**	1.1	18/12/2007	18	Complex STB-only: Suggest adding progressive download to VoD Suggest putting Conditional Access System (not Encryption system!) as a separate bullet and not under T – Commerce – this is a function of the Middleware Omission of Videoguard (NDS's Conditional Access solution with largest market share!)	Ok
19/02/2008	**1**	1.1	18/12/2007	19	4.: Also include telephone (PSTN/POTS) modem in this category	Ok
19/02/2008	**1**	1.1	18/12/2007	19	6. and 7.: Internal Mass Storage rather than HDD	Ok
18/01/2008	**1**	1.1	18/12/2007	19	Typical levels of complexity: • STB with CA and return path: Return path should also include Ethernet return. • Most conditional access systems implemented in modern IP STB's do not include a conditional access module. Conditional access is typically implemented within the main decoder chip, using a secure processor. FYI, at the moment we are only developing one IP STB with smartcards, which are actually being used to provide CA to an auxiliary terrestrial DVB-T tuner (nothing to do with the IP channel). • Would it mean that products with level 1 and 2 (having passive standby) are being treated within LOT6 and products with level 3 and up will not be covered by LOT6?	Modified: ethernet included; no comment possible from the consultants on the scope of (possible) ims
20/02/2008	**1**	1.1	18/12/2007	19	Examples should include STB with networking capabilities, particularly as slave boxes connecting to any primary box could help to reduce the whole home energy footprint as they operate through the main STB (server).	Ok

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20/02/2008	**1**	1.1	18/12/2007	20	We do not understand why the remote control is included for power consumption considerations. The diagram on page 20 is not identical to the one in the CoC document unless it has been updated since the last meeting. It is also quite old, in the CoC doc for several years and probably needs an update for both documents if it is to be used as an example. Remote should be in the lower section not affecting the power budget and the LNB in the section for products that are part of the STB budget. But terrestrial amp for antenna where fitted should also be part of budget if STB provides power and it is used, just as our TV link power is included.	Remote control will be considered for ecodesign aspects, not for direct power consumption considerations; diagramm slightly update according to other comments, serves for illustration only; antenna and LNB power supply included
15/01/2008	**1**	1.1	18/12/2007	20	Figure 1-3 generic block diagram for a digital receiver: We understand that this block diagram could be derived from one block diagram contained in CoC V5, but the "descrambling" function is missing from the table that is presented in task 1 report, although this function is of course key for complex STB. → In consequence we would propose to simply add the word "descrambling" in the Demux & Routing block=> it would become "Demux, Descrambling and Routing". → In addition, we believe that POD should be replaced by DVB-CI, as DVB-CI is the wording common in the EU while POD refers to a similar function in the US, but restricted to cable.	Modified accordingly
15/01/2008	**1**	1.1	18/12/2007	20	External components: A routing function can be embedded in a complex STB and consequently be part of the power consumption of a complex STB. → We would propose to replace the word "Router" by "External Router" at the bottom of page 20.	Ok, added "external"
15/01/2008	**1**	1.2.	18/12/2007	22	EU test standard on Energy Consumption It is stated (page 22) that EN62087 is the reference testing method for The EU CoC for digital TV services. → For accuracy purposes we would like to add that the CoC refers to a testing method derived from the EN62087 (> the LNB current is not set at the value indicated in EN62087, and this makes a huge difference in the final power requirements).	Ok, modified the text in order to be more accurate
20/02/2008	**1**	1.2.	18/12/2007	24	Energy Star have realised that reducing power consumption is as much about "on" mode as it is about any other mode. This is an interesting proposition.	No changes required

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20/02/2008	**1**	1.2	18/12/2007	25	Not sure why this references EN docs but then showing 115 volts ac in the tables. Looks like a mix between EN and Energy Star.	Ok, modified the specifications 230 Volts 50 Hz
08/10/2008	**1**	1.2.	30/06/2008	25	The text recognises that safety standards "could introduce some requirements that affect the design of the product", and correctly identifies EN60065 as the safety standard for complex set top boxes. However the text doesn't note the fact that safety standards could also introduce requirements that affect the installation and use of the product. Significant for the purposes of this study is that EN60065 clause 5.4.2 requires the instructions supplied with the apparatus to state that the mains disconnect device (e.g. mains plug or hard-off switch) "shall remain readily operable" when the apparatus is installed. Therefore the user of a complex set top box will have a readily operable means of disconnecting it from the mains supply, provided that it has been correctly installed according to the instructions.	Ok - added"Moreover, EN60065 clause 5.4.2 requires the instructions supplied with the apparatus to state that the mains disconnect device (e.g. Mains plug or hard-off switch) "shall remain readily operable" when the apparatus is installed. "
15/01/2008	**1**	1.3.	18/12/2007	26	Legislation and voluntary agreement… This paragraph does not mention the Ecodesign requirements related to standby and "off" mode power consumption of energy using products established in EU directive 2005/32/EC. → Although it may appear at first of no use to mention IM on lot 6 due to its "brotherhood" with this IM on lot 18, IM on lot 6 does set power use limits for standby and off mode that in our understanding directly impact complex STBs.	Added a paragraphe on eup directive and on lot 6 draft IM
19/02/2008	**1**	1.3	18/12/2007	41	Standards based on technical documents of DVB: Omission of the DVB standard relating to conditional access	Was already mentioned in the annexes, but is now more clearly visible in text
08/01/2008	**1**	1.4	18/12/2007	43	The figure 1-9 on page 43 summarizes the functionality aspects, but the experience of the Code of Conduct learns that you have to deal with these aspects/features in a smart way in order to reduce complexity (see also remark above). It seems in any way too complex to base an implementing measure upon.	Will be taken into account in later tasks
17/11/2008	**2**	2.1	07/05/2008	5	2.1 Generic and Economic data (page5) There is no single robust source reporting sales of complex STBs in the EU. In contrast to the EU market, it may be worth noting that in the UK position there are only two complex STB offerings (from SKY and Virgin Media) dominating the market, and there is an obvious domination of both the cable and satellite digital STB market by subscription Service Providers throughout Northern Europe.	No action necessary

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26/05/2008	**2**	2.2	07/05/2008	7	How do multi-room STB fit in this categorization?	Replied provided by e-mail
26/05/2008	**2**	2.2	07/05/2008	8	Table 2.3 : The last two rows both have the name 'DVR'.	No action necessary
17/11/2008	**2**	2.2	07/05/2008	15	2.2 Market and stock data (page15) The study estimates that sales of STBs are still growing but stock is expected to level off between 2010 and 2015 thereafter falling by 50% in 2020, as STB functionality is absorbed into other products (eg TV, computers, media centres). UK MTP attach their data and projection for the UK market in the following chart which shows a similar levelling off between 2010 and 2015, but in contrast, remaining at this level until 2020. It may be worth noting that the UK consumer currently has little or no choice of product. (Note: Freesat would not currently be classified as a complex STB although there is no formal statement from the platform specifiers that there is no potentially activated embedded conditional access). The policy options considered should take into account this lack of consumer choice as other EU countries may be in a similar position.	As the stbs are merged with other products, they are excluded from the original scope of complex stbs as defined in Task 1
26/05/2008	**2**	2.3	07/05/2008	31	As a very rough outlook in 2020 the number of complex STB in use migh be half of that in 2020 (??), but	Corrected half of that in 2015
17/11/2008	**2**	2.3	07/05/2008	31	2.3 Summary of market trends (page 31) It is predicted that high definition (HD) units will dominate the market, with 80% of units having media storage capacity by 2015. In the UK, the HD feature and storage mechanism are provided by the service provider via a subscription arrangement rather than an upfront purchase cost - thus changing the economics of growth. Currently 40% of UK sales are recordable devices; this is projected to reach 100% by 2012.	No action necessary
26/05/2008	**2**	2.3	07/05/2008	31	Regarding trends, forecasting the stock of (complex) STBsin the future (2015, 2020) is anyhow very difficult, because of (possible) merging with personal/media computers. But maybe the guess that the number of complex STB equals the number of Pay TV subscribers is the best one can do at this moment.	No action necessary
05/08/2008	**3**	-	21/07/2008	-	General: The document is a study on "Consumer behaviour and Local infrastructure". Yet the draft document in several places puts forth product implementation concepts, which are out of scope. We suggest that the document	Task 3 also assesses how product design can affect consumer behaviour

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					be revised to stick to the scope	
08/08/2008	**3**	3.1	21/07/2008	5	Use patterns for TV sets It is mentioned that the use time of the STB is similar to that of the TV. However later on in the task (on page 6) it is mentioned that the average on time for STB will be estimated to be slightly higher than the than the average on mode time for the TV. It will be more correct to write that the use time of the STB has a strong correlation to that of the TV. TV on mode time will in many households not be similar to the TV view duration time	"Similar" replaced by "correlated"
08/10/2008	**3**	3.1	21/07/2008	5	The text states in the first paragraph that "most of the existing STBs typically do not have a standby passive mode………Off-mode is hardly used either, since complex STB need to be constantly in on-mode…". At the bottom of the third paragraph the text states "Among the end-users disconnecting or turning off their STB in the evening after watching TV, it is assumed that 50% disconnect their STB and that 50% use the off-mode". If very few existing STBs provide an off-mode, then the assumption that 50% of those users (10% of all users) use off-mode cannot be true.	Following to the final stakeholder meeting discussions, the use pattern of complex stbs was modified. 10%===> 1%
08/08/2008	**3**	3.1	21/07/2008	5	As you have explained later on in task 3 the STB do not need constantly to be in the On-mode in order to be updated properly. It is possible to update the STB when it is turned on (however the consumer will have to wait a short time before the STB will be able to provide its main function) We agree that the operating modes on and standby active are in focus for the estimation of the existing consumer behaviour. However it is important that the study analyse the effect of changes in consumer behaviour due to the implementation of STB with standby passive and off modes.	No action necessary
17/11/2008	**3**	3.1	21/07/2008	5	3.1.1.1 Use patterns for TV's The study assumes that a single TV in a household will have an on-mode time of 4 hours per day. MTP assumes on-mode time is 5 hours per day for primary TVs, to which it is assumed the majority of CSTBs are attached. A review of the EU average for these figures is essential, in the light of some major UK Service Provider figures that almost double them to 9 hours per day.	Following to the stakeholder meeting, on mode time was set to 9 hours instead of 4.5 (for STBs without internal mass storage media). Off mode times were 10 times reduced

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17/11/2008	**3**	3.1	21/07/2008	5	3.1.1.2 Use patterns of complex STBs The study assumes that a percentage of users will disconnect or turn off their complex set-top boxes when they have finished their TV viewing of an evening (similar to simple set-top boxes) but some reduction in numbers is made for complex STBs with hard storage. It is likely that this is an overly optimistic estimate. It is also common practice for Service Providers to advise their customers to simply leave their STBs 'on' at all time to receive updates during the night. This has obvious implications for the assumed usage patterns. Current UK complex STBs take 1-2 minutes to reboot from "cold" which customers will undoubtedly perceive as a significant barrier to disconnection or hard-off. MTP usage assumes two patterns: • 40% of use in line with TV on-time (5hr on, 19 hr standby) o For recording devices an additional 25% is added to this • 60% leave CSTB on all the time (24hr on) o With the majority of Satellite users enabling autostandby (16 hr on, 8 hr standby) Based on this and other minor corrections, the average on-time is: • Satellite 11hr on, 13 hr standby • Cable 17 hr on, 7 hr standby It is suggested that some sensitivity analysis is implemented to address the disparities between MTP and EuP study usage assumptions. (table 3.1 page7) The table of complex STB usage patterns may need to be reassessed, or at least have some sensitivity analysis carried out around it, as current figures appear to be underestimated. In order to acknowledge the uncertainties around usage, the report could include some mention of possible ranges in usage due to stakeholder comments and particularly in light of the recommendations given by Service Providers to consumers.	Assumptions regarding the time in off mode were revised in the light of the comments received during the final stakeholder meeting (10 fold reduction)
08/08/2008	**3**	3.1	21/07/2008	7	It is mentioned that once the standby passive mode is implemented the duration of the standby passive and standby active mode respectively could be 4.5 hours and 15 hours. We do not think that the STB need to be in active standby 15 hours per day. It must be possible considerably to reduce further the time in standby active.	No action necessary 6- lower active standby mode times were assumed in Task 5/6

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08/08/2008	**3**	3.1	21/07/2008	7	We are not in favour of the Energy Control Panel mentioned as an example on page 8. It will give the consumer the expression that it is not possible to have a STB which is both good performing and energy efficient. And that is not the case. However we agree that it is important to inform the consumers about the power management abilities and how they are functioning. An auto standby passive mode is mentioned as another efficient solution. We recommend this solution being analysed as a design option later in the study.	No action necessary
08/08/2008	**3**	3.1	21/07/2008	7	Is there any investigation of the consumer acceptance of waiting the couple of minutes necessary to update the STB after it has been turned off?	No action necessary
05/08/2008	**3**	3.1.2	21/07/2008	7	Sub clause 3. 1. 2: The report does not elaborate on the complexities and confusion that "Energy Control Panel" presents to the typical user. People have hard time programming their DVR and setting up parental control. We recommend that the authors include information on the behaviour of the average user with regard to the complexity of the STB in conjunction with energy control functions.	Added "However, it the setting of such energy control functions might be difficult for an average user, in conjunction with other settings available in a complex STB (e.g. Parental control, recording functions). "
17/11/2008	**3**	3.4	21/07/2008		The observations of long re-boot time from hard-off and the need for the STB to be in either on-mode or standby active mode to receive update information from the service provider are supported by MTP – current usage assumptions in the report fail to take appropriate account of the impact of this factor on the usage profile.	The use patterns initially assumed in the draft version were modified
08/08/2008	**3**	3.4	21/07/2008	14	The observations of long re-boot time from hard-off and the need for the STB to be in either on-mode or standby active mode to receive update information from the service provider are supported by MTP – current usage assumptions in the report fail to take appropriate account of the impact of this factor on the usage profile.	No action necessary

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08/08/2008	**3**	3.4	21/07/2008	14,15	Although it seems to be the current praxis, complex set-top boxes do not need constantly being in a mode that enables the boxes to receive signals from broadcasters. The study already describes several possibilities to overcome the problem. The power management possibility described in the bottom of page 14 and at the top of page 15 is interesting and has a large saving potential. We are looking forward the have more details on that in the coming tasks. How often does service providers normally perform download and update activities which have a longer duration (more than for instance 1 minute)?	No action necessary
08/08/2008	**3**	3.4	21/07/2008	15	Buying decision: Focus on first price and split incentives. The split intensive described in this section is not a barrier for eco-design. On the contrary it is an argument for implementation of mandatory energy efficiency eco-design requirements.	Split incentive can be a barrier to the uptake of ecodesigned products
08/08/2008	**3**	3.4	21/07/2008	15	Lack of available consumer information is not a barrier for implementation of eco-design requirements.	Lack of available consumer information can be a barrier to the uptake of ecodesigned products
08/08/2008	**3**	3.4	21/07/2008	16	Mid-term scenarios should include the implementation of passive standby and use patterns including this mode.	In Task 8
17/08/2008	**4**	4.1.	08/08/2008	5	Page 5: which standby mode was reported by Stiftung Warentest?	Switching the STB through the remote control into standby, which in most cases is likely to be active standby, but for some stbs rather passive standby
17/11/2008	**4**	4.1	08/08/2008	5	4.1 Production phase (page 5) The data used for the study is based on reverse engineering of a legacy product which was already in the marketplace in 2007 and reported on in November 2007. As complex STBs are constantly evolving, it would be useful to cross reference this data with a product which was brought out in mid 2008 or is ready for imminent launch onto the market pre-Christmas 2008. This should not require too much time and would be seen as adding value to the study. It is important to note that , the product in the study is a European-based mainly-retail product, whereas the majority of complex STBs in the UK and the rest of Europe, are from service providers which include a return path and therefore have additional components (compared to retail STBs) which need to be powered.	BOM data was adapted (e.g. Second tuners virtually added to the stbs) and despite being retail boxes the components and materials used are technically similar to that used in complex stbs provided by service providers. Moreover, the modifications in boms are assumed to have a negligible impact on the outcomes of the ecoreport . It is agreed, that a comparison with a 2008 STB would add value to the study, but such an analysis of short-term changes is neither part of the given methodology nor does the disassembly of a single product would be representative for the change in the market. Actually, from the BOM perspective, the disassembled Dreamcast design is anticipated to represent a growing high-

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						end market segment.
08/10/2008	**4**	4.1	08/08/2008	5	The last sentence on page 5 "Most of the boxes have delay times from disconnected / hard-off of 10-20 seconds" provides a misleading summary of the results: • The mean delay time for the 13 boxes is 20.6 seconds • 4 of the boxes (30% of those tested) have delay times longer than 20 seconds • For boxes featuring either HD or a HDD, the delay times range from 19.2 to 53.8 seconds; the mean delay time for these 4 boxes being 32.1 seconds.	9 out of 13 is achieve reboot delay times <20 seconds
27/08/2008	**4**	4.1	08/08/2008	6	Production Phase A delay time of 10 – 20 seconds from disconnected or 2 - 10 seconds from standby is not very long and maybe consumers are willing to accept that. Maybe they just have to know that the box is uploading (to be sure that the box is functioning and not out of order). This could be done by a message on the display. Maybe also the expected uploading time could be shown. Are there any known analysis of the consumer acceptance of delay time and how long delay time consumers are willing to accept?	No action necessary - here the delay times were measured without the CA configured; no known analysis of accepted delay times
27/08/2008	**4**	4.1	08/08/2008	5	Are the standby values mentioned in table 4-1 standby active or standby passive values?	Switching the STB through the remote control into standby, which in most cases is likely to be active standby, but for some stbs rather passive standby
17/08/2008	**4**	4.1.	08/08/2008	6	Page 6: relation switch-on delay versus standby power The data in table 4-1 does not "prove" a relation between switch-on delay and standby power. The relation is negative, see figure above, but the R-square is very low. Furthermore, there are STBs with relatively low standby power (2,1 and 2,5 W) and short (3,3 and 4,3 s) switch-on delays, but also several STBs with much higher standby powers and almost the same switch-on delays. The two boxes that have a "standby" power below 1 W, have the same switch-on delay time for standby and off/unplugged. This begs the question whether the "standby" in this case is not merely a soft off.	No action necessary

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17/11/2008	**5**	5.2	08/08/2008	11	5.2 Base case environmental impact assessment (page11 onwards). MTP usage patterns are different from those used in the study. Reducing active standby consumption will be more important than reducing "on" consumption in the long-term for reasons highlighted above - mainly the amount of time the STBs will be left in this mode. Targeting active standby consumption separately from total energy consumption (TEC) in tier 1 appears ambitious given the broad range of products described in the Base Cases.	No action necessary
27/08/2008	**4**	4.3	08/08/2008	20	4.3 Use Phase (Product) Do you have any explanation of the fact that the catalogue values are higher than the measured values? There seems to be very few available data for STB with additional functions such as HD and extra tuner.	Catalogue values are mostly derived from maximum specified values with a certain design safety margin
17/08/2008	**4**	4.3	08/08/2008	20	Section 4.3 (Use phase) There seems to be a fundamental problem in deriving typical power consumption for individual features from power consumption data for the total STB. An example is the return path. Figures for STB with return path in the report are: - table 4-10 (DVB-S): 20-30 W - table 4-13 (type unknown): 8-16 W - table 4-16 (IPTV STB): 19-25 W So the "add-on" for the return path seems to depend on the type of box, so it is difficult to provide a estimate for complex STB in general. Another aspect is that the estimated power consumptions in table 4-15 do not give any clue about whether this is the power that is needed (apart from the feedback by manufacturers); in other words, the report provides no engineering data on power consumption of HDD, 2nd tuner, HD and return path.	The measurement of each single component is not a sufficient data regarding the power requirements of a complex STB. The design is also an important parameter which affects the overall power requirement of the STB, i.e. A complex STB can have very energy efficient components but still have overall poor energy efficiency because of the way it has been designed. Also, the study focuses on "real life products" existing on the market and theoretically it is possible to add up the different power requirements related to different features and functionalities but that would not reflect the situation of current products on the market. In the revised report now the aspect of dedicated HDD power consumption is adressed seperately.
17/11/2008	**4**	4.3	08/08/2008	20,21	The risk of using catalogue data is highlighted in the report. Where both measured and catalogue data was available, it was found that on-mode consumption was typically 20-50% lower than the catalogue values. The study contractors could work with industry to obtain more measured data to improve the accuracy of target setting.	Feedback from the industry was obtained when estimating the power requirements of the different operating modes
17/11/2008	**4**	4.3	08/08/2008	31	MTP recognises the difficulty in expressing a power consumption per functionality as there are often interdependencies between the functionalities. It will be important to be clear on any such interdependencies when policy options are considered.	No action necessary

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27/08/2008	**4**	4.3	08/08/2008	32	We agree that it does not seem to be necessary to make a distinction between transmission platforms in case of cable, terrestrial and satellite. In this case we recommend that your proposal for requirements (in task 8) is made independent of the technology (transmission platform). Off course it will also depend off the results of the coming analyses.	No action necessary
17/11/2008	**4**	4.3	08/08/2008	32	For advance features to be implemented, the STB needs to remain in a mode which allows for receiving and processing of a minimum amount of data. This is not possible if a hard off switch is used. The use of a hard off switch may be limited through service provider advice to users, and through users potentially experiencing a degradation in the user experience when using the off switch (slow boot up). Therefore, rather than focusing solutions around hard off switches, a more pragmatic approach would be to develop ambitious EuP requirements for a low power mode, from which the complex STB could wake up at intervals to receive data. MTP would strongly supports stringent requirements in this low power mode.	No action necessary
17/08/2008	**4**	4.3.	08/08/2008	33	Table 4-16: providing the yearly energy consumption figures in kWh (rounded to whole kWh) improves the readability of this table.	Ok - modified in the final version of task 4
27/08/2008	**4**	4.4	08/08/2008	34	4.4.2 Interaction between the complex STB and the service provider. A number of typical examples of why the CSTB needs to be always in on or active standby mode is mentioned on page 36. We think that a lot of the advanced functions mentioned will be seldom used of many consumers. Advances functions should therefore not always be active. They should only be active and consume energy when the services they deliver are actively requested by the consumers.	No action necessary
17/08/2008	**4**	4.4	08/08/2008	34	Page 34: external power supply and remote control are not external to the product, they belong to the product (as put on the market).	Separate here means not included in the STB's casing
17/08/2008	**4**	4.4	08/08/2008	36	Page 36: that the power consumption of complex STBs in the use phase is high is due to the fact that the STB needs to be in standby active mode AND that the power consumption in the standby active mode is high. This offers two options for savings: less time in standby active (but as you argue this is not an option for many complex boxes) and/or reduced standby active power consumption.	No action necessary

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17/11/2008	**4**	Annexe	08/08/2008		The feedback does not indicate a strong consensus on power consumption measured in watts. An annual Total Energy Consumption (TEC) is likely to gain greater acceptance from industry and may therefore allow a speedier introduction of more efficient products to the market. MTP would encourage the contractors to look at a (TEC) approach for tier 1, providing this approach is appropriately robust and defensible based on evidence. The stakeholder feedback also highlights the lack of standby features in the DOCSIS (EURODOCSIS) specification. It is important that these features are addressed despite the long timescale required to change the specification (3 years minimum).	No action necessary
27/08/2008	**5**	-	08/08/2008	-	General comment The analyses show that active standby mode is the most energy consuming mode. Therefore it is very important to come up with proposals for reducing the consumption in active standby mode. We recommend introduction of a passive standby mode in all boxes and effective power management systems to reduce as much as possible the time in on-mode and active standby mode.	No action necessary
17/08/2008	**5**	5.1.	08/08/2008	5	Page 5: The report contains 6 Base Cases and 1 product case. However, are the differences in Life Cycle impact between the Base Cases, apart from the energy consumption, really significant? I haven't done the spreadsheet calculations, but I guess that if you would take the same power consumption (off, standby, on) for each Base Case, the Life Cycle impact would be (about) the same. This would greatly reduce the complexity of the report: you could use one "material" basecase with several variants for the power consumption.	No action: Actually it is required by the methodology to establish a BOM for each Base Case. Although the differences are minor regarding "manufacturing" compared to the "use phase" it is not up to the contractors to decide, what is "significant" and needs to be adressed by an EuP IM - therefore we just document the BOM differences not to rule out any conclusions affecting BOM aspects
17/11/2008	**5**	5.1	08/08/2008	6	Table 5.1 (page 6) The 7 Base Cases necessary to address this area highlight the diversity of product and features in the marketplace and underline the difficulty of setting ambitious targets. Targets will need to be deliberately challenging across all scenarios. Feedback from industry is contrary to some of the assumptions in this table, particularly the 20% figure for units incorporating a second tuner, which UK industry considered could be much higher, possibly 80%. The assumption of 20%-80% split in sales between units with a return path and those without would not apply for a UK market as almost 100% of complex STBs in the market are from service providers that require a return path. Given the lack of a standby function in the DOCSIS cable modem specification this assumption could lead to a significant error in the Base Case data.	Market share were modified in the final version (80% with second tuner, 20% without)

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17/08/2008	**5**	5.4	08/08/2008	24	Page 24: Life Cycle Environmental Impacts What is the use of the comparison with the simple set-top box study? In 2010 simple STB might be expected to be towards the top of their penetration, whereas the penetration of complex STB in 2007 was still low.	Added "but observe the differences regarding market dynamics: Whereas the market for complex STBs sees significant growth rates and consequently the potential for rising total electricity consumption, the market segment of simple STBs is likely to grow at much lower rates by 2010"
17/08/2008	**5**	5.4	08/08/2008	27	Page 27: The report concludes that the End-of-Life phase is relevant, but is this because the WEEE is not functioning 100% with regard to Consumer Electronics/STBs? Put it otherwise, would the end-of-life phase also be relevant when the WEEE would be functioning 100%?	Assuming 0% of material is landfilled (instead of 28%) the end-of-life phase still remains significant
22/09/2008	**6**	-	17/09/2008	-	This task report clearly shows the challenge of improving the environmental performance of complex STBs is a joined operation of STB manufacturers, silicon designers, middleware providers and service providers. The key to stimulate and measure such improvement is a duty cycle as described in the lower part of figure 6-4, where the unit is able to wake-up (fast) from a low power standby mode and returns to this mode when tasks (e.g. remote programming, EPG update) have been finished. If this duty cycle will be used for testing the STB then a real TEC approach can be followed regarding criteria. The power consumption in the low standby mode should be maximum 1 W.	No action necessary
30/09/2008	**6**	6.1.	17/09/2008	5	Page 5 By comparison of a slim design option with a not miniaturised design option the material and energy consumption of the external power supply should be included in the analysis of the environmental effects and LLCC.	Energy consumption of the external power supply is included in the analysis (both environmental and LLCC), but for simplification not listed in the BOM, indeed
22/09/2008	**6**	6.1.	17/09/2008	9	Page 9 (Low standby consumption): As discussed in the rest of the report the standby power as such must be complemented with a fast start-up time.	No action necessary
30/09/2008	**6**	6.1.	17/09/2008	10	Page 10 It is argued that a fixed or predictable time for software updates might lead to higher security risks. What kind of risk is it? In any case it should be possible for service providers to change update time for instance on a daily or weekly basis in order to prevent that risk. The alternative is products that are always on. Is that safer?	Risk hacker compromises their system

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17/11/2008	**6**	6.1	17/09/2008	10	6.1.2 Low power standby mode (page 10) In terms of functionality that must be maintained in a low power standby function, MTP would advise adding the following to the list of requirements: RF bypass, scart loopthrough, and in-home distribution of DVR signals. This would allow the complex STB to be put in standby even if the attached display is being used to view a signal from another source. Industry has voiced concerns that if very low power standby modes are used then the STB will take a long time to come out of standby. This is a considerable risk as it may discourage consumers from using the standby function – therefore a pragmatic approach needs to be taken when considering standby requirements (note that stakeholders believe that it is possible to mask some, but not all, of this time to the user, e.g. through use of innovative user interfaces).	No action necessary: A 1-W-low-power-standby actually is not achievable with RF bypass, scart loopthrough and in-home distributed DVR signals. Actually, distribution of DVR signals would be considered on-mode as this is a main function of an STB.
08/10/2008	**6**	6.1	17/09/2008	11	Suggest adding more detail to this section: It should also be noted that service providers require a high level of software security in order to prevent hackers accessing their media content. The software security features in complex STB require considerable unpacking and de-encrypting of code during boot up, and this, together with advanced OS features, further increases the time to boot.	Added in footnote "One stakeholder mentioned that service providers also require a high level of software security in order to prevent hackers accessing their media content. Such features further increase the time to boot."
30/09/2008	**6**	6.1.	17/09/2008	12	Page 12 How much power is required for the LNB (Low Noise Block)? On page 22 it is mentioned that some low energy LNB solutions exists and a reference is made for the preparatory study on simple settop boxes. However the study for simple settop boxes does not include information about the power consumption of the LNB. STB in general is not expected to have a very long lifetime (according to task 3 the typical economic lifetime is 3-4 years). How much longer will the STB last when the LNB is permanently powered and what are we talking about? Will the lifetime for instance be increased from 2 to 4 years or from 6-7 years?	The LNB as such is not in the product scope and not an aspect which is specific for complex STBs either. In General, power consumption of LNBs is in the range of a few Watts, depending also on configuration of the satellite dish system. Lifetime of the STB does not depend on the lifetime of the LNB as the LNB comes as a separate part and will be exchanged once it fails.

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17/11/2008	**6**	6.1	17/09/2008	12	6.1.2.3 Scenario (page12). MTP strongly supports the concept of an STB entering low power standby after viewing has ceased with wake-up intervals to download information from the service provider, whilst recognising industry concerns that the whole population of STBs must not "wake-up" at the same time to avoid generating excess traffic on the service provider's network thereby overloading systems. It will be important for the study to make recommendations regarding how the high level of cooperation required between all stakeholders to achieve this objective can be achieved. This could be, for example, via each service provider being allocated one wake identifier (or many, depending on quantity of boxes being covered). This identifier would be associated with a unique time trigger for the service provider, which they could use as a flag within their boxes to control their wake scheduling. A standards organisation could become involved to act as an impartial party in allocating these time slots / trigger points.	No action necessary; the proposed approaches are in principle supported and might provide suitable solutions to avoid overload problems. However, it is not in the scope of the study to make recommendations, how industry should organise to comply with possible regulations
22/09/2008	**6**	6.1.	17/09/2008	12	Page 12 (LNB and standby): regarding standby the power consumption of the LNB is not included, i.e. is regarded separately.	No action necessary
08/10/2008	**6**	6.1	17/09/2008	13	Suggest adding a third essential requirement bullet point to the list at the end of this section: • Boot time significantly reduced so that users do not find start up delays unacceptable	Agree - added in report
08/10/2008	**6**	6.2	17/09/2008	15	Suggest adding a comment to first paragraph: If stopping and starting the HDD to save power reduces the reliability of the HDD there would be a severe environmental impact caused by the need to replace HDD. Indeed, customers are more likely to replace the complete STB than to seek a repair.	No action: stopping and starting the HDD is already implemented in the majority of PVRs; but this has not been reported by industry experts as a major concern regarding reliability as such
17/11/2008	**6**	6.2	17/09/2008	16	6.2.3 Hard-off switch (page 16). Such a device could be inappropriate for complex STBs given the need for the STB to maintain regular contact with the service provider's network. Also, complex STBs have a long boot-time from cold which may discourage some consumers from using the function.	No action necessary

Date	Task	Sub-section	Commented version's publication date	Page	Comment	Answer / Action
17/11/2008	**6**	6.2	17/09/2008	16	6.2.4 Hard disk drive (HDD) and solid state drive (SSD) (page16) Insufficient consideration has been given to the fact that most of the products in the study which incorporated storage would have been fitted with a 3.5" hard disk drive (standard desktop pc component). With the PC market in recent years moving to laptops away from desktop PCs , 2.5" hard disk drives are now equivalent in price but with greatly reduced power consumption compared to their desktop counterparts. SSDs require further development before they offer the cost and reliability required for continuous read/write operation. The report does not include any projection of price deflation or reliability improvement of solid state devices. This is a major gap in the analysis.	Two improvement options: "state of the art 2.5" HDD" and "state of the art 3.5" were added to the analysis; note: the HDDs used in STBs are different from those used in PCs / laptops (mainly due to noise reasons)
22/09/2008	**6**	6.2.	17/09/2008	16	Page 16 (hard-off switch): the report indicates that many pay TV STBs come with a hard-off switch but given the duty cycle of the STB (see figure 6.4) such a switch will not be used, except for maybe (longer) holidays.	No action necessary
17/11/2008	**6**	6.2.	17/09/2008	16	6.2.5 System on a chip/silicon improvements. Semiconductor device manufacturers are continually developing their products to increase integration and miniaturisation to get more value from the substrate. Many power consumption improvements have been a natural consequence of such development. These developments are expected to continue. The nvidia tegra, is an example of the low power consumption that can be achieved by current technology (under 2W for full HD), although cost of this solution may currently be high: www.nvidia.com/page/handheld.html. Da Vinci Silicon solutions discussed in the SSTB EuP study from Texas Instruments are also relevant in this context.	No action necessary
22/09/2008	**6**	6.2.	17/09/2008	19	Page 19 (EURODOCSIS): the problem identified here - no power management supported by (EURO)DOCSIS – is the major problem regarding cable STB and could be highlighted more.	Added in footnote: "Currently power management is not supported by (EURO)DOCSIS"
30/09/2008	**6**	6.2	17/09/2008	19	Page 19 It is very important to solve problems with communication standards (Eurodocsis) in order to support implementation of power saving modes in cable STB. For ADSL systems it should be considered how the existing standard-support of power saving modes could be utilized in an eco-design context.	No action necessary

Date	Task	Sub-section	Commented version's publication date	Page	Comment	Answer / Action
17/11/2008	**6**	6.2	17/09/2008	19	6.2.8 Modem Standby (page 19). The increased integration that will result from the cable modem chip (ASIC) merging with the main STB microprocessor in future generations of silicon devices is likely to result in lower power consumption (possibly 0.5W) as in system on a chip described above. The report identifies a major opportunity to save power by "turning down" the power used by the modem when little or no traffic is exchanged through the network (modems typically use around 5W power under normal operation). Whilst this is technically possible, it will require support from the communications standards used for network interactions – DOCSIS/EURODOCSIS for cable modems, and DSL/ADSL for triple play or IPTV boxes. Changing the communications standards could take 3 years or more. This supports the suggestion that targeting active standby power in Tier 1 would be quite ambitious. MTP would advise that a detailed information exchange occur between the Commission and Cable Service Providers on the potential cost of the cable termination system (CMTS) required to implement a network infrastructure that will provide an energy requirement proportional to the end user platform data requirement.	No action necessary
17/11/2008	**6**	6.2.	17/09/2008	20	6.2.9 Power circuitry (page 20) MTP assumes that ePSU efficiency improvements will be covered under the ePSU implementing measure	No action necessary
17/11/2008	**6**	6.2.	17/09/2008	22	6.2.11.3 Automatic Power Down. MTP supports this option and notes that it has been successfully deployed in the UK by BSkyB since early 2007. The MTP suggests that the on mode usage scenarios are qualified in the context of more recent usage data available from the European Digital STB Service Providers contributing to the current revision of the EC CoC for Digital TV Service Systems.	No action necessary
30/09/2008	**6**	6.3	17/09/2008	23	The example in section 6.2.11.3 shows that it is possible to introduce automatic power down for complex settop boxes and that the amount of saving is considerable.	No action necessary
30/09/2008	**6**	6.4;	17/09/2008	25	According to experts from industry, power management aspects are assigned the highest improvement potential (table 6-6). However in the section below table 6-6 it is concluded that software aspects are assigned the highest saving potential.	No action necessary: software is one of the "enablers" of power management, so this is not a contradiction
17/11/2008	**6**	6.4.	17/09/2008	25	6.4 Conclusions and summary of task 6 (page26) MTP supports the stakeholder feedback that Improved hard disk drives, power management and system on chip improvements seem to offer the greatest opportunities for power saving in complex STBs.	No action necessary

Date	Task	Sub-section	Commented version's publication date	Page	Comment	Answer / Action
27/10/2008	**7**	-	03/10/2008	-	Comments on task 7 The cost effective saving potentials shown in task 7 are considerable and we are looking forward to see your proposals for implementing measures in task 8. We consider it very important that your proposal includes requirements for a low power standby mode and a power management system to ensure that this mode is used as much as possible. The low power mode could be an active or passive standby mode if only it comply with the requirements in the standby regulation. If low power standby modes are implemented for all complex set-top boxes consumers will get used to the fact that set-top boxes from time to time need to spend a short period of time for updating of software. Most consumers are already familiar to this from updating of computer software. Furthermore manufacturers will be encouraged to develop systems with the lowest possible consumer inconvenience. However, it is important that consumers receive an announcement/warning when they must wait for updating, otherwise they may be worried that something is wrong with the set-top box or the television.	No action necessary
17/11/2008	**7**	7.1	03/10/2008	5	7.1.1.1 Low power standby mode Whilst it is important to encourage low power mode options, consumer participation plays a significant role in the achievement of greater power efficiency. Accordingly, MTP would suggest retention of certain functionalities (see comments on task 6) within this mode to guarantee customer acceptance.	No action necessary
17/11/2008	**7**	7.1	03/10/2008	5	7.1.1.2 Disable automatic recording/rewind functionality (page 5). This rewind feature is likely to be one of the major benefits perceived by a customer when deciding to buy a STB with HDD recording and is designed to overcome the irritation of unpredictable interruptions to viewing. It is likely that only a negligible number of consumers will actively disable this feature and therefore the potential for improvement with this option is negligible.	Disabling features is now calculated as a seperate option in the revised report, taking into account these comments, but notice, that there are STB PVRs on the market, where the manufacturers decided not to implement the rewind functionality at all; so this is in principle an option even when it comes to the STB features as such
17/11/2008	**7**	7.1	03/10/2008	7	7.1.3 Hard-off switch. (page 7) This may not achieve the expected savings – see comments under task 6.	The use pattern of complex STBs was revised and the improvement potential of each options were re-calculated
17/11/2008	**7**	7.1	03/10/2008	9	7.1.5.2 High Definition/advanced codecs (page 9). MTP evidence supports the view that future generations of silicon will be less power hungry.	No action necessary

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17/11/2008	**7**	7.1	03/10/2008	10	7.1.6 Solid state disk (SSD). MTP recognises the long term prospect of using SSD to reduce power consumption. Developments in this area are rapid and some STBs could be employing such technology by the time the tier 2 levels are introduced. Greater emphasis needs to be placed on the short to mid term option of using laptop HDDs instead of desktop HDDs.	Two improvement options: "state of the art 2.5" HDD" and "state of the art 3.5" were added to the analysis
17/11/2008	**7**	7.4.	03/10/2008	37	Table 7-25 overview of BAT option for each Base Case/product case (page 37). This table overstates the potential improvement somewhat due to the following: • The duty (use) cycle in the study underestimates the on-time, • The number of units employing a return path is understated • The benefit from a hard-off switch is overstated as its use by the vast majority of consumers is unlikely in practice. However, the direction and order of magnitude statements remain valid	Assumptions related to the duty cycle, off mode time and market shares of STBs with return path were revised in light of the comments received during the final stakeholder meeting
08/10/2008	**8**	-	not published yet	-	Having studied the issues surrounding passive standby in detail, it would be worth commenting whether the provision of a low power mode is appropriate for the intended use of a complex set-top box, in terms of the future implementing measure for standby and off-mode losses which you originally referred to back in 1.3.1.1.	Please refer to Task 8, section 8.2.4

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